Research Journal of Agronomy
MEDWELL PUBLICATIONS

Sustainable Agriculture and its Determinants in Northern Bangladesh

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Key words: Agriculture, sustainability, farmer's perception, sustainability index, determinants, Bangladesh

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Page No.: 17-24
Volume: 12, Issue 3, 2018
ISSN: 1815-9354
Research Journal of Agronomy
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Abstract: The present study is an attempt to examine farmer's perception of sustainable agricultureand its determinants in Northern Bangladesh. Using farm-level survey data, the study measures the knowledge of the farmers toward sustainable agriculture and determines the extent to which different factors influence their perception. By random sampling technique, a total of 100 farmers are selected. The perception of farmers about sustainable agriculture is measured using Likert scale. The sample farmers ranked certain selected sustainable agricultural practices on a 5-point scale basis and the total of these ranksformed the sustainable agriculture perception index. The index scores are calculated for each farmer and aretaken as the dependent variable in the regression analysis model. Descriptive analysis has been done to understand the level of perception of the farmers about sustainable agriculture while the regression analysis enablesus to identify the key determinants of farmer's perception about sustainable agriculture in the study area. Finally, some recommendations are made based on the findings towards enhancing sustainable agriculture in Bangladesh.

INTRODUCTION

Agriculture is one of the most important economic sectors in Bangladesh. Farming is the ancient and the most common profession in the country. The country has atotal population of about 160 millions, population density of 1174 persons per square kilometer and population growth rate of 1.37% per year (BBS., 2011, 2012a, b; Hasan *et al.*, 2013). The country has 8.52 million hectares of cultivable land with 15.18 million farm holdings and 28.52 million farmer families (BBS., 2012a, b). Cultivable land per person in Bangladesh is only 0.05 ha, equivalent to 0.125 acre (BBS., 2012a, b; Hasan *et al*., 2013, World Bank, 2014). However, high population growth rate has been further decreasing this lower per capita cultivable land with excess demand for land for settlements, roads, industry and other infrastructural developments (Rasul and Thapa, 2004). Over the last 30-40 years, the cultivable land in Bangladesh has been decreasing by around 1% and has been getting fragmented because of sharing it into growing population. Large population size and low per capita cultivable land have been compelling farmers towards intensive agricultural practices to meet additional food demand for growing population which has made Bangladesh agriculture morerisky in the context of sustainability (Rasul and Thapa, 2004). Bangladesh agriculture has been changed rapidly after the introduction

of green revolution technology in 1960s and after its Liberation War in 1971 (Pinstrup-Andersen and Hazell, 1985; Hossain, 1998; MoA., 2006; Faroque *et al*., 2011). Crop productivity has increased due to new technologies, mechanization, application of chemical fertilizer and pesticide, use of irrigation and adoption of modern and high yielding crop varieties, HYVs (Faroque *et al*., 2011). As a result of intensified agricultural practices, food grain production in the country has been increased by manifold and the country has introduced herself in the world as self sufficientin food (rice) grain production (MoA., 2006; Faroque *et al.* 2011). Although, these rapid changes in agriculture have many sound effects on the economy and on the standard of living of the people, these changes have posed some harmful effects on the environment, society, human health and finally, on economy as intensified agriculture totally ignores the aspects of environment, biodiversity, human health, soil fertility and soil organism (Hossain, 1988; MoA., 2006; Faroque *et al*., 2011; Pingali, 2012). The world is now worried about intensive agricultural practices and its negative consequences on the environment, natural resources and agriculture sustainability. Environmentalists, ecologists, policy makers, farmers and public are concerned as to situation of soil degradation, soil erosion, water pollution, declining ground water tables, excessive use of chemical fertilizer and pesticide, destruction of natural habitats for wild life and insects and pest resistance against insecticides and pesticides (Leeuwis and van den Ban, 2004; Al-Subaiee *et al*., 2005; Sadati *et al*., 2010). Therefore, due to negative impacts of intensive agricultural activities, sustainable agriculture that would mitigate food demand for both present and future generations has been proved as most important challenge of the 21st century (Quamar, 2002; Rasul and Thapa, 2004; Leeuwis and van den Ban, 2004). The objective of this study, therefore is to assess farmer's perception of sustainable agricultural practices and to estimate its determinants in the case of Northern Bangladesh.

Literature review: Agriculture is the main source of livelihood for animal and people. Unsystematic and unscientific agricultural practices have been making agriculture more unsustainable. But to ensure economic profitability, environmental health and social and economic equity sustainable agriculture is essential. There are extensive studies in the field of sustainable agriculture around the world. Some studies are synthesized in this study.

Hosseini *et al*. (2011) analyzed the socio-economic determinants of sustainable agriculture in Iran. They applied correlation and regression analysis techniques to estimate the effects of economic and social factors on farmer's perception of sustainable agriculture. The regression analysis found that economic and policy making factors explain 19% of variance on the perception of farmers on sustainable agriculture. In addition, the result found that extension and education factors also affect farmer's perception. The study concluded that farmers have not clear understanding about the methods of sustainable agriculture and hence, more training and education should provide to farmers about the role of factors that promote sustainable agriculture. Sadati *et al*. (2010) studied the attitude and perceptions of farmer's towards sustainable agriculture and estimated the effect of factors affecting their perceptions in Iran. They found that 73.4% of respondents have moderate perceptions as regard to sustainable agriculture. The results of the study revealed that there is positive correlation between literacy rate, agriculture extension services, off-farm income, training, level of sustainable agriculture system, job satisfaction and farmer's perceptions about sustainable agriculture. On the other hand, negative correlation exists between age of farmers, experience, size of family, cultivable land and farmer's perception about sustainable agriculture. Regression results of the study showed that 'farmers' perceptions on sustainable agriculture', 'job satisfaction and 'literacy rate' are effective factors on farmer's attitude towards sustainable agriculture.

Tatlidil *et al*. (2009) assessed farmer's perceptions towards sustainable agriculture and explored the effects of socio-economic factors on farmer's perception of sustainable agriculture. They used 21 selected sustainable agricultural practices to understand the farmer's perception about sustainable agriculture. They calculated sustainable agriculture perception index using five points Likert scale and used the index as the dependent variable in the multiple regression model. The results of the study indicated that the higher the 'education level of farmer's, 'agriculture extension contracts', 'ownership of land' and 'access to information' the greater the perceptions of farmers towards sustainable agriculture practices. The study suggested policy makers and extension organizations to concentrate more on those factors which help farmers achieving more knowledge about sustainable agricultural practices. Rasul and Thapa (2004) measured the sustainability of conventional agriculture system in Bangladesh. They examined the sustainability of conventional and ecological agricultural production system in terms of environmental soundness, economic viability and social acceptability to compare between them. They used twelve indicators to imagine the sustainability of Bangladesh agriculture. The study found significant variations between two production systems, especially, in crop diversification, management of soil fertility, management of pests and diseases and use of agro-chemical. On the other hand, no significant variations were found in land use pattern, yield of crop and its stability, risk and uncertainties and food security. The study also found that ecological agriculture has a tendency towards becoming more environment-friendly, economically and socially sound than conventional agriculture system as it use less chemical inputs and more organic matter to soil.

Bosshaq *et al*. (2013) studied the determinants of sustainable agricultural system in Minudashat region of Iran. The results of the study showed that ecological, economic and social participation factors play vital role in the sustainability of agricultural system. Gomes *et al*. (2008) applied DEA Model to assess the agriculture sustainability that depends on the maintenance of production systems for long periods of time. Therefore, the model was run for the periods of 1986 and 2002. Non parametric regression models were used to identify the factors affecting the efficiency of sustainability. The results of the study indicated that most of the farmers increased the efficiency of agriculture sustainability along time. Roy *et al*. (2013) examined the indicators for sustainable rice farming in Bangladesh. They used a set of economic indicators, social and environment dimensions. The study found that social indicators play more significant contribution to promote rice farming sustainability in Bangladesh.

Dale and Polaskyb (2007) investigated the environmental impacts of agricultural practices in USA. They found that agricultural practices affect ecosystem services such as water quality, pollination, soil preservation, carbon sequestration, nutrient cycling and biodiversity conservation and in turn, ecosystem services affect agricultural productivity. Zhen *et al*. (2005) explored the current pressure on production resources such as land and water in China. The study assessed economic, environmental and social aspects of crop production methods using selected indicators. The results of the study found that all crop production methods in the study area are economically viable. However, such improvement in agriculture has generated some cost to environment, natural resources and human health. They found that environmental degradation in China has been originating through ground water depletion, soil compaction and salinization, contamination in groundwater, loss of insects and pest where as health problems have been originated through the contamination of agro-products and farmer's sickness. The study also revealed that only 6% study farmers follow the recommendations of the corresponding agents for balanced input use.

MATERIALS AND METHODS

Study area and data collection: The present study is based on primary data collected directly from the farmers of Rajshahi district. A total of 100 farmers were selected randomly and interviewed using a structured questionnaire. From Rajshahi district Paba Upazila was selected at first purposively. From Paba Upazila two unions were selected randomly and from the two unions four villages were selected again at random basis. From each village 25 farmers were interviewed and during the interview, farmer's knowledge and perceptions were assessed using their opinions on 23 sustainable agricultural practices or sustainability statements. The practices and statements that are consistent to Bangladesh agriculture were chosen from earlier literature such as Tatlidil *et al*. (2009), Sadati *et al*. (2010) and Hosseini *et al*. (2011).

The model: The statistical tools such as five point Likert scale and multiple regression model are used in this study to assess farmer's perceptions of sustainable agriculture and to identify the effects of different socio-economic and farm level factors on farmer's perception of sustainable agriculture.

Development of sustainability index: Five points Likert scale has been used to assess the farmer's perception about sustainable agriculture whereas influence of socio-economic and farm level characteristics on farmers perception has been estimated through OLS regression analysis technique. Five point Likert scale has ranged from 1 = strongly disagree to 5 = strongly agree. The farmers were asked to rate each item as 1 = strongly disagree or 2 = slightly agree or 3 = moderately agree or 4 = highly agree or 5 = strongly agree. If respondent assign the maximum rating of 5 to every practice or statement, the respondent assumed to have maximum perception of sustainability (5×23 = 115). On the other hand, if a respondent assign the minimum rating of 1 to every practice or statement, the respondent assumed to have lowest perception of sustainability (1×23 = 23). Therefore, the perception value would lie in between 23-115. Rahman (2005) constructed perception index of the farmers about the impact of the use of technologies in agriculture where he has used a weighted index for perception. Following Rahman (2005), the adapted version of agricultural sustainability index used for this study is as follows:

$$SI_k = \sum_{i=1}^{23} \sum_{j=1}^{5} M_i N_j \quad (1)$$

Where:

SI_k = To sustainability index for the kth farmer

M_i = The opinion of the kth farmer on ith sustainable agricultural practices or sustainability statements

A value of 1 is assigned for each sustainable agricultural practices or sustainability statements where the farmer is aware of the indicators and 0 otherwise. N_j is the level of awareness of the kth farmer about a certain sustainable agricultural practice or statement based on 5 point Likert scale (very low, low, moderate, high, very high). A rate of 1 is assigned for very low awareness and 5 for very high awareness (Rahman, 2005). The higher value of the index indicates the positive idea about sustainable agriculture concept and very lower value of

the index indicates the ignorance about sustainable agricultural practices (Sadati *et al*., 2010). Average perception of farmer's about sustainable agriculture is estimated using simple arithmetic mean and average sustainability perception per sustainable agricultural practices or sustainability statements is estimated by simply dividing the total value of the index by total number of practices or statements.

Farmers are usually found to contain low, moderate or high perception about sustainability issues of agriculture. Thus, classification of farmers has been done based on their level of perception as to sustainable agriculture using interval standard deviation from mean followed by Sadati *et al*. (2010):

- p = very low: min≤p< (mean-standard deviation)
- q = low: (mean-standard deviation)≤q<mean
- r = moderate: mean≤r<(mean+standard deviation)
- s = high: (mean+standard deviation)≤s≤max

Using these intervals farmer's perception about sustainable agriculture was categorized into four groups as vary low, low, moderate and high.

Regression model: It is generally believed that farmer's perception about sustainable agriculture expressed by the sustainability index estimated using equation 1is influenced by many socioeconomic and farm level characteristics of the farm households. Tatlidil *et al*. (2009) holds that age, experience, education, family size, extension contacts, media exposure and farm size influence the perception level of the farmers about sustainability practices and issues of agriculture. Hosseini *et al*. (2011) suggested age, sex and farming experience of the farmers to be the main determinants of perception while Sadati *et al*. (2010) considered age, sex, education, farming experience, total off farm income, agriculture extension visits, total cultivable land and family size to be the main determinants of farmer's perception of sustainable agriculture. Thus, to examine the determinants of farmer's perception about sustainable agriculture, a multiple regression model was applied and a total of eleven explanatory variables were used to explain farmer's awareness about sustainable agriculture which was selected based on abovementioned literature. In addition, sustainability index, calculated using Eq. 1 was used as the dependent variable in the regression model. The regression model thus takes the following form:

$$SI = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11}+\mu_i \quad (2)$$

Where:

SI = Perception index of farmers about sustainable agriculture
X_1 = Age of farmer
X_2 = Farming experience
X_3 = Education level of farmer
X_4 = Total off farm income
X_5 = Agriculture extension visit
X_6 = Farm size
X_7 = Family size
X_8 = Land ownership
X_9 = Reading news paper
X_{10} = Watching television
X_{11} = Training received

Measurement of dependant and independent variables: The measurement units of all variables are not same because of having different categories of variables. The dependent variable is farmer's perception index of sustainable agriculture with a lower value of 23 and higher value of 115. The explanatory variables are the age, sex, experience, education level, total off farm income, agriculture extension visits, farm size, family size, land ownership, reading news paper, watching television. Table 1 lists definitions of the variables and measurement methods.

Table 1: Measurement of variables used in regression model

Variables	Types	Unit of measurement	Previous studies
Perception index of farmers (SI)	Continuous		Tatlidil *et al.* (2009), Sadati *et al*. (2010) and Hosseini *et al.* (2011)
Age of farmer (X_1)	Continuous	Year	Tatlidil *et al.* (2009), Sadati *et al*. (2010) and Hosseini *et al.* (2011)
Farming experience (X_2)	Continuous	Year	Tatlidil *et al.* (2009), Sadati *et al*. (2010) and Hosseini *et al.* (2011)
Education of farmer (X_3)	Continuous	Years of schooling	Tatlidil *et al*. (2009) and Sadati *et al*. (2010)
Total off farm income (X_4)	Continuous	Taka	Tatlidil *et al.* (2009) and Sadati *et al*. (2010)
Agriculture extension visit (X_5)	Continuous	Number of visits in a year	Tatlidil *et al*. (2009) and Sadati *et al*. (2010)
Farm size (X_6)	Continuous	In big ha	Tatlidil *et al*. (2009) and Sadati *et al*. (2010)
Family size (X_7)	Continuous	In number of person	Tatlidil *et al*. (2009) and Sadati *et al*. (2010)
Land ownership (X_8)	Dummy	Own land = 1; 0 otherwise	Tatlidil *et al*. (2009)
Reading newspaper (X_9)	Dummy	Several times a month = 1; 0 otherwise	Tatlidil *et al.* (2009)
Watching television (X_{10})	Dummy	At least 5 h a week = 1; 0 otherwise	Tatlidil *et al*. (2009)
Training received (X_{11})	Dummy	1 = yes, 0 = no	Tatlidil *et al*. (2009)

RESULTS AND DISCUSSION

Descriptive statistics of the variables used in regression model: Table 2 presents descriptions of the socio-economic characteristics and the variables used in regression model. The perception of farmers about agricultural sustainability ranged from 23-115 and the mean perception was found to 66.67 in the study area. The average age of the respondents was 43.60 years where as the average farming experience of them was 22.28 years. Table 2 shows that the average education of farmers in the study area was only 5.47 years of schooling. The average family size of the farmers was 5.20 persons per family and annual average off farm income was Tk. 84157. The average size of farm to each farmer was equal to 5.62 big ha. Majority of the farmers were landowner (78%). The average agriculture extension visits in the study area was 2.42 per year. Most of the farmers (66%) in study area did not read news paper where as 84% farmers watched television at least 5 h a week. Table 2 also shows that only 30% respondents have received training on agricultural issues.

Description and ranking of sustainable agricultural practices or sustainability statements: Farmers were asked to rate 23 sustainable agricultural practices and statements separately for calculating the level of perception about sustainable agriculture. Based on the imposed rate, calculated level of perception of the selected sustainable agricultural practices and statements are shown in Table 3. It is assumed that application of organic and animal fertilizer in soil increases its fertility which in turn increases crop productivity. Therefore, organic and animal fertilizers are most important inputs of sustainable agriculture. Farmers in the study area are asked whether organic and animal fertilizer increase soil fertility. Calculating result using sustainability index shows that mean value of perception by farmers of this statement is 4.22 (rank 1). This result indicates that farmers in the study area are aware about using organic and animal fertilizer in their land to increase the productivity or keep previous productivity level of their land. It is also known to all that green fertilizer increase soil fertility and land productivity. The farmers are aware about the using of this input and from Table 3 it is observed that they had moderate perception level (rank 3) to this statement.

Intensive irrigation reduces both surface water availability and ground water table which are barriers to the way of keeping sustainable agriculture. Calculated results shows that the mean value of perception index of 'intensive irrigation reduce surface water availability' is 3.61 (rank 4th). This result means that farmers have moderate perception about the importance of surface water availability in keeping sustainable agriculture. On the other hand, the mean value of perception index 'intensive irrigation reduce ground water table' is 3.47 (rank 7th) indicating lower level of perception.

Most often farmers sell their agricultural commodities to middle man which reduces their profits. If farmers set up marketing cooperatives, they would able to sell their commodities to final consumers directly which would ultimately increase their income. With more income farmers would contribute more to sustainable agriculture. The farmers in the study area are asked whether personal involvement in commodity marketing is helpful for agriculture, in response, farmers rank this statement as 5th importance. Effective extension contacts with farmers increase their knowledge about agricultural production system which helps them to take proper decision and measures when they face problems in growing crops. Table 3 shows that farmers rank'effective extension contract's as the 6th indicators of sustainable agriculture.

Nowadays, farmers are found to use chemical fertilizer and pesticide in agriculture in discriminately which harms environment and soil at a large extent. Farmers in the study area rank this agricultural practice as the 8th important factor. Farmers were also rank

Table 2: Descriptive statistics of the variables used in regression model

	Continuous variable		Categorical variables	
Variables of the regression model	Mean	SD	Percentage	-
Perception index	66.67	9.59	-	-
Age of farmers (year)	43.60	11.97	-	-
Farming experience (year)	22.28	12.57	-	-
Education (years of schooling)	5.47	4.72	-	-
Total off farm income (in Tk.)	84157	61100.7	-	-
Extension contacts (No. of visits in a year)	2.42	2.10	-	-
Farm size (in big ha)	5.62	3.87	-	-
Family size (total persons in family)	5.20	2.24	-	-
Land ownership type (1 = own land, 0 = otherwise)	-	-	1 = 78	0 = 22
Reading newspaper (several times a month = 1, 0 otherwise)	-	-	1 = 34	0 = 66
Watching television (at least 5 h. a week = 1, 0 otherwise)	-	-	1 = 84	0 = 16
Training received (if received in five years = 1,0 otherwise)	-	-	1 = 30	0 = 70

Table 3: Sustainability indicators and statements

Sustainable indicators/Statements	Mean	SD	CV	Rank
Organic and animal fertilizer increase soil fertility	4.22	0.71	0.17	1
Increased crop productivity is due mainly to increased use of seeds	3.92	0.73	0.19	2
Green manure increase soil fertility	3.73	1.05	0.28	3
Intensive irrigation reduce surface water availability (irrigation efficiency)	3.61	1.06	0.29	4
Personal involvement in commodity marketing is helpful for agriculture (profitability)	3.59	1.48	0.41	5
Effective extension contacts is helpful for agricultural development	3.54	1.01	0.29	6
Intensive irrigation reduce ground water table (irrigation efficiency)	3.47	1.13	0.33	7
Indiscriminate use of pesticides is harmful for environment and soil	3.46	1.22	0.40	8
Use of high doses of chemical fertilizer and pesticides harm crops	3.31	1.12	0.34	9
Proper use of chemical fertilizer and pesticides do not harm soil fertility and environment	3.16	1.28	0.40	10
Indiscriminate use of fertilizer and pesticides is harmful human health	3.06	1.22	0.40	11
Crop diversification at farm level increase farm income	3.02	1.13	0.34	12
Mixed cropping increase land fertility and farm productivity	2.79	1.51	0.54	13
Crop rotation and diversification reduce farm pest and crop disease	2.65	1.41	0.53	14
Growing cover crop (pulse, etc.) increase soil fertility	2.39	1.53	0.64	15
During farming people try to reduce environmental damage	2.38	1.62	0.68	16
Fragmentation of farm land reduce crop production	2.35	1.25	0.53	17
Intensive agricultural practice reduce water holding capacity of the soil	2.35	1.46	0.62	18
Use of modern machineries in agriculture increase productivity	2.22	1.78	0.80	19
Intensive agricultural practices erodes soil surface	2.16	1.21	0.56	20
Soil test should carry out to keep soil fertility	1.96	1.28	0.66	21
Burning residues on the land after harvest harm soil organism	1.82	1.35	0.74	22
Soil is getting toxic due to use of chemical fertilizer and pesticides	1.51	0.75	0.50	23

'chemical fertilizer and pesticides do not harm soil fertility and environment' as 10th statement among 23 practices or statements. Sometimes farmers are also found to use of high doses of chemical fertilizer and pesticides in their land to increase productivity without considering recommended doses that should use. Farmers rate the statement of 'excess use of chemical fertilizer and pesticides harm crops and farmer's as 9th important factor. Indiscriminate use of chemical fertilizer and pesticides not only harm environment and soil quality but also harm human health directly and indirectly. Farmers in the study area rate this statement as 11th statement.

Mixed cropping, crop rotation and diversification increase land fertility and productivity and decrease crop pest and diseases. Crop diversification also increases farm income. Thus mixed cropping, crop rotation and diversification are essential practices of sustainable agriculture. From Table 3 it is found that farmers give 12th rank to the statement of 'crop diversification increase farm income'. Again, they give 13th rank to 'mixed crop increase land fertility and farm productivity' and 14th rank to 'crop rotation and diversification reduce farm pest and crop disease'.

Growing cover crop is useful for keeping or increasing the fertility of land, keeping moisture of land, lessening soil erosion, etc. They also reduce mineral leaching and compaction and suppress perennial and winter annual weed growth. The top growth adds organic matter when it is tilled into the land soil. The cover crop's root system also provides organic matter and opens passageways that help improve air and water movement in the soil. However, from Table 3 it is found that the perception of farmers about this sustainable agricultural practice is not satisfactory, since, they gave 15th rank to this practice. Fragmentation of land is a common agricultural phenomenon in Bangladesh which is a constraint to efficient crop production and agricultural modernization. In addition, management, supervision of scattered plots is more difficult, time consuming and costly. Thus, land fragmentation harms crop productivity. From Table 3 it is observed that farmers has given 17th rank to this phenomenon which reflects the lack of awareness of farmers about sustainable agricultural.

Intensive agricultural practice such as more irrigation, use of more chemical fertilizer and pesticides etc. reduce water holding capacity of the soil, erodes soil surface and increase soil toxicity. Therefore, soil test should carry out to keep soil fertility and grow healthy agricultural commodities.

However, Table 3 indicates that farmers give 18th rank to 'intensive agricultural practice reduce water holding capacity of the soil', 20th rank to 'intensive agricultural practices erodes soil surface' and 21th ranked to 'soil test should carry out to keep soil fertility' which mean that farmers have lower knowledge about these sustainable agricultural practices. Use of modern machineries in agriculture increases productivity. Farmers are asked about this statement and they gave 19th rank to this statement. Burning crop residues after harvesting is a problem for sustainable agriculture. Many farmers burn the residues in their fields because some farmers believe that burned residues require less labor. However, modern

agriculture does not consider that this practice is useful for agriculture, since, fire kills many beneficial soil microorganisms which lower organic matter and yields, reduce soil infiltration capacity and promote soil erosion. In is surprising that most of the farmers in the study area do not know about the harmful sides of burning residues in agricultural land. From Table 3, it is found that the farmers rank this practice as 22th practice. Soil is getting toxic due to use of chemical fertilizer and pesticides. Farmers give 23th rank to this statement.

Classification of farmers based on their perception level: The result of the study showed that 22% farmers have very low level of knowledge about sustainable agriculture whereas 38% respondents have low level of perception.

Table 4 also shows that 28% respondents have moderate perception and only 12% respondents have high perception towards the sustainability of agriculture.

Results of regression model: To identify the factors influencing the perception of farmer's about the sustainable agriculture in the study area the specified multiple regression model (Eq. 2) has been estimated. The OLS estimates of coefficients of the explanatory variables on 'perception index of farmer's of Paba Upazila of Rajshahi district are presented in Table 5. The final results show that the age, experience, education, farm size and extension visits are significant factors influencing farmer's perception of sustainable agriculture with 'age' and 'family size' having a negative influence while experience, education and extension visits have the expected positive influence on perception. It might be surprising that age of the owners has negative impact on perception. This result could be explained by the fact that farming decision, farm management capacity etc. of farmers decline due to increase in the age of the farmers. It is also appeared from Table 3 that family size has negative impact on perception of farmers about sustainable agriculture. It might be the farmers who have more members in his family are less concentrated to their land to produce crops scientifically.

From Table 5 it is found that experience, education and agriculture extension visits have positive effect on farmer's perception of sustainable agriculture. It might be more educated and experienced farmers are more aware about environment, biodiversity, human health, soil fertility and soil organism.

Major findings: From the analysis it is found that average perception score of farmers about sustainable agriculture is 63.14 and indicator wise average perception is 2.87 which is very low. This is almost similar to the findings of Tatlidil *et al*. (2009 in the case of Turkey (2.84). This finding is consistent considering the level of education of the farmers, lack of environmental education and lack of media exposure and trainings opportunities of farmers in the rural area. Farmers are found to have less perception about some issues of sustainable agriculture such as soil toxicity, residue management, soil organism, soil erosion, water holding capacity of soil, testing of soil etc. From regression result it is found that age, experience and education of farmers, farm size and extension contacts have significant influence on farmers perception about sustainable agriculture. While age of farmer and farm size have negative effects, farming experience, education level and extension contacts have positive effects on farmers perception about sustainable agriculture. Interestingly, television watching, newspaper reading and training could appear to be significant determinant of farmer's perception of sustainable agriculture.

Table 4: Classification of farmers based on their perception level

Range of perception	Total (%)	Cumulative (%)
Very low (p)	22	22
Low (q)	38	60
Moderate (r)	28	88
High (s)	12	100

p = very low; min≤p<(mean-standard deviation); q = low; (mean-standard deviation)≤q<mean; r = moderate: mean≤r<(mean+standard deviation); s = high: (mean+standard deviation)≤s≤max

Table 5: Regression results

Variables	B	SE	β	t-values	p-values	VIF
Constant	68.788	7.809	-	8.809	0.000	-
Age	-0.162	0.088	-0.202	-1.841	0.073	6.501
Experience	0.248	0.066	0.325	3.758	0.001	6.624
Education	0.128	0.055	0.063	2.327	0.025	1.689
Total off income	-7.64E-07	0.000	-0.009	-0.047	0.962	1.663
Extension Visit	0.089	0.015	0.029	5.933	0.000	1.252
Farm area	-0.692	0.411	-0.279	-1.684	0.099	1.474
Family size	-0.159	0.751	-0.037	-0.212	0.833	1.442
Land ownership	0.056	3.261	0.003	0.017	0.987	1.180
Reading news paper	-3.792	3.63	-0.199	-1.045	0.303	1.700
Watching television	-0.122	0.437	-0.039	-0.279	0.782	1.337
Training	2.94	3.589	0.140	0.819	0.418	1.371

R^2 = 0.16; Adjusted R^2 = -0.023; Durbin Watson = 1.496

CONCLUSION

Sustainable agriculture is the production of crops or other plants or animal products using farming techniques that protect the environment, public health, human communities and animal welfare. This form of agriculture enables us to produce healthful food without compromising future generation's ability to produce the same. However, the whole world is now worried about intensive agricultural practices and its negative consequences on the environment, natural resources and long run agriculture sustainability as intensified agriculture totally ignores the aspects of environment, biodiversity, human health, soil fertility, soil organism. Therefore, the government and non-government organization should come forward to increase awareness of people about sustainable agriculture.

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