



Farmers' Attitude towards Production and Utilization of Biochar as Ecofriendly Practice

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Authors' contributions

This research study was carried out in collaboration among all authors. Authors MSR and JKB designed the study, gathered review of literature and collected data and wrote the first draft of the research. Author MRK managed the analyses of the study and performed the statistical analysis, wrote the protocol and the manuscript for publication. Author MMI helped in managing the literature and filed level cooperation. All authors read and approved the final manuscript.

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ABSTRACT

The main objective of the study was to determine the farmers' attitude towards production and utilization of biochar as ecofriendly practice. Data were collected through personal interview from 104 randomly selected farmers at Nawabgang Upazila (sub-district) of Dinajpur district in the northern Bangladesh. A pretested and structured interview schedule was used to collect data from the respondents during 15 March to 18 April, 2017. Simple and direct questions with different scales were used to obtain information. Descriptive statistics are used to explain the selected characteristics of the farmers. The co-efficient of correlation (r) test was computed in order to explore the relationships between ten selected characteristics of the farmers and their attitude towards biochar production and utilization as ecofriendly practice. The results indicated that more

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than three-fourths (76.92%) farmers had highly favorable attitude towards biochar production and utilization as eco-friendly practice, while 15.38% moderately favorable attitude and 7.7% had slightly favorable attitude. Correlation coefficient analysis indicated that among 10 characteristics of farmers such as farm size, annual household income, training received, credit received, organizational participation and extension media contact had significant relationships with their attitude toward biochar production and utilization. However, age, education, family size and cosmopolitaness had no significant relationships with their attitude towards production and utilization of biochar as ecofriendly practice. The top ranked problem faced by the farmers in implementing of biochar production and utilization was found on 'lack of woody fuel'. It might be recommended that biochar preparation should be done by using other raw materials such as tree leaves or branches, jute sticks etc available in the locality. Further proper steps should be taken by the concerned authority to maximize extension contact through farm visit, demonstrations and mass media on biochar benefits for enhancing the use of biochar.

Keywords: Farmers; attitude; biochar production; utilization; ecofriendly practice.

1. INTRODUCTION

The prominent challenges of Bangladesh are: (a) high population density that will need increased demand of food and energy; (2) land degradation with low organic matter and (3) vulnerable to climate change effect [1]. The country has 150 million people with a high population density. The government predicts that with a high growth rate 1.59%, the total population will rise to approximately 265 million by 2050, putting increasing pressure on scarce resources (land and forest) for additional demand of food and energy [2]. Agriculture is the leading contributor to Green House Gas (GHG) emission (39% of total emissions in Bangladesh), coming from consisting of the sub-sectors such as rice cultivation (32%), enteric fermentation (31%), manure (12%), and the remainder from other sub-sectors [3]. Energy sector is the second highest emitter (33% of total emission), while biomass fuel combustion is responsible for emitting 21% [4]. It is frequently cited Bangladesh as one of the most vulnerable countries in the world [5,6]. In addition, the country has been suffering extreme natural disaster due to climatic change [7]. Bangladesh's Intended Nationally Determined Contribution (INDC), published in September 2015 and puts forth an unconditional contribution to reduce GHG emissions by 5% within 2030 from existing mitigation actions, such as: improve energy efficiency in production and consumption, renewable energy development, lower emissions from agricultural land and waste as well as afforestation [8]. Biochar seems to be one of the recent technologies that have multiple opportunities to overcome many challenges such as efficient biomass management, fostering renewable energy, eco-friendly agriculture and

mitigating climate change. Biochar is charcoal made from organic residues that are carbonized at temperatures between 450-750°C in the absence of oxygen (pyrolysis). People have known for millennia that the ash and charcoal are good for plant growth [9].

In 2013, Bangladesh Biochar Initiative (BBI) was formulated to foster the use of Biochar producing stove and its end product Biochar for environment friendly cooking mechanism and sustainable agricultural development. Canadian scientist Professor Dr. Julian Winter and CCDB (Christian Commission for Development in Bangladesh) Policy Advisor Md Mahbulul Islam recently invented low cost Natural Draft-Top-Lit-Up-Draft (ND-TLUD) gasifier cooking stove (local name Akha Chula) which is environment and agriculture friendly and can be used for cooking and heating with locally available biomass. The basic operating principle of an ND-TLUD is quite simple and compatible to the women's cooking habits of Bangladesh. The resulting end product of the cooking process is called Biochar [9]. Biochar systems are usually carbon-negative and sequestering carbon dioxide from the atmosphere. It increases the water-holding capacity, pore size and distribution on beneficial microbial communities in the soil. The opportunities of biochar promotion using *Akha Chula* could be written as: a) *Akha Chula*, which produces high heat or renewable energy without smoking and black spots while consuming less time for cooking food materials; and b) both *Akha Chula* and biochar are environmentally friendly, ensuring long term soil fertility and better crop yield [10]. Using the biochar as organic materials in small scale farming will have an immediate impact on household nutrition and income in

Bangladesh. The benefits of organic farming seemed to be environmentally friendly, socially acceptable and helpful for climate change mitigation [11].

An attitude as the degree of positive or negative affect associated with some psychological objects such as symbol, phrase, slogan, person, institution, ideal or ideas towards which people can differ in varying degrees [12]. Attitude is psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor [13]. Empirical research, however, fails to support clear distinctions between thoughts, emotions, and behavioral intentions associated with a particular attitude [14]. Thus some views of attitude structure see the cognitive and behavioral components as derivative of affect or affect and behavior as derivative of underlying beliefs [15]. Attitudes form directly as a result of experience. They may emerge due to direct personal experience, or they may result from observation. Various socioeconomic characteristics of individuals have a strong influence on the variation of attitudes [16]. Therefore, the individual level of attitude is affected by various personal and socio-economic characteristics, those includes personal age, education, training skill, household farm size and annual income [17]; household member or family size [18]; organizational participation [19] and information through extension media [20]. From the view of above discussions, the main objective of the study was: a) to determine and describe some selected characteristics of the farmers; b) to determine farmers' attitude towards biochar production and utilization; c) to explore the relationship between the characteristics of the farmers and their attitude toward production and utilization and d) to determine the problem faced by the farmers in biochar production and utilization as ecofriendly practice.

2. MATERIALS AND METHODS

2.1 Location of the Study

The study was conducted in Daudpur union of Nawabgang Upazila under Dinajpur district in the northern region of Bangladesh. *Santal* and *Orau* tribal people lives in the study area. *Santal* and *Orau* tribal people are very poor with lacking of communication facilities and literacy contributes to low productivity. CCDB recognized that the ethnic communities would be further marginalized if appropriate development interventions are not made. Accordingly, CCDB initiated a biochar program in Nawabgang

Upazila for the development of tribal communities.

2.2 Data Collection, Processing and Statistical Analysis

Data were collected during the period from 15 March to 18 April 2017, using interview schedule from 104 farmers. The interview schedule was pretested with 10 farmers prior to final data collection from the respondents. During pre-testing, farmers cited 12 problems, but 7 problems were kept in the interview schedule as closed from for data collection having citation value more the fifty percent. After data collection, collected data were coded, compiled, tabulated and analyzed. The Statistical Package for Social Science (SPSS) 20.0 computer program was used for analyzing the data. Descriptive statistics such as frequency, number, percentage, mean, standard deviation and rank order was used for categorization and describing the variables. Pearson's Product Moment Correlation Coefficient (r) was used for testing the relationships between the concerned variables. At least 5 percent ($P=0.05$) level of probability was used as a basis for rejection of the null-hypotheses throughout the study.

2.3 Measurement of Selected Characteristics and the Focus Issue 'Attitude'

Ten selected characteristics of the farmers such as age, education, family size, farm size, training received annual household income, credit received, cosmopolitaness, organizational participation, and contact with extension media were measured by appropriate technique. Twelve statements consisting of 6 positive and 6 negative regarding biochar production and utilization were asked to the respondents. The respondents were asked to indicate against each statement whether strongly agree, agree, undecided, disagree and strongly disagree with a corresponding score of 5,4,3,2 and 1 for the positive and vice-versa for the negative statements. The score of a farmers' attitude towards positive and negative statements of biochar production and utilization were computed by summing his responses to all the items. Therefore, scores of the respondents could range from 0 to 60; 0 indicating highly unfavorable attitude and 60 highly favorable attitudes towards biochar production. Attitude Index (AI) and Rank Order (RO) were also estimated towards biochar production and utilization. The scores of individual question

against the statement strongly agreed, agreed, undecided, disagreed and strongly disagreed were computed by summing the all responses would be indicated as Attitude Index (AI). The scores of AI against the 12 questions were arranged with highest scores to lowest scores and distributed as Rank Order (RO) 1 to 12 respectively. The following formula would be followed to calculate AI:

$$\text{Attitude Index (AI) for positive statements} = F_{SA} \times 5 + F_A \times 4 + F_U \times 3 + F_{DA} \times 2 + F_{SD} \times 1$$

Where,

F_{SA} = Frequency of respondents with 'strongly agreed'
 F_A = Frequency of respondents with 'agreed'
 F_U = Frequency of respondents with 'undecided'
 F_{DA} = Frequency of respondents with 'disagreed'
 F_{SD} = Frequency of respondents with 'strongly disagreed'

$$\text{Attitude Index (AI) for negative statements} = F_{SA} \times 1 + F_A \times 2 + F_U \times 3 + F_{DA} \times 4 + F_{SD} \times 5$$

Where,

F_{SA} = Frequency of respondents indicating strongly agree
 F_A = Frequency of respondents indicating agree
 F_U = Frequency of respondents indicating undecided
 F_{DA} = Frequency of respondents indicating disagree
 F_{SD} = Frequency of respondents indicating strongly disagree

Where, the Attitude Index (AI) value could range from 104 to 520. This means that 104 initially less favorable and 520 indicated high attitude towards biochar production and utilization.

2.4 Measurements of Problems in Biochar Production and Utilization

Seven problems were selected faced by the farmers in biochar production and utilization. The respondents were asked to response on four alternatives responses as 'not at all', 'low', 'medium' and 'high' for each of seven selected problems. Scores were assigned to those alternative responses as 0, 1, 2 and 3 respectively. To ascertain the comparison among the problems, Problem Faced Index (PFI) was computed by using the following formula:

$$PFI = N_h \times 3 + N_m \times 2 + N_l \times 1 + N_n \times 0$$

Where,

PFI = Problem Faced Index
 N_h = Number of respondents facing problem 'high' extent
 N_m = Number of respondents facing problem 'medium' extent
 N_l = Number of respondents facing problem 'low' extent
 N_n = Number of respondents facing problem 'not at all'

Thus PFI for a particular problem could range from '0' to '312', while '0' indicating no problem faced and '312' indicating highest problem faced. PFI for all the factors were determined. Finally, a rank order was made on the basis of PFI.

3. RESULTS AND DISCUSSION

3.1 Selected Characteristics of the Farmers

The selected characteristics of farmers were classified into suitable categories for interpretation in relation to the attitude towards biochar production and utilization. The highest proportions (56.7 percent) of the farmers were young followed by 35.6 percent middle aged and 7.7 percent old aged. About 38.5 percent farmers could sign only and 37.5 percent had secondary level education. The family size of the farmers ranged from 2 to 9 and just above half of the farmers 54.8 percent had medium sized family followed by 37.5 percent small family and only 7.7 percent large family. Thus, the majority (92.3 percent) of the farmers had small to medium sized family. The farm size of the farmers ranged from 0.01 to 3.43 hectare and slightly more than half (51.9 percent) of the farmers were under small farm size category followed by 40.4 percent, 6.7 percent and only 1.0 percent under landless, medium and large farm size category respectively. Annual household income of the farmers ranged from 25 to 350 and the majority (78.0 percent) of the farmers had medium income compared to 17 percent of them having high income and only 9 percent had low income. Thus, the huge majority (91.3 percent) of the farmers had medium to high income. Around 45.2 percent farmers had no training compared to 45.2, 7.7 and 1.9 percent having short, mid and long-term training exposure respectively. The credit received scores of the farmers ranged from 0 to 30 thousand BDT (Bangladesh Taka), 55.8

percent of the farmers had no credit received compared to 30.8, 9.6 and 3.8 percent having short, medium and high credit received respectively. Thus, the more than four-fifths (86.6 percent) of the farmers had no to low credit received.

The cosmopolitanism score of the farmers ranged from 1 to 15 and slightly above half portion (51.9 percent) of the farmers had low cosmopolitanism while near 46.2 percent had medium cosmopolitanism and 1.9 percent had high cosmopolitanism. Thus, the overwhelming majority (98.1 percent) of the farmers were in low to medium cosmopolitanism category. Organizational participation score of the farmers ranged from 0 to 6 and slightly above two-thirds portion (68.3 percent) of the farmers had low participation in organization, 26.0 percent medium, 3.8 high and only 1.9 percent had low organizational participation. Thus, overwhelming majority (94.3 percent) of the farmers had low to medium organizational participation. The observed Contact with extension media scores of the farmers ranged from 2 to 26 against the possible range of 0 to 36 and the near about three-fifths proportion (58.7 percent) of the farmers had low contact with extension media as compared to 39.4 and only 1.9 percent having medium and high Contact with extension media respectively. Thus, majority (98.1 percent) of the farmers had low to medium contact with extension media.

3.2 Overall Attitude of Farmers towards Biochar Production and Utilization

Farmers' attitude towards biochar production and utilization for sustainable agriculture scores ranged from 19 to 58 whereas the expected ranged 1 to 60. The mean of farmers was 48.64 with a standard deviation of 5.96. Based on the observed attitude scores, the farmers were classified into three categories as: "slightly favorable" (≤ 20), "moderately favorable" (21-40), "highly favorable" (≥ 41). The distribution of the farmers according to their attitude towards biochar production and utilization has been shown in Table 2. Data presented in Table 2. indicated that more than three-fourths (76.92%) of the farmers had highly favorable attitude towards biochar production and utilization as ecofriendly practice, while 15.38% moderately favorable attitude and only 7.7% had slightly favorable attitude. This is due to that the cooking stove *Akha* is helping healthy environment in kitchen, easy to use through any kind of

biomass, less smoke and less expensive. Ahmed (2013) also found that highest proportion of the farmers had highly favorable attitude in the respective research study [21].

3.3 Rank Order of Attitude Statements towards Biochar Production and Utilization

Data contained in Table 3 revealed that the statements such as "biochar production is smoke free and safe for women and children health" had AI value of 459 as ranked 1st. This is due to that this cooking stove (local name *akha*) is helping healthy environment in kitchen, easy to use through any kind of biomass, less smoke and less expensive. It reduces carbon dioxide during cooking and helping reducing carbon in air (Green House Gas) and mitigating climate change. "Production and utilization of biochar is environment and agriculture friendly" had AI value of 459 and ranked 2. This is due to that this *akha* make clean cooking helping for women and children health. Data contained in Table 3. revealed that the statement "price of *akha* is higher than other cooking stove" and "using biochar can reduce the soil water holding capacity" are the jointly second last ranked statement in the attitude index table having AI value of 382. This is due to preservation of biochar is easy for them.

3.4 Relationship between Selected Characteristics of Farmers and Focus Issue

Pearson's Product Moment Correlation Coefficient 'r' was used to test the null hypothesis concerning the relationship between any two variables. The summary results of test of correlation coefficient are shown in Table 4. Correlation analyses indicated that among ten selected characteristics farm size, annual household income, training received, credit received, organizational participation and contact with extension media of the farmers had positive significant relationships with their attitude biochar production and utilization as ecofriendly practice. It meant that these characteristics significantly affected the farmers' attitude regarding biochar production and utilization. Therefore, these findings were also relevant previous outcome of respective field of study such as training skill, household farm size and annual income [17]; organizational participation [19] and information media [20]. On the other hand, age, education, family size and

Table 1. Categorization of the farmers based on selected characteristics (N=104)

Farmers' characteristics	Scoring method	Range		Categories	Respondents		Mean	SD
		Possible	Observed		No.	%		
Age	No. of year	Unknown	19-70	Young (≤ 35)	59	56.7	35.64	10.71
				Middle aged (36-50)	37	35.6		
				Old (≥ 51)	8	7.7		
Education	Year of schooling	Unknown	0-17	Illiterate (0)	2	1.9	4.92	4.46
				Can sign only (0.5)	40	38.5		
				Primary (1-5)	16	15.4		
				Secondary (6-10)	39	37.5		
				Above SSC (≥ 11)	7	6.7		
Family size	No. of members	Unknown	2-9	Small (≤ 3)	39	37.5	4.20	1.58
				Medium (4-6)	57	54.8		
				Large (≥ 7)	8	7.7		
Farm size	Hectare	Unknown	0.01-3.43	Landless (0.0-0.2)	42	40.4	0.39	0.48
				Small (0.21-1.0)	54	51.9		
				Medium (1.01-3.0)	7	6.7		
				Large (>3.0)	1	1.0		
Annual household income	('000' Tk.)	Unknown	25-350	Low (≤ 58)	9	8.7	128.47	70.47
				Medium (59-198)	78	75.0		
				High (>198)	17	16.3		
Training received	Days	Unknown	0-8	No (0)	47	45.2	1.36	1.59
				Short (≤ 3)	47	45.2		
				Mid-term (4-6)	8	7.7		
				Long-term (≥ 6)	2	1.9		
Credit received	('000' Tk.)	Unknown	0-30	No (0)	58	55.8	4.24	7.23
				Low (≤ 10)	32	30.8		
				Medium (11-20)	10	9.6		
				High (≥ 21)	4	3.8		
Cosmopolitaness	Score	0-18	1-15	Low (≤ 6)	54	51.9	6.07	2.79
				Medium (7-12)	48	46.2		
				High (≥ 13)	2	1.9		
Organizational participation	Score	0-6	0-6	No (0)	2	1.9	1.46	1.03
				Low (≤ 2)	71	68.3		
				Medium (3-4)	27	26.0		
				High (≥ 5)	4	3.8		
Contact with extension media	Score	0-36	2-26	Low (up to 12)	61	58.7	11.81	4.58
				Medium (13-24)	41	39.4		
				High (above 24)	2	1.9		

Table 2. Categorizations of the farmers according to their attitude

Possible	Range		Categories	Respondents (N=104)		Mean	Std. Dev.
	Observed			Number	Percent		
1-60	19-58		Slightly favorable (up to 20)	8	7.7	48.64	5.96
			Moderately favorable (21-40)	16	15.38		
			Highly favorable (above 40)	80	76.92		

Table 3. Rank order of attitude indices towards production and utilization of Biochar

Sl. no.	Statements	Frequency of the Respondents					¹ AI	² RO
		SA	A	NO	DA	SD		
Related to production								
1.(+)	Biochar can be easily produced through the cooking stove Akha	0	3	18	71	12	404	7 th
2.(-)	Price of Akha is higher than other cooking stove	3	67	31	3	0	382	11.5 th
3.(+)	Heat of Akha is more efficient than traditional cooking process	0	0	27	56	21	410	5 th
4.(-)	Temperature control during cooking in Akha is not easy	18	63	21	2	0	409	6 th
5.(+)	Biochar production is smoke free and safe for women and children health	0	2	15	25	62	459	1 st
6.(-)	Production of Biochar is laborious task	18	51	32	3	0	396	9 th
Related to utilization								
7. (+)	Biochar retains soil organic matter for life-long period	2	4	16	38	44	430	3 rd
8. (-)	Biochar is not available enough for using large scale crop field	24	41	37	2	0	399	8 th
9.(+)	Biochar can enhance the yield and quality of crops	0	4	15	51	34	427	4 th
10.(-)	Biochar produced crops are unsafe for human health	8	57	37	2	0	383	10 th
11.(-)	Using Biochar can reduce the soil water holding capacity	4	68	26	6	0	382	11.5 th
12.(+)	Production and utilization of biochar is environment and agriculture friendly	0	3	21	20	60	449	2 nd

Note: SA =Strongly Agree; A = Agree; NO = No Opinion; DA = Disagree and SD = Strongly Disagree; ¹AI = Attitude Index and ²RO = Rank Order

Table 4. Correlation between focus issue and selected characteristics

Focus issue	Selected characteristics	Correlation value of 'r' with 102 df
Attitude of towards biochar production and utilization	Age	-0.159
	Education	0.061
	Family size	-0.007
	Farm size	0.237*
	Annual household income	0.315**
	Training received	0.337**
	Credit received	0.194*
	Cosmopoliteness	0.037
	Organizational participation	0.291*
	Contact with extension media	0.200*

** Correlation is significant at the 0.01 level; and * Correlation is significant at the 0.05 level

Table 5. Rank orders of the problems faced by the farmers

Sl. no.	Problems	Percentage of the farmers				PFI	Rank order
		Not at all	Low	Medium	High		
1.	Lack of woody fuel material	9	6	45	44	228	1 st
2.	Need kerosene oil for initially fire	19	34	34	17	153	3 rd
3.	Lack of Akha Chula in market	28	41	25	10	121	5 th
4.	Storage problem of biochar	55	48	1	0	50	7 th
5.	Lack of information about Akha	27	50	24	3	107	6 th
6.	Time consuming to crushing before use of biochar	3	16	49	36	222	2 nd
7.	Lack of biochar for large scale	24	26	37	17	151	4 th

cosmopolitanism had no significant relationships with their attitude towards biochar production and utilization as ecofriendly practice.

3.5 Problems Faced by Farmers in Biochar Production and Utilization

The distributions of the farmer based on their facing problems are presented in Table 5 along with Problem Facing Index (PFI) and the Rank Order (RO). The PFI in biochar production and utilization ranged from 50 to 228 against the possible range 0 to 312. The data from the research revealed that the highest problem faced by the farmers in biochar production and utilization was found on 'lack of woody fuel' (PFI =228). The result might be due to that most of the farmers are poor and use dry leaves and tree branches in cooking purpose. They cannot use woody fuel because it is costly. The 2nd important highest problem faced by the farmers in biochar production and utilization was found on 'lack of information' (PFI=222). The result might be due to that most of them are poor educated and they cannot get available information from different sources (internet, social media and extension personnel). Lowest proportion of farmers faced problems on 'need kerosene oil for initially fire' (PFI =50).

4. CONCLUSION AND RECOMMENDATIONS

The main aim of the research was to determine the farmers' attitude towards production and utilization of biochar as ecofriendly practice. More than three-fourths of the tribal farmers had highly favorable attitude towards biochar production and utilization for sustainable agriculture. Thus, it meant that farmers are very much enthusiastic and ambitious regarding the statements of biochar production and utilization. The significant characteristics of the farmers contributed to increase the attitude level towards biochar production and utilization. Hence, training received, organizational participation and extension media contact had significant influence on the farmers' attitude towards production and utilization of biochar as ecofriendly practice. Farmers might get more information from different information sources, and increase the attitude towards biochar production and utilization. Training opportunity and organizational participation makes person cosmopolite which ultimately facilitates to gain more knowledge and change the attitude level regarding production and utilization of biochar.

The major problem faced by the farmers in biochar production and utilization was found on 'lack of woody fuel'. It is recommended that that biochar preparation should be done by other raw materials such as tree leaves or branches, jute sticks etc available in the locality. Further proper steps should be taken by the concerned authority to maximize extension media contact on biochar benefits so that farmer's attitude level might be increased to use biochar effectively.

CONSENT

As per international standard, respondents' opinions has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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