Barriers Faced by Small Farmers in Adopting the Integrated Plant Nutrient System for Sustainable Farming Development

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Abstract

This paper presents findings of a study on the barriers faced by small farmers in adopting the integrated plant nutrient system (IPNS) for sustainable farming development. The study was conducted in 3 villages in the central sub-district of Narail, in Bangladesh. Data were collected through interviews with 110, randomly selected farmers. The majority were found to use plant nutrient sources either inadequately or only moderately. Manure was found to be used much less frequently than fertilizers, even though in the past it was the main source of soil nutrients for farmers in the region. The results indicate that more than three quarters of the farmers questioned confronted moderate barriers in adopting IPNS, while 20% faced severe barriers. In addition the barriers faced were found to be inversely proportional to the farmers' education level, farm size, innovativeness, extension contact network, knowledge of the IPNS technique and the perceived benefits of using manure.
Key words: Farmer, barrier, IPNS, sustainable agriculture, Bangladesh.

Introduction

Background

Agriculture is the backbone of the Bangladeshi economy, with approximately 144 million people depending on it for subsistence. One third of Bangladesh's GDP comes from agriculture (Ahmed, 2000) while approximately two thirds (68.5 %) of the labor market is engaged in farming (Anonymous, 1999).

The vast majority of the population lives below poverty line. Most of the farmers are small scale, with each having a maximum of 1.0 hectares (ha) of farmland. They are unable to increase production easily, since they lack capital for the investment in modern technology. They are highly vulnerable to natural disasters and, while they tend to have large families, they are often unable to send their children to school and often lack sufficient food for the family unit. They therefore tend to use large amounts of chemical fertilizers to increase production. Cow dung and crop residues, which were often used as fertilizers in the past, are now often used for fuel instead however; the continued, exclusive use of chemical fertilizers may lead to decreased soil fertility in the long term. The aim of the integrated plant nutrient system (IPNS) is in increase the use of farm yard

manures (FYM), compost, and green waste, together with limited chemical fertilizers, to replenish organic matter in degraded soils, helping to make them fertile and hence able to sustain future production.

At present, chemical fertilizers are a major component of modern farming. Approximately 50% of the world's crop production is attributed to fertilizer use and this trend is increasing throughout the world (Bockman et al. 1990). It is estimated that by 2020, the sources of plant nutrients will be 21% from soil, 9% from manure and 70% from fertilizers. FAO (2001) data also indicate that crop production supported by fertilizer use will continue to dominate future agricultural productivity, especially in developing countries with associated soil degradation. This is a vicious circle in poorer countries since the continued nutrient exhaustion of soils leads to an increasing dependence on fertilizers to maintain crop yields, which in turn degrades the soil still further. Increased crop production can be sustained by the balanced use of organic matter/manures and chemical fertilizers (Lal and Singh, 1998). IPNS is a modern system of nutrient management, providing ideal nutrition for a specific crop and has recently gained great significance in the context of sustainable crop production. It is also an important component of sustainable agricultural intensification, as well as crop, pest, soil and water management. Its main objective is to avoid the over exploitation of nutrient resources and while maintaining the long-term soil fertility and preventing soil degradation (Hossain, 2002). There are, as yet, relatively few studies documenting its effectiveness in the field and it is this lack of data that the research reported here aims to help address.

The Problem

The farmers of Bangladesh are classified as either, small, medium or large scale farmers. About 46% of all rural households own less than 0.2-0.3 ha for farming (Begum, 2002), while more than 65% of the farmers possess only 0.2 to 1.0 ha (small scale farmers (Anonymous, 2004)). These small farmers work directly in the fields and rely on agriculture as their only means of living.

In recent years an alarming fall in the organic matter content of cultivated soils has been observed in the country. The organic matter content is now only 0.1-1.5 %, which is very low compared to other developing countries (Sayeed, 2003). This decline is thought to be due mainly to the poor attention given by the farmers to soil improvement and maintenance. To increase soil fertility it is essential to use chemical fertilizers and natural products (such as manures) in a balanced way. The integrated management of plant nutrient sources through soil conservation practices and the judicial use of organic and inorganic fertilizers offer the opportunity to sustain agriculture over a long period of time. IPNS incorporates many technologies (including soil conservation practices) and prevents the unnecessary loss of nutrients from fields through erosion. The components of IPNS include chemical fertilizers, organic manures (e.g., FYM, compost, etc.), green manure (e.g. *Sesbania*, black gram, etc.), crop residues (e.g.

wheat, rice), crop rotation with legumes and bio-fertilizers (e.g. *Rhizobium*, blue green algae and *Azolla*).

As described above, maintaining soil fertility on a sustainable basis has become a challenge in developing countries, especially the increasing dependence of farmers on chemical fertilizers for crop production. IPNS is recognized to be a useful means for achieving higher production while maintaining integrated techniques of soil fertility has been introduced to Bangladeshi farmers via an extension service. But little is known about how many farmers have moved from solely relying on chemical fertilizers to practicing IPNS since it is a modern, scientific innovation, whereas farmers in Bangladesh use older farming techniques and have a low level of education. They also have limited access to information and a limited knowledge and understanding of the benefits of IPNS. This study therefore investigated whether these issues might be significant obstacles that farmers have to overcome when adopting IPNS. The results are expected to be useful in providing project planners with an understanding of how the adoption of IPNS can be promoted to small scale farmers.

Specific objectives

The specific objectives of this study are as follows:

- To identify the available sources of soil nutrients, along with the extent of their use by Bangladeshi farmers in crop production.
- To determine and describe the extent of the barriers small farmers face in adopting IPNS for sustainable farming development.
- To explore the relationship between the selected characteristics of farmers and their barriers in adopting IPNS. The characteristics selected include; age, education level, family size, farm size, annual income, organizational participation, innovativeness, extension contacts, perception of benefits from using manure and knowledge of IPNS.

Definition of key terms

Small farmers: The farmers who have, at best, one hectare of land. This is in accordance with the criterion set by the Bangladesh Bureau of Statistics.

Sustainable farming development: The successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources.

Integrated plant nutrient system (IPNS): The combined use of chemical fertilizers and organic manure in an efficient manner, in order to improve and sustain soil fertility and crop productivity.

Barrier/obstacle: Anything that restrains or obstructs progress, access, etc. Small farmers' barriers in adopting IPNS refer to the degree to which they face difficulties in adopting the technique towards sustainable farming development.

Cosmopoliteness: The degree or the frequency at which a respondent visits places outside of their local areas or social system/group.

Extension contact network: An individual's exposure to various communication media and sources, it is linked to the dissemination of new technologies among the farmers.

Innovativeness: The degree to which an individual is quicker in adopting new ideas than other members of their peer group (Rogers, 1995).

Organizational participation: Taking part in different social organizations, either as an ordinary member, executive committee member or as an officer.

Perception: The process by which we receive information or stimuli from our environment and transform it into psychological awareness.

Methodology

Study area and data collection

The study was conducted among the farmers of 3 villages of the central sub district of the Narail district in Bangladesh. The study area was selected because intensive farming with different crops is common. In addition, the majority (62%) of farmers in the study area were small scale farmers (the others were large and medium scale farmers). The total number of the small scale farmers was 445. Of these, 110 small scale farmers were randomly selected to participate in the study. Farmers were questioned using a personal interview schedule consisting of questions related to the nature of barriers/obstacles and the characteristics of the respondents.

Measuring the extent of use of nutrient sources

A 4 point scale was used for computing the extent of use of nutrient sources of the farmers in the following way:

Extent of use	Scores assigned
Sufficient	3
Moderate	2
Not sufficient	1
No use	0

The weights of responses of all the selected nutrient sources were taken together

to obtain an 'extent of use' score. Thus, the extent of use score of a respondent could range from 0 to 51 since there were a total of 17 types of nutrient source. In contrast, the extent of use score for each statement was calculated by using extent of use index (EUI) and was calculated using the following formula:

Extent of Use of Index = P_s x 3 + P_m x 2 + P_{ns} x 1 + P_n x 0

Where;

P_s = The percentage of small farmers who expressed 'sufficient' use of any one nutrient source

P_m = The percentage of small farmers who expressed 'moderate' use of any one nutrient source

P_{ns} =The percentage of small farmers who expressed 'insufficient' use for any one nutrient source

P_n = The percentage of small farmers who expressed 'no use' for any one nutrient source.

Thus, the EUI index of any nutrient source could range from 0 to 300, where '0'indicates no use and '300'indicates sufficient use of the nutrient source.

Measurement of barrier issues in adopting IPNS

The barriers faced by small scale farmers in adopting IPNS towards sustainable farming development were the central focus of this work. Twenty potential problems, including those related to information, management and training and adoption of IPNS, were pre-selected for study. Respondents were asked to indicate their response for each question on a four-point scale, which, ranged from 'high' to 'not at all'. To aid data coding and analysis these options were assigned scores as follows:

Severity of the problem	Weight assigned
High	3
Medium	2
Low	1
Not at all	0

As there were 20 problems to consider, a respondent could score between 0 and 60.. The barrier score was calculated using a barrier index (BI) as follows:

Barrier Index = $B_h \times 3 + B_m \times 2 + B_l \times 1 + B_n \times 0$

Where,

B_h = The percentage of small farmers who felt they faced 'large' barriers to IPNS use.

B_m = The percentage of small farmers who felt they faced 'medium' barriers to IPNS use.

B_l = The percentage of small farmers who felt they faced 'low' barriers to IPNS use.

B_n = The percentage of small farmers who felt they faced 'no' barriers to IPNS use.

Any one barrier of the index (BI) could range from 0 to 300, with '0' indicating no barrier at all and '300' indicating the highest barrier.

Scored causal diagrams (SCDs) (Galpin *et al.,* 2000) were constructed with a group of 10 farmers to identify the major causes of obstacles as well as links (such as cause and effect) among each obstacle, as well as their contribution to the overall concern of the study (i.e. the barrier in adopting IPNS by the small farmers). The SCD technique helps the farmers and researcher to identify the linkages and relationships between different problems together. The addition of a scoring method helps to clarify the nature of problem and identify the 'root' cause(s). The scoring process also helps to analyze the relative importance of problems and causes as well as to prioritize them.

In SCD, the 'end problem' is placed in a circle. The immediate causes of this 'end problem' are also placed in circles. Arrows are then drawn from the end problem to the cause, with the thickness of the arrow indicating the extent to which each cause contributes to the end problem. The end problem (i.e. the barrier) is scored as 100 and this is then distributed back according to the relative importance to all the causal problems. This indicates the relative importance of each intermediary causes affecting the respective end problem. The total process was conducted in consultation with the farmers who identified the barriers they faced in adopting IPNS and the linkages between them.

Data analysis

Various statistics, such as percentage distribution, range, mean and the standard deviation were calculated and the results were used in describing the variables. The relationship between each characteristic of the respondents and the degree of problem confrontation was ascertained by using Pearson's product moment correlation coefficient (Kothari, 1995). A null hypothesis was then formulated for each of the relationships and a 5% level of probability was used to reject them.

Results and Discussion

Selected Characteristics of the Small Farmers

Young and middle-aged farmers made up 32 and 36% of the total farming population in the study area respectively. Of those questioned 16 and 47 % of the respondents possessed primary and secondary education respectively while 31% were found to be illiterate. The family sizes of the respondents, ranged from 2 to 16 members while farm sizes ranged from 0.14 to 1.00 hectares. Three quarters of the respondents were in either the low or medium income category. Organizational participation (87%), innovativeness (99%), extension contact (96%) of the

respondents was either in the low or medium category. Almost all (99 %) of the respondents possessed medium to high knowledge of IPNS and 100% of the respondents had medium to high perceptions of the benefits to be gained from using manures over fertilizer. Relevant features of the characteristics of the farmers are taken below in Table 1.

Table 1. Salient features of the small farmers' selected characteristics

Characteristics (scoring method)	Range		Categories	Farmers		Mean
	Probable	Observed		No.	%	
Age (Years)	-	17-75	Young (< 35)	35	31.8	44.97
			Middle aged (35-50)	39	35.5	
			Old (>50)	36	32.7	
Education (Year of schooling)	-	0-14	No education (0)	34	30.9	5.53
			Primary (1-5)	18	16.4	
			Secondary (6-10)	52	47.3	
			Higher Seco. (11-12)	3	2.7	
			Bachelor (>12)	3	2.7	
Family size (Number of members)	-	2-16	Small (up to 4)	12	10.9	5.45
			Medium (5-6)	81	73.6	
			Large (>6)	17	15.5	
Farm size (Hectare)	-	0.14-1.00	Small (<0.39)	26	23.6	0.66
			Medium (>0.40-0.92)	59	53.6	
			Large (>0.92)	25	22.7	
Annual income ('000' taka)	-	10-132	Low (<34)	45	40.9	48.78
			Medium (34-64)	37	33.6	
			High (>64)	28	25.5	
Organizational participation (Rated score)	-	0-37	Low (<4)	73	66.4	3.83
			Medium (4-11)	23	20.9	
			High (>11)	14	12.7	
Innovativeness (Rated score)	0-80	0-52	Low (≤25)	60	54.5	24.92
			Medium (26-50)	49	44.6	
			High (>50)	1	0.9	

Extension contact (Rated score)	0-36	2-26	Low (≤12) Medium (13-24) High (>24)	39 66 5	35.5 60.0 4.6	13.48
Knowledge on IPNS (Rated score)	0-25	9-20	Low (<10) Medium (10-17) High (>17)	1 83 26	0.9 75.5 23.6	15.74
Perception of benefit from using manures (Rated score)	0-48	25-44	Low (<20) Medium (20-35) High (>35)	0 42 68	0 38.2 61.8	35.97

Sources of soil nutrients and their extent of use compared to the perceived need of small scale farmers

Seventeen sources of soil nutrient materials were pre-identified or this study. Farmers were asked to indicate how much they use and how much they think they ideally need. The extent of use score of each nutrient source was calculated by using an EUI and has been ranked accordingly in table 2.

Table 2. Details of extent of use of the soil nutrient sources on seventeen items

Name of the sources of soil nutrients	Extent of use compared to actual need				EUI
	Sufficient (percent)	Moderate (percent)	Not sufficient (percent)	No use (Percent)	
Compost	2.7	41.9	45.4	9.9	137.4
Cow dung	2.7	30	50.9	16.4	119.1
Green manure	0	22.7	36.4	40.9	81.8
Oil cake	0	0	27.3	72.7	27.3
Poultry feces	0	0	22.4	77.6	22.4
Fish meal	0	0	10.0	90.0	10.0
Blood meal	0	0	2.7	97.3	2.7
Bone meal	0	0	0	100.0	0
Urea	97.3	2.7	0	0	297.3
Triple Super Phosphate	84.6	9.0	6.4	0	278.1
Muriate of Potash	51.8	25.5	22.7	0	229.1
Zypsum	9.0	9.2	81.8	0	127.2
Zinc fertilizer	0	28.7	21.4	49.9	78.8
SSP (Single Super Phosphate)	0	10.9	37.3	51.8	59.1
Boron fertilizer	0	9.0	10.9	80.1	28.9
DAP (Di-amonium phosphate)	0	0	24.6	75.5	24.6
Urea super granule	0	0	21.8	78.2	21.8

Among the nutrient sources used by farmers, urea had the highest extent of use score and was therefore first in the rank order, (approximately 97% of small scale farmers used urea sufficiently). Urea is an easily available source of nitrogen (N) that is taken up easily by crops. Farmers therefore often feel encouraged to use urea without considering its consequence. TSP had the second highest rank order score. Approximately 84% of the farmers used TSP sufficiently. MP had the third highest score and about three quarters of the farmers used MP either moderately or sufficiently.

Compost had the fourth highest score with approximately 50% of respondents being found to be moderate users of compost. Although most of the respondents had good perceptions about compost, they were unable to use large amounts as their farms are far away from their households and they could not transport it effectively.

Cow dung had the sixth highest rank score. Approximately 80% of the respondents were 'moderate' to 'insufficient' users of cow dung, mainly as they lacked cattle. Cow dung and other farm residues are also used as fuel in farm kitchens. This causes competition between the use of cow dung, as a fuel or a fertilizer and usually it is easier for the farmer to use it as the former.

The extent of use of each nutrient source was measured by computing the extent of use score, which could theoretically range from 0 to 51. The scores actually observed ranged from 17 to 39, with a mean of 23 and standard deviation 5.62. Based on these scores, the farmers were classified into three categories namely 'inadequate users', 'moderate users' and 'sufficient users'. The distribution of farmers according to their extent of use of nutrients is presented in Table 3.

Table 3. Categorization of the respondents according to their extent of use of nutrient sources

Category (*based on score*)	Farmers		Mean	Standard deviation
	No.	%		
Inadequate user (<17)	35	31.8	23.41	5.62
Moderate user (17-30)	57	51.8		
Sufficient user (>30)	18	16.4		

The majority of farmers (83.16 %) used various nutrient sources either inadequately or only moderately. The study reveals that overall, the extent of use of natural nutrient sources was low because of the high use of chemical fertilizers. This is likely to be because, they are readily available, easy to use and affect the plants very quickly.

Barriers faced by small scale farmers in adopting IPNS

It was found that the barrier index (BI) of the 20 pre selected barriers ranged from 47.28 to 222.72.

Table 4. Rank order of the barriers confronted by small farmers in adopting IPNS

Barrier faced		Barrier level				Barrier index
		High (%)	Medium (%)	Low (%)	None (%)	
1.	The need to use cow dung as fuel.	59.09	22.73	0	18.18	222.72
2.	A lack of IPNS materials.	34.55	54.54	8.18	2.73	220.91
3.	A lack of sufficient demonstration plots.	30	51.82	10	8.18	203.64
4.	A lack of space to prepare manures, especially green manure.	22.73	50.91	19.09	7.29	189.08
5.	The high labor costs of adopting IPNS.	22.73	42.75	33.64	0.91	187.27
6.	The need to use crop residues used as fuel.	13.64	54.55	9.09	22.72	159.09
7.	The fact that the preparation and storage of compost and FYM are labor intensive and time consuming.	13.64	45.45	22.73	18.18	154.55
8.	A lack of interest in learning about the IPNS technique (due mainly to the aforementioned large economic and labor costs.	8.18	45.45	27.28	19.09	142.74
9.	A lack of funds to prepare manure	0	45.45	45.46	9.09	136.37
10.	The lack of credit facilities to obtain funds for the preparation of manure	8.18	33.64	41.81	16.36	134.13
11.	The fact that heavy rainfall at certain times of year makes preparing manure very difficult.	0	27.27	50	22.73	104.55
12.	The inability to attend training regularly.	29.09	66.36	1.82	2.73	221.81
13.	A lack of training facilities to teach farmers how to prepare and use IPNS components.	18.18	65.45	13.64	2.73	199.09
14.	A low propensity to participate in IPNS related training programs	19.09	50	22.73	8.18	180
15.	The inability to understand training material due to illiteracy.	38.18	1.82	7.27	52.72	125.46
16.	A lack of knowledge in applying balanced fertilizers.	23.64	58.18	18.18	0	205.45
17.	A generally lack of leaflets, booklets and other information on IPNS.	37.27	30.91	21.82	10	195.45
18.	A lack of technical knowledge in preparing manures (compost, FYM etc).	4.55	60.91	31.82	2.73	167.29
19.	A lack of knowledge of the use of manures in adopting IPNS.	4.55	43.64	49.09	2.73	150
20.	Doubts over the effectiveness of manures in adopting IPNS.	0.91	2.73	39.09	57.27	47.28

The most common barrier confronted by small scale farmers was 'the use of cow dung as fuel' (as indicated by its BI of 223). Farmers traditionally know that application of cow dung and other organic sources of nutrients are very helpful for higher production but the severe scarcity of wood fuel in poor rural communities compels them to use cow dung as fuel. Moreover, the number of cows in farming societies is gradually decreasing and, as a result, the total production of cow dung is also declining.

The second and third most often confronted barriers confronted were 'inability to attend training regularly due to the long distance between training areas and farms' and the 'lack of IPNS materials' respectively. The barrier confronted by the least small scale farmers was 'doubt about the effectiveness of manures in building IPNS.'

Overall barriers of the small farmers in adopting IPNS

The observed barrier score range was 13 to 45 against a possible range of 0 to 60, with an average of 36.05 and a standard deviation of 5.38. From these barrier scores, the small scale farmers were classified into 3 categories as shown in Table 5.

Table 5. Classification of the small farmers according to their overall barrier

Categories (based on score)	Farmers		Mean	SD
	No.	%		
Low barriers (≤20)	1	0.91		
Medium barriers (21-40)	88	80.0	36.05	5.38
High barriers (>40)	21	19.09		

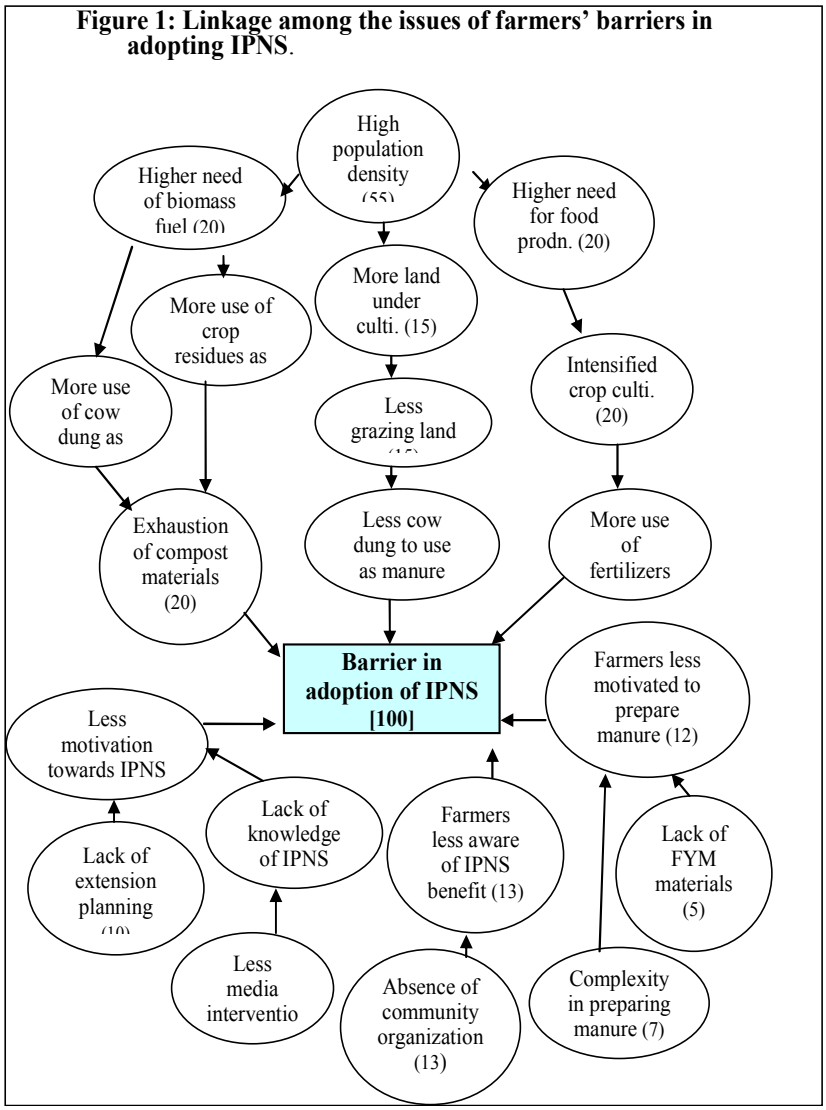
Table 5 reveals that 80 % of the small farmers faced moderate barriers to IPNS implementation, while 19% faced high barriers. Similar results have been reported by other workers in the field Hossain (2002). In this study, the barriers faced by most (99 %) of the small farmers in adopting IPNS include the use of cow dung as fuel, the inability to attend training regularly, the lack of IPNS materials, lack of knowledge in applying balanced fertilizers, an absence of sufficient demonstration plots, a lack of training facilities to prepare and use IPNS components, and the lack of printed materials about IPNS.

Linkage among the main aspects of barriers in adopting IPNS

After considering 'Barriers in adoption of IPNS' as the 'core problem', farmers identified the 'high population density' as the main 'end problem'. This factor alone contributed 55% of the core problem (Figure 1). This population pressure in the

study area has therefore been scored as the main block to the farmers in accepting IPNS for integrated soil nutrient management. The immediate issues arising from the high population density were 'higher demand for fuel', 'more land under cultivation' and 'greater need of food production' which contributed 20, 15 and 20% respectively to the core problem. 'Lack of extension planning' and 'less media intervention' was the two end problems that contributed least to the core problem at 10% each. Absence of community organization (13%) was also viewed as important as a barrier to adopting IPNS. Conversely, 'complexity in preparing manure' and 'lack of FYM materials to prepare manure' made the farmers less motivated in preparing manure.

Figure 1: Linkage among the issues of farmers' barriers in adopting IPNS.



Probable measures to solve the problems perceived by the small farmers

During interview the small farmers were asked to give their opinion on the possible solution to the problems that they face. The solutions are arranged in rank order in Table 6.

Table 6. Probable solution to barriers related in adopting IPNS as perceived by the farmers

Solutions	Percent of citations	Rank order
Setting demonstration plots	75.90	1
Supplying another source of fuel	63.00	2
Adequate supply of IPNS materials in time	60.00	3
Providing sufficient extension services	55.72	4
Make awareness about IPNS	50.54	5
Distribution of green manure seed (e.g. dhaincha, soybean etc.) with low price	38.45	6
Providing sufficient government support	19.09	7
Providing sufficient training facilities	18.00	8

'Setting sufficient demonstration plots' is the top ranked measure suggested by 77% of the small scale farmers. They believe that sufficient demonstration plots may provide them with useful medium to understand and observe IPNS in detail. 'Supplying another source of fuel' is the next most important measure, (being suggested by 63 per cent of the small farmers). This would allow manure to be used on fields rather than as a fuel, lessening the need for chemical fertilizers
'Adequate supply of IPNS materials' is another important measure identified by the study. Therefore an adequate supply of IPNS materials needs be supplied to farmers to help them take up the technique.

'Providing sufficient extension services' is the next highest ranked measure (55.72%). About 47% of the respondents in the present study were found to have either no education, or at most primary education. Similar findings were also observed by Hossain (2002). With such a poor educational background it is not surprising that farmers cannot take the advantage of written materials such as leaflets that are often made available by the local extension services. Instead they mostly depend on the information made available by word of mouth from local extension workers from either GOs or NGOs or both. Therefore, farmers' access to information depends largely on whether there are sufficient extension workers, whether the extension workers are trained and equipped with necessary support to

carry out their jobs and whether extension workers are supervised properly. Strengthening extension services focusing particularly on the above mentioned issues may aid farmers to take advantage of IPNS innovations in future.

Relationships between the selected characteristics of the farmers and their barrier confrontation

The purpose of this section is to examine the relationship of each of the individual characteristics of the farmers and the extent of the barriers they face in adopting IPNS. Pearson's product moment co-efficient of correlations (r) were computed and placed in Table 7.

Table 7. Co-efficient of correlation between selected characteristics and barriers confronted by the farmers

Selected characteristics	Co-efficient of correlation
Age	0.187
Education	-0.213*
Family size	0.026
Farm size	-0.260**
Annual income	-0.171
Organizational participation	-0.115
Innovativeness	-0.412***
Extension contact	-0.221*
Perception of benefits from using manure	-0.216*
Knowledge on IPNS	-0.409***

**= Significant at 5% level; ** = Significant at 1% level;*
**** = Significant at 0.1% level*

The 'r' value suggests that education of the respondents had a significant negative relationship with their barriers confronted. This means that higher the education, the lower the barriers in adopting IPNS and vice versa. Education upgrades individuals' knowledge and skills. Better educated people can undertake better management. Formal institutional education, albeit the main means for gaining knowledge, non-formal education or extension educational programs are particularly useful for adults and have been known to be successful. Extension education program focusing on knowledge and skills required for implementing IPNS may be helpful as evidenced by the studies of Hossain (2002), Rahman (1995), Islam (1987), Haque (1995) and Kashem (1977).

The ‘r’ value also indicates that the larger the farm size of the respondents, the lower the barriers in adopting IPNS, and vice versa. Farmers with relatively large farms may have come in contact with friends, neighbors, relatives, block supervisors and/or others to seek solutions to their farming problems. Through these interpersonal contacts, farmers obtain greater chances to discuss their problems and gain knowledge of solutions already tried and tested by other farmers. This is in agreement with previous studies in this area, such as Mansur (1989) and Rahman (1996).

The innovativeness of the respondents also had a significant, negative relationship with the ability to overcome barriers to IPNS implementation. Higher innovativeness in an individual helps them to adopt new technology (Rogers, 1995) which in turn motivates them to overcome barriers and so innovative, farmers were found to face fewer barriers in adopting IPNS. Again, similar findings have been observed in the past by workers such as Hossain (2002), Akanda (1993) and Rahman (1995) in their studies in Bangladesh.

This study also found that the larger the extension contact networks of the respondents, the lower the barriers in adopting IPNS. Small farmers are generally neglected by extension services, but some of them may come in contact with, local leaders by virtue of their own initiative. These farmers are directly or indirectly exposed to agricultural technology and able to more easily overcome barriers in adopting new technology in farming. It is likely that this is why increasing extension contact reduces the problems of small scale farmers in adopting new technologies. Previous studies in Bangladesh also suggest that proper extension contact may reduce farmers problems in adopting modern technologies in farming (Akanda, 1993; Rahman, 1995; Bhuyian, 2002 and others).

The perception of the respondents on the benefits from using manure was found to have a significant negative relationship with their ability to overcome barriers in implementing IPNS. This means that better perception of the benefits of using manure helps farmers to overcome their problems in adopting IPNS
Knowledge of IPNS in the respondents had a negative relationship with the barriers they faced. Small scale farmers, who have knowledge and experience of modern agricultural technology related to adopting IPNS, will face fewer barriers than those who have not acquired such knowledge. Similar observations were made by Hossain (2002) in his study on resource poor farmers’ problems in using manure in their crop fields.

Conclusion

On the basis of the findings of this study, the following conclusions can be drawn:

1. The findings of this study reveal that small scale farmers faced various barriers in adopting IPNS. They also suggest measures to break down these barriers. It is recommended that IPNS project planners should take steps to ensure the adequate supply of IPNS materials, the availability of alternate sources of fuel and the setting up of sufficient demonstration plots near farmers' homes. Appropriate extension campaigns may also be launched in order to motivate farmers to use more manure on their fields.

2. Farmers have a low level of education which may mean they would be unable to manage the complex issues of IPNS. Participation in adult education and training programs will likely help in this regard. The SFFP (Soil Fertility and Fertilizer Project) of the Department of Agriculture Extension (DAE) is a good step in this direction but further steps are needed to attain a sustainable nutritional balance of soil in Bangladesh.

3. The findings of the study also revealed a significant negative relationship between knowledge of IPNS and innovativeness, and the barriers in adopting IPNS. Hence, those promoting IPNS would likely improve its take up by making arrangements for frequent training-teaching programs for farmers to help motivate them to take up new technology and improve their practical knowledge of IPNS.

4. A significant negative relationship was found between the small farmers' extension contact network and their barriers in adopting IPNS. It is therefore recommended that the activities of Block Supervisors (i.e. the field-level extension worker of DAE) and NGO workers be increased so that farmers maintain good contacts with extension agents. In this way their perception of IPNS could be improved.

5. Most of the small scale farmers were found to have a limited idea of IPNS. This is not a good sign for soil management achieving sustainability in agricultural production on its own. The authorities of DAE and other organizations should therefore promote different IPNS related activities through training, field visits etc. so that farmers could understand the technical issues of IPNS more thoroughly.

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