FARMERS' PERCEPTION OF INTEGRATED SOIL FERTILITY AND NUTRIENT MANAGEMENT FOR SUSTAINABLE CROP PRODUCTION: A STUDY OF RURAL AREAS IN BANGLADESH

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Abstract

This study aimed to determine farmers' perception of integrated soil fertility and nutrient management for sustainable crop production. Integrated soil fertility (ISF) and nutrient management (NM) is an advanced approach to maintain soil fertility and to enhance crop productivity. A total number of 120 farmers from eight villages in four districts of Bangladesh were selected using a stratified random sampling method and data were collected from each farmer through personal interviews. Five point, Likert-type response scales were used to measure farmers' perception of the issues. The findings of different categories of farmers indicated that landless, marginal and small farmers had a low level of awareness when compared with medium and large farm holders. The overall perception of farmers in the study areas revealed that a significant proportion (78%) had either a low or a very low level of perception while 22% had a medium to high level of perception. Findings from individual interviews with farmers indicated that they perceived themselves as having a low perception of preparation of farm yard manure and the role of organic matter as well as the beneficial aspect of ISF and NM for sustainable crop production. Among the nine characteristics of farmers, four characteristics- education level, farming experience, farm size and communication exposure influenced farmers positively. However, two characteristics- family size and fertilizer use negatively influenced farmers' perception of ISF and NM for sustainable crop production.

Introduction

Some three quarters of the world's absolute poor live in rural areas, and their livelihoods are most often linked to agriculture. Like other developing countries, the economy of Bangladesh draws its main strength from agriculture because of the potentiality to produce multiplier effects on the growth of other sectors of the economy. It is the principal source of livelihood for most of the poor and has a key role in building their household food security. While the country's economy is progressively diversifying, agriculture still contributes 24 percent of the Gross Domestic Product, employs 66 percent of the workforce and accounts for roughly 15 percent of export earnings (Bangladesh Bureau of Statistics [BBS], 2003). Despite increases in shares of fisheries, forestry and livestock, traditional crops alone account for 70 percent share of agricultural output (Ministry of Agriculture [MOA], 2003). Thus, crop production remains central to the country's agriculture. Growth in crop production, especially the production of food grains shaped the performance of the agriculture sector over the last three decades; however, a gap still exists between total food production and the total food requirements of the country. Hence, the Government of Bangladesh has to import about one million metric tons of food grains, mainly rice and wheat in each fiscal year to fulfill the gap (MOA).

Integrated soil fertility and nutrient management is an alternative to maintain soil fertility and to enhance crop productivity. Although it is an age-old practice, its importance was not very much realized in the pre-green revolution era due to the low nutrient demand of the existing subsistence agriculture in Bangladesh. This approach aims for efficient and judicious use of all the major sources of

plant nutrients in an integrated manner, so as to maintain and improve the soil's organic matter for sustained crop productivity. This is all done without any deleterious effect on the physico-chemical and biological properties of the soil on a long term basis (Gruhn, Francesco, & Montague, 2000). The major components of integrated soil fertility and nutrient management system are fertilizers, farmyard manure/compost, green manure, crop residues/recyclable wastes and bio-fertilizers. These components possess great diversity in terms of chemical and physical properties, nutrient release efficiencies, positional availability, and crop specificity and farmers' acceptability (Food and Agriculture Organizations of the United Nations [FAO], 1998).

Integrated management of soil fertility and plant nutrients is an important prerequisite for boosting up crop production and sustaining higher yield over a period of time. Future strategies for increasing agricultural production will have to focus on using available natural resources more efficiently, effectively and sustainably than in the past (Gruhn et al., 2000). Since there is no scope to increase the net cultivable land, intensive cropping through integrated soil fertility and nutrient management could be one of the important means to further increase of crop production in Bangladesh (FAO, 2004). This system helps farmers to make a decision regarding proper way of farm management which enhances high crop yields and improves the soil fertility in the long run. Assessing farmers' perceptions is an important means to evaluate their knowledge level on a particular issue, as perception refers to an individual's current appraisal of an object or program (Hikson and Keith, 2000). May (1969) concludes that people base their perceptions on past experience and knowledge; therefore, if a person has limited knowledge and experience about a topic, then they can not accurately perceive it or form an opinion on it. Therefore, this study is thought to be a timely one to investigate farmers' perception of integrated soil fertility (ISF) and nutrient management (NM) systems for sustainable crop production so that it might be helpful to the concerned policy makers to have the field level idea during their policy makings.

Review of Previous Research

Some research has been conducted about perception, including issues related to sustainable agriculture such as environment, soil conservation, information sources, and involvement of agricultural courses at secondary level of education and higher. To date, very little research has been formulated to determine farmers' perception of sustainable crop production. Williams and Wise (1997) reported that agricultural teachers perceived themselves as having additional things to learn about sustainable agriculture practices and students rated themselves as only knowing a little about them. Bruening, Radhakrishma, and Rollins (1992) maintained that farmers who had more than a high school education perceived water pollution, manure mismanagement, and nutrient mismanagement as more serious environmental issues than those farmers who had not completed high school. Ahmed, Karablieh, and Al-Kadi (2004) argued that higher perception ratings were observed for those who utilize more sources of information and preferred group extension. Duncan (2004) reported that the secondary educators either agreed or strongly agreed that the agricultural training program will contribute to students' success in the agriculture industry and that the program offers a valuable educational experience for students. Moore (1988) concluded that according to teacher educators, a myriad of factors, such as social stratification, political instability, transportation, and national education policies appear to be the responsible for the agricultural and educational development problems. To date, however, no research has identified the farmers' perception of ISF and NM for sustainable crop production.

Purpose and Objectives

The purpose of the study, therefore, was to determine farmers' perception of ISF and NM systems. The specific objectives of the study were: 1) to assess farmers' perception of ISF and NM for sustainable crop

production of rural areas in Bangladesh; 2) to ascertain selected individual characteristics of farmers; and 3) to describe the individual characteristics of farmers that may influence on their perceptions about ISF and NM.

Methods and Procedures

Study area, Population and Sample

The study was conducted in eight villages of the following districts: Mymensingh, Jamalpur, Sherpur and Netrokona in Bangladesh (Table 1).

The average cropping intensity of the study areas is 218%, i.e. the farmers of the study areas cultivate their lands intensively (more than 2 times in a year). Intensive cultivation needs proper management of soil, plant nutrients and other production factors to obtain better yields and to maintain soil fertility (FAO, 1998). However, according to BBS (2003) the yield of different agricultural crops remained stagnant or getting reduced since few years of the areas. Besides, soil fertility of the areas is declining gradually (Bangladesh Agricultural Research Council [BARC], 1999).

Table 1
Distribution of Farmers According to Their Location and Sample Size

Name of Districts	No. of Villages	Sample size obtained					Total sample
		Landless	Marginal	Small	Medium	Large	
Mymensingh	2	10	10	5	5	2	32
Jamalpur	2	10	9	5	5	2	31
Sherpur	2	10	8	5	5	2	30
Netrokona	2	9	7	4	5	2	27
Total	8	39 [35]	34 [30]	19 [15]	20 [16]	8 [4]	120 [100]

Note. Figures in parenthesis indicate the percentage of different categories of farmers in the study areas. Source: BBS, 2003

The Department of Agricultural Extension (DAE) and other agricultural organizations identified that improper management of soil fertility and plant nutrients is one of the important reasons for stagnating/reducing the yield of different crops as well as declining soil fertility in the study areas. However, 598 farmers from 494 farm families in eight villages were considered as the population of this study. About twenty percent of total population i.e. 120 farmers (39 landless, 34 marginal, 19 small, 20 medium and 8 large) from these farm families were selected using the stratified random sampling based on their own farm size which constituted the sample of this study.

Instrumentation

The instrument used to collect data was an interview schedule designed by the researchers. Part I of the schedule composed of questions pertaining to characteristics of the farmers. After discussions with the extension personnel and the elites of the study areas, nine characteristics of farmers (age, level of education, farming experience, family size, annual income, fertilizers use, manures use, communication exposure and innovativeness) were selected as "individual" characteristics. Part II was composed of statements addressing ISF and NM for sustainable crop production. Twenty two statements (13 positive and 9 negative statements) were developed regarding these

issues using five-point Likert-type scale responses.

The choices were: 1 = strongly disagree, 2 = disagree, 3 = neutral or undecided, 4 = agree, 5 = strongly agree for positive statement and a reverse system of scoring for negative statements. The statements were refined through consultation with an expert panel consisting of scientists from the Soil Science and Plant Nutrition Division of the Bangladesh Agricultural Research Council. The perception section of the instrument was assessed by calculating a Cronbach's alpha coefficient as a measure of instrument reliability to analyze interval data. The Cronbach's alpha coefficient used for the statements for this section was 0.81.

Data Collection and Analysis

Data were collected from both primary and secondary sources during 2005-2006. Primary data were collected from the 120 sample farmers through face-to-face interviews, while secondary sources of data were collected from BBS and agricultural and rural development reports. The Statistical Package for Social Sciences (SPSS) was used to analyze the data. Descriptive statistics including frequency distribution, percentages, means, and standard deviations were used along with multiple regression analysis.

Findings

Perception of Different Categories of Farmers

All categories of farmers in the study areas were asked to mention their level of perception of integrated soil fertility and nutrient management for sustainable crop production. Data in Table 2 indicate that a significant proportion of landless, marginal and small farmers had either a low or a very low level of perception. In contrast, almost all medium and large farmers of the study areas had medium level of perception. Very limited numbers of farmers were found to have a high perception of integrated soil fertility and nutrient management for sustainable crop production.

Table 2
Categories of Farmers Based on Perception Along With Means and Standard Deviations (N = 120)

Categories of farmers	Level of perception (Score)	Farmers *f*	Farmers %	Possible range	Observed range	*M*	*SD*
Landless (39)	Very low (32-45)	28	72	22-110	32- 59	38.15	4.36
	Low (56-59)	11	28				
Marginal (34)	Very low (32-45)	14	41	22-110	34- 59	47.06	2.38
	Low (56-59)	20	59				
Small (19)	Very low (32-45)	2	11	22-110	35-75	54.18	7.59
	Low (56-59)	12	63				
	Medium (60-73)	5	26				
Medium (20)	Low (56-59)	6	30	22-110	46-78	67.43	6.73
	Medium (60-73)	10	50				
	High (>73)	4	20				
Large (8)	Low (56-59)	1	13	22-110	50-83	71.19	7.65
	Medium(60-73)	3	37				
	High (>73)	4	50				

In the study areas, landless, marginal and small farmers constitute about 80% of the total farming community. These categories of farmers normally engage themselves in crop production activities more frequently than their medium and large-scale counterparts. But they do not have adequate knowledge and awareness to manage their farms properly. They often do not receive sufficient technical support from the government extension workers due to their unavailability for the job areas and their bias or desire to work with farmers of a higher status in the society. Only a limited number of Non-Government Organizations (NGOs) work with landless, marginal and small farmers, however, such encounters often motivate them to run small-scale off-farm businesses rather than increasing agricultural production. Due to lack of proper knowledge of efficient farm management along with financial inability to buy agricultural inputs when needed, farmers (especially landless, marginal and small farmers) could not maintain the yield of agricultural crops in a sustainable way.

Statements of Farmers' Perception

Statements of farmers' perception were measured by using rank order of the statement along with mean and standard deviation. As indicated in Table 3, the statements ranked first and second by the respondents were "preparation of farm yard manure is labor intensive" and "soil organic matter has very little impact upon water holding capacity of soil," respectively.

Table 3
Mean Rankings and Standard Deviations for Statements Perceived by Farmers of Integrated Soil Fertility and Nutrient Management for Sustainable Crop Production

Rank	Statement used for determination of farmers perception	*M*[a]	*SD*
1	Preparation of farm yard manure is labor intensive	4.28	0.91
2	Soil organic matter has very little impact upon water holding capacity of soil	4.24	0.86
3	Applying mulches to soil has no impact on soil property rather a waste of labor and time	4.15	0.92
4	Allowing blue green algae in rice field hampers the growth and development of rice plants by sharing nutrients	4.09	1.03
5	Sulfur (S) and Zinc (Zn) fertilizer has no impact upon crop yield rather wastage of money	3.98	1.06
6	Cultivation of green manure crops has very little impact on soil fertility, rather it occupies land	3.83	0.94
7	Crop residue management has little impact on increasing soil organic matter status and preventing soil erosion	3.75	1.01
8	Soil fertility and crop productivity can be managed to a large extent by applying only chemical fertilizers	3.68	1.13
9	Cow dung and crop residue management has little impact on soil fertility improvement, so it is better to use these as fuel for cooking	3.42	1.16
10	Compost is a good source of organic matter and it is easy to prepare and apply	3.36	1.09
11	Legume cultivation has minimum impact upon incorporating organic matter and nitrogen to the soil	3.09	1.17
12	Cultivation of mixed crops not only increase total production but also reduce soil erosion	2.94	1.11
13	Liquid manure prepared from urine and various plant extracts can be used for controlling pets and diseases	3.12	1.23
14	Application of lime as soil amendment is less effective	2.78	1.19
15	Soil organic matter is essential for maintaining soil fertility and crop yields	2.71	1.15

Rank	Statement used for determination of farmers perception	*M*[a]	*SD*
16	Green leaf manure helps to improve soil structure, and reduce weed population	2.68	1.16
17	Crop rotation is an important practice that helps maintain soil fertility and controls weeds, pest, and diseases	2.21	0.83
18	Soil organic matter helps to improve soil's physical, chemical and biological properties	2.02	1.29
19	Application of both organic and inorganic fertilizers is very important for obtaining a better yield	1.91	1.31
20	Integrated soil fertility and nutrition management system for crop production is costly and labor- intensive	1.83	1.29
21	Integrated soil fertility and nutrition management system not only enhances crop yields but also maintains soil fertility in the long-run	1.80	1.26
22	Integrated soil fertility and nutrition management system discourage environmental pollution	1.77	1.08

[a] Scale: 1 = strongly disagree; 2 = disagree; 3 = neutral or undecided; 4 = agree; 5 = strongly agree for positive statements and a reverse system of scoring for negative statements

The fact that the top ranked statements were mostly concerned with organic manure indicates those farmers' inadequate knowledge and awareness about preparing and using this substance may be the reasons among others for this kind of perception. On the other hand, most of the low ranking statements were solely related to the beneficial aspects of soil fertility and nutrient management for sustainable crop production. With the help of an on-going soil fertility management project, a limited number of farmers from medium and large farm holdings in the study areas could learn practices for maintaining and improving the soil's fertility. Apart from these groups, others farmers (landless, marginal and small groups) who constitute about four-fifths of the farming community did not receive information about soil fertility management. Moreover, there were no integrated plant nutrient management programs for crop production in the study areas sponsored by Government Extension Department or an NGO. Therefore, farmers knew very little about the beneficial aspects of this management system.

Farmers' Overall Perception

The observed score of farmers' perception ranged from 32 to 83, with an average of 56.71 and a standard deviation of 5.38. Data in Table 4 indicate that little more than two-fifth (41%) of the respondents had a low level of perception followed by very low (37%). Only 22% of the respondents perceived themselves as having a medium to high level of perception of ISF and NM for sustainable crop production.

Table 4
Distribution of Farmers According to Their Level of Perception

Level of perception (score)	Farmers		Possible range	Observed range	*M*	*SD*
	f	%				
Very low (32-45)	44	37	22-110	32-83	56.71	5.38
Low (46-59)	50	41				
Medium (60-72)	18	15				
High (>72)	8	7				

During field surveys, it was observed that a significant proportion of farmers in the study areas had inadequate access to information sources. Despite the fact that the Department of Agricultural Extension under the Ministry of Agriculture and the Danish International Development Agency (DANIDA) were jointly implementing a soil fertility management project since 2001, the field level workers of that project could not yet reach to all categories of farmers which would give all farmers equal priority due to the following reasons: 1) inadequate skills of field-level workers; and 2) field-level workers were often preferred to work with medium and large farmers because of their high social prestige. As a result, the landless, marginal and small farmers of the study areas had complaints about the project workers. As they were often denied support and information either from government extension agents or project workers, their knowledge about proper management of soil fertility and plant nutrients for sustainable crop production was very limited.

Farmers' Characteristics Profile

The majority (47%) of the farmers were in the age categories of 31-50 years followed by 15-30 years. A little less than four-fifths (77%) of the respondents had an elementary to middle school level of education and four-fifths (80%) were found to have a low to medium level of farming experiences. Findings of family size indicates that a significant proportion (76%) of the respondents belong to medium to large families (medium: 5-7 person/family and large: > 8 person/family). About two-thirds (66%) of the farmers were categorized in the low (35,100-75000Tk; 1US $ = 68Tk) to medium income (75,100-115,000 Tk) category. However, a little less than one-half (48%) of the respondents use fertilizers in self-assessed doses, while 39% use in the partially recommended doses. The majority (79%) of the farmers use a very low to low quantity of manures and an overwhelming majority (77%) were found to have a very low level of communication exposure, followed by a medium level (23%), while a significant proportion (70%) had either a low or medium level of innovativeness.

According to Islam (1990), human perception is a function of personality and culture. Hence, in order to have an understanding of farmer's perception, it is necessary to get information about his personality and culture. Personality is the unique, integrated or organized system of all behaviors of a person (Ray, 1996). Culture, on the other hand, is that complex whole, which includes knowledge, belief, customs and other capabilities and habits acquired by a person as a member of a society (Taylor, 1924). Thus, an individual's perception is influenced by his personal and cultural characteristics.

Influence of Farmers' Characteristics upon their Perceptions

This section examines the farmers' characteristics that influence their perception of ISF and NM for sustainable crop production. Regression results in Table 5 indicate that among nine characteristics, six were found to be statistically significant predictors. Among them, the following four were identified as significant predictors producing positive regression coefficients:

1) education level; 2) farming experience; 3) farm size; and 4) communication exposure. Farmers who possessed one or more of these characters at a high level were found to have a higher level of perception. Education helps people to increase their knowledge and understanding about particular idea and makes them more communicative in nature.

Table 5
Farmers' Characteristic and Their Influence on Perceptions of Integrated Soil Fertility and Nutrient Management

Farmers' characteristics	Coefficient (b)	SE	*t*-value	*p*
Age	.094	.083	1.391	.161
Education level***	.308	.023	4.392	.001
Farming experience***	.343	.020	4.451	.001
Family size*	-.158	.013	-1.293	.048
Farm Size**	.145	.025	2.419	.015
Fertilizers use**	-.183	.111	-1.204	.039
Manure use	.072	.013	1.235	.241
Communication exposure**	.216	.011	2.232	.031
Innovativeness	.085	.128	.934	.352

Intercept = 29.42, R^2 = .716, Adjusted R^2 = .691, F value =78.31
* p < .10, ** p < .05, *** p < .001

Hossain (1999) found that farm size did not have a significant influence over farmers' perception of farm management. This may be the effect of NGO's activities in the study areas. NGOs often motivate landless, marginal and small farmers to run their farms in such a way to reap the maximum benefit from a piece of land using the available farm resources. This helps improve their knowledge about farm management. Farming experience, on the other hand, also shows positive effects on farmers' perception. This significant positive effect can be comprehended in such a way that farmers who run their farms for a long time develop knowledge and skills that might impact and strengthen their perception.

On the contrary, two characteristics were identified as significant predictors producing negative regression coefficients. These were: 1) family size; and 2) fertilizer use for crop production. Respondents who possessed one or both of those characteristics it a large size/quantity had produced less perception of integrated soil fertility and nutrient management system. Family size is an important determining factor in access to education, employment, and income in rural Bangladesh. It was observed that, landless, marginal and small farmers are often the members of large size of families. These categories of farmers suffer from a lack of education, employment, and other opportunities of the rural social system. Moreover, due to lack of

proper knowledge and financial inability they often use imbalanced doses of fertilizers for crop production which badly affects crop yields and soil fertility.

Conclusions

The study pointed out that although a soil fertility management project had been running in the study areas since 2001, a considerable proportion of the farmers especially from landless, marginal and small farm holders perceived themselves as having either a low or very low awareness of ISF and NM for sustainable crop production. Medium and high levels of awareness were observed only for those who were belonged to medium and large farm holders. Ramamurthy (1976) also found that farm size had a significant positive influence upon IR-8 adopters and their perception of profitability in India due to their greater access to information sources and more knowledge in farming. Farmers' education, farming experience and communication exposure also had significant positive influence on farmers' perception. Hossain (1999) also found similar trends in education that may be because of more or less similar socio-economic conditions of rural Bangladesh. Kashem and Mikuni (1998) did not find any significant influence of farm size and farmers' education upon their perception of (indigenous technical knowledge (ITK) in Japan. In the developing world, farm size may be considered as an important determinant that directly influences education and other physical facilities that help develop knowledge and experience in farming and improved communication skills. In developed countries like Japan, farmers often have equal opportunities in terms of education and farming aspects, irrespective of farm size. Therefore, these two factors do not normally influence perceptions.

Farmers' family size and use of fertilizers, on the other hand, negatively influenced their perceptions of ISF and NM for sustainable crop production. Farmers who belong to large families usually do not have access to adequate facilities to develop farming skills properly and use fertilizers without considering the actual requirement of plants and soils. Chintawar (1997) reported oppositely about family size and farmers' perception towards the utility of bio-gas plant in India. However, as individual's perception is a process concerned with the acquisition and interpretation of information from his/her own environment, it depends on the individual where he lives as well as his/her experiences. Increasing farmers' knowledge and perception may be the important consideration for the dissemination of any improved technology for crop production. This may even be more true in developing countries like Bangladesh where agriculture is a principal source of household food security and livelihoods.

Recommendations

Based on the conclusions above and practical field observations, the following recommendations are put forward which may be useful for policy planning.

1. An integrated soil fertility and nutrient management program may be organized with the provision that all categories of farmers are involved. The Department of Agricultural Extension (DAE) and other agricultural development organizations should motivate their field level workers to conduct extension works leaving the biasness of working with specific farmers groups only.
2. Special attention should be focused on the development of farmers' skills for preparation and use of organic manures. The extension workers of the on-going soil fertility management project may insist to work jointly with NGO workers who have good access to the landless, marginal and small farm holders.
3. Initiatives should be taken to increase the availability of information sources and mass literacy program may be organized to improve farmers' knowledge and perception about ISF and NM for sustainable crop production, respectively.

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