International Journal of Agricultural Research

ISSN 1816-4897

Academic Journals Inc.

www.academicjournals.com

International Journal of Agricultural Research 3 (3): 188-195, 2008
ISSN 1816-4897

Resource-Poor Farmers' Constraints Regarding Integrated Soil Fertility and Nutrient Management System Practices: A Study in Rural Bangladesh

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Abstract: The main focus of this study was to determine the constraints faced by resource-poor farmers concerning the practice of ISF and NM systems of crop production. Field work was conducted in eight villages from four districts in Bangladesh and data were collected from 92 resource-poor farmers through group discussions and personal interviews. Four-point rating scales were used and summed to quantify farmers' constraints. Frequency distributions and a Constraint Index (CI) were used to measure the constraints faced by the different categories of resource-poor farmers. Present findings indicate that landless and marginal categories of resource-poor farmers faced comparatively more constraints than resource-poor small farmers did. Present findings also revealed that the constraint on landless and marginal farmers were similar, while the situation, faced by small farmers was different. Based on the Constraint Index (CI), the top two constraints for landless and marginal farmers were a lack of knowledge about ISF and NM systems and the lack of financial resources to buy fertilizers in time. On the other hand, the unavailability and unstable market price of fertilizers during crop seasons and limited initiatives by the agricultural extension department to motivate farmers to practice ISF and NM were the major constraints on small farmers according to the CI concerning the practice of ISF and NM regarding crop production.

Key words: Resource-poor farmers, constraints, integrated soil fertility management, nutrient management, crop production, Bangladesh

INTRODUCTION

The unsustainable nature of conventional agriculture manifests itself as stagnant or declining crop yields, reduced soil fertility, increasing ecological degradation and worsening rural socio-economic conditions (Lucas and Debuque, 1993). Agriculture in a country needs to be highly efficient to sustain farmers' livelihoods. At the same time, agricultural production methods should be sustainable and result in minimal environmental pollution.

Agriculture has always relied on the human management of soil, plant nutrients and other natural resources. A healthy resource base is essential to agriculture and the agricultural sector's ability to spur national and household economic growth. It has become increasingly clear to international agencies, academics, governments and Non-Governmental Organizations (NGOs) that conventional farming practices, based on the Green Revolution in Asia, are fatally flawed (Sununtar and Jonathan, 1998). A new system of crop production is essential to sustainably obtain better crop yields and properly manage soil resources.

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Throughout the developing world, resource-poor farmers work land in risk-prone, marginal environments, typically without modern agricultural technologies. In the coming years, most worldwide population increases will occur in the developing world. The developing world will account for about 85% of the increased demand for cereals and meat. Providing enough food for the rapidly increasing population in developing countries like Bangladesh is a continuing challenge.

The limited availability of additional land for crop production, along with the declining growth of major food crop yields, has heightened concerns about agriculture's ability to feed Bangladesh's teeming population. There is little opportunity to expand available arable land to meet the increased demands of a burgeoning population. Therefore, to meet its increasing food needs, Bangladesh must produce more food from its existing farmlands. This can only be done by increasing crop yields and stepping up cropping intensity (Doos, 1994; Alexandrators, 1995). In this regard, the adoption of Integrated Soil Fertility (ISF) and Nutrient Management (NM) systems may help farmers to enhance crop production and to conserve natural resources (FAO, 2003).

In Bangladesh, resource-poor farmers are a significant proportion (76%) of the farming community, with cultivated land of up to 1 ha and are directly involved in crop production. According to BBS (2004), they are classified into three categories: i) landless resource-poor farmers (cultivating up to 0.2 ha of land); ii) marginal resource-poor farmers (cultivating from 0.21 to 0.6 ha of land) and iii) small resource-poor farmers (cultivating from 0.61 to 1.0 ha of land). The agriculture sector in Bangladesh provides homes and livelihoods to the majority of the country's poor, therefore, improving agricultural and natural resources is critical to any effort aimed at achieving food security and reducing poverty.

Developing the agricultural sector while efficiently managing natural resources and improving the living standards of resource-poor farmers, are the major challenges for the Government of Bangladesh. However, improved soil and nutrient resource management will directly benefit poor farming households by increasing farm production, diversifying production options and increasing farm incomes (Dayal, 2003).

To obtain better crop yields, maintain soil fertility and minimize environmental pollution over the long term, it is essential to use soil and nutrient resources effectively. In this regard, farmers' constraints need to be addressed properly (IFPRI, 2004). Ugwoke (2005) argued that farmers' personal constraints (such as limited financial resources and excessive personal commitments) seriously affect the implementation of crop production technologies. Pandey (1999), on the other hand, pointed out that some of the problems farmers face in developing countries when adopting rice production technologies include late or irregular disbursement of loan payments, the irregular or late supply of fertilizers and other agrochemicals. In addition, high transportation costs, the lack of adequate quality seed, irrigation problems, pests and diseases are critical problems facing rice production in Bangladesh (FAO, 1998). According to Chowdhury (1996), increasing infrastructure, such as highways and irrigation canals, has obstructed natural drainage patterns, in water-logging crop fields.

The above discussion makes it clear that researchers are already investigating the problems, faced by the farmers regarding rice and crop production in Bangladesh. To date, no research has been conducted in Bangladesh on the constraints facing resource-poor farmers concerning the practice of Integrated Soil Fertility (ISF) and Nutrient Management (NM) systems for crop production. Therefore, an assessment of these constraints is the objective of this study.

MATERIALS AND METHODS

Study Area and Data Collection

Eight villages from four districts (Mymesingh, Jamalpur, Sherpur and Netokona), previously known as the greater Mymnesingh of Bangladesh were selected as the study areas for this research.

These areas were selected because of: i) low agricultural productivity (BBS, 2004) and ii) the gradual declination of soil fertility (BARC, 1999). Since resource-poor farmers practiced soil fertility and nutrient management systems on a limited scale compared to resource-rich farmers, resource-poor farmers were selected as the subject of this study. A total of 342 resource-poor farm families from the eight villages were selected as the survey units and the family heads (the principal decision maker of a given family) from each were the population of the study.

About 27% of the total population (92 resource-poor farm families comprised of 39 from the landless category, 34 from the marginal category and 19 from the small category) was randomly selected in proportion to national averages to serve as the sample of the study. Data were collected from those 92 family heads using a structured interview script and group discussion. The script was prepared to ensure that sufficient information was collected to meet the main objectives of the study. Interviews were conducted in-person and survey information was collected during a period spanning December 2005-January 2006.

Selection and Measurement of Constraints on the Implementation of ISF and NM Systems

To identify the constraints under which resource-poor farmers operate, when practicing ISF and NM systems of crop production, 8 group discussions were organized with the help of the personnel of the department of agricultural extension in the farmers' respective areas. Twenty farmers from different categories constituted a group and they were encouraged to list the constraints on them concerning the practice of ISF and NM systems of crop production. Based on the group responses, 14 constraints were selected and the farmers were asked to rate the severity of these constraints as high, medium, low and no constraint and these responses were assigned weights of 3, 2, 1 and 0, respectively. Thus, the total score from a given respondent for the fourteen items could range from 0 to 42. The reliability of these scores was estimated by calculating Cronbach's alpha coefficient, calculated as 0.84. The constraints faced by the farmers, when practicing ISF and NM systems of crop production, were measured and examined in two ways: i) according to a frequency distribution of the total score obtained from respondents for all fourteen items; and ii) by calculating the Constraint Index (CI) to rank the items. The Constraint Index (CI) was calculated using the following formula.

$$\text{Constraint index (CI)} = Phc\times3 + Pmc\times2 + Plc\times1 + Pnc\times0$$

Where:

Phc = Percentage of resource-poor farmers facing high constraints
Pmc = Percentage of resource-poor farmers facing medium constraints
Plc = Percentage of resource-poor farmers facing low constraints
Pnc = Percentage of resource-poor farmers facing no constraints

The Constraint Index (CI) of any item could range from 0 to 300. A value of 0 indicates no constraint while a value of 300 indicates a high level of constraint. Descriptive statistics such as frequency distribution, mean, percentage, standard deviation and rank order were employed to analyze the data using the Statistical Package for Social Sciences (SPSS). All the data collected was grouped, summarized and presented in tabular form.

RESULTS AND DISCUSSION

Field-Cropped Areas and Resource-Poor Farm Families

Land is the basic natural resource that provides a habitat and sustenance for living organisms. It is also a major focus for economic activities. In terms of food production, land is the critical resource

Table 1: Distribution of Field Cropped Area (FCA) of resource-poor farm families

Farmers' categories	Farmers (%)	Land given to others (% of total FCA)			Own cultivation (% of total FCA)
		Share-cropping	Mortgage	Lease	
Landless (<0.2 ha)	35 (30)	19	24	0	57
Marginal (0.2-0.6 ha)	34 (32)	20	12	2	66
Small (0.61-1 ha)	13 (17)	10	9	3	78

Figures in parentheses indicate the national average of land holdings/family, Source: BBS 2004 and Field Survey, 2005-2006

Table 2: Average number of livestock and poultry in each family

Farmers' categories	Cow/bull	Goat	Sheep	Poultry
Landless	0.76	1.02	0.34	6.78
Marginal	1.34	1.56	0.52	6.81
Small	1.83	1.79	0.65	9.78

Source: Field Survey, 2005-2006, the following tables are the same as the survey

concerning food security. The data in Table 1 shows that the percentage of landless and marginal-level resource-poor farmers in the study area was higher than the Bangladesh national average. On the other hand, there were fewer farmers belonging to the small category than the national average.

The amount of field-cropped area given to others as part of a share-cropping or mortgage system by landless and marginal farmers was higher than for small farmers. Thus, the total Field-Cropped Area (FCA) cultivated by small farmers was higher than for the other two categories of farmers. When landless and marginal farmers need large sums of money for their daughter's marriage or emergency needs, they hand over their lands to rich farmers or landlords on the condition that their lands are returned once the loan is repaid. Unfortunately, landless and marginal farmers' poverty means that it often takes a long time for them to recover their lands. This makes their livelihoods more difficult and puts more stress on food security.

Livestock and Poultry Possession by Resource-Poor Farm Families

In developing countries like Bangladesh, in both the wet and dry tropics, livestock and poultry excreta are still an integral component of soil fertility management. Furthermore, excreta comprise a substantial share of the monetary value of livestock products. Many of the nutrients harvested from crops grown on a farm and fed to livestock may be recycled back to crop fields through manure. Thus, manure nutrient management always has been and continues to be an important economic consideration for farms with livestock or poultry (CMEG, 2007).

The data in Table 2 shows that none of the resource-poor landless families have cows or bulls, while the marginal and small categories of resource-poor farm families typically have more than one cow or bull. The marginal and small categories of resource-poor farmers also typically have more goats and sheep than landless farmers. A bull or cow often serves as draft power for land preparation in Bangladesh and excreta from livestock are good sources of organic matter.

During the field survey, it was observed that the landless and marginal families in the study areas use dry cow dung (or a special kind of stick produced from cow dung and home waste) for cooking instead of in the fields, more frequently than small farmers. Consequently, the organic matter content of their soil is gradually decreasing, having a negative effect on soil fertility and overall crop productivity.

Human Capital, Education and Expertise of Resource-Poor Farm Families

Following the importance of land and livestock possession, the education and expertise of active family members are some of a rural Bangladeshi family's resources. The data in Table 3 shows that the average number of members active in crop production is higher for landless families than for marginal

Table 3: Active members, education and training experience of resource-poor farm families (per family)

Farmers' categories	Active members (15-50 years)	Family education (years of schooling)	Training experience (times of training received in a year)
Landless	5.16	3.61	2.31
Marginal	4.35	4.52	2.48
Small	4.11	6.29	4.79

Table 4: Yield obtained by the different categories of farmers Unit

	Rice						
Farmers' categories	Aus	Aman	Boro	Wheat	Potato	Mustard	Pulses
	(mt ha^{-1})						
Landless	1.12 (0.84)	1.58 (0.90)	2.11 (0.92)	1.59 (0.91)	7.86 (0.93)	0.43 (0.81)	0.62 (0.83)
Marginal	1.20 (0.87)	1.69 (0.91)	2.20 (0.93)	1.70 (0.93)	8.21 (0.93)	0.51 (0.85)	0.68 (0.86)
Small	1.53 (0.97)	1.97 (0.96)	2.58 (0.97)	1.98 (0.96)	9.72 (1.01)	0.72 (0.92)	0.96 (0.81)

Figures in parenthesis () indicate ratios compared with national average yield

and small farm families. Small farm families' maximum educational level and of the amount of training received by actively farming family members is higher than for marginal and landless farm families in the study areas.

The children of landless and marginal farmers often cannot get the opportunity to continue their education after the elementary level because of their family's lack of financial resources. After dropping out of school, they help their parents' farm or work as day laborers. By contrast, the children of small farm families continue their education past the secondary level. If they drop out at the secondary level, they receive training from government agencies or NGOs and start earning income.

Members of small farm families receive training from organizations that face fewer problems thanks to greater resources and higher organizational participation. The educational status and income of a family are some of the factors influencing a family's likelihood of adopting (and continuing to use) a new technology (WB, 2004). Therefore, improving the educational level of and training available to, landless and marginal farm families will increase the likelihood that ISF and NM systems will be implemented to improve crop production.

Crop Yields for Different Categories of Farmers

The data in Table 4 demonstrates that based on national average yield data for several crops, gaps exist between the yields obtained by small farmers and to the yields obtained by landless and marginal farmers. In some cases, the yields obtained by small farmers in the study areas are even higher than the national average. This is because small farmers possess more resources and are more involved in ongoing soil fertility management than landless and marginal farmers. Even so, small farmers do not practice sufficient soil fertility management.

The soil is viewed as a fragile, living medium that must be protected and nurtured to ensure its long-term productivity and stability. Plant nutrients, on the other hand, need a given quantity and mix of nutrients for the proper growth and development of crop plants. According to IAC (2004), agronomic measures to improve soil fertility and crop productivity along with the proper management of available plant nutrient resources might lead to dramatic yield improvement. One of the many reasons landless and marginal farmers in the study area have lower crop yields than small farmers is that they have limited facilities to practice improved soil fertility and nutrient management systems.

Comparative Constraints Faced by the Different Categories of Resource-Poor Farmers

The data in Table 5 indicates that an overwhelming majority of the landless (90%) and marginal (76%) categories of resource-poor farmers face a high level of constraint, while less than one-half (47%) of small farmers face a high level of constraint. Medium level farmers faced the lowest level of constraint (42%). Since small farmers are comparatively better off than the landless and marginal

Table 5: Farmers' overall constraints

Farmers' categories	Level of constraints faced (score)	Farmers No. (%)	Observed range	Mean	SD
Landless (39)	Medium (20-26)	4 (10)	20-36	32.56	3.42
	High (27-36)	35 (90)			
Marginal (34)	Medium (20-26)	8 (24)	20-35	27.31	3.19
	High (27-35)	26 (76)			
Small (19)	Low (14-19)	2 (11)	14-32	23.18	2.53
	Medium (20-26)	8 (42)			
	High (27-32)	9 (47)			

Table 6: Farmers' constraint index (CI) with rank order by constraint

	Farmers' constraint index (CI)		
Statements of constrains	Landless	Marginal	Small
Lack of knowledge about ISF and NM system	274 (1)	266 (1)	208 (4)
Financial inability to buy fertilizers in time	267 (2)	261 (2)	220 (3)
Unavailability and unstable market price of fertilizers during crop seasons	257 (4)	254 (3)	252 (1)
Lack of knowledge about the beneficial aspect of combined use of organic manures and fertilizers	244 (3)	218 (5)	135 (8)
Limited initiative by the extension department to motivate farmers about practice of ISF and NM system	230 (5)	235 (4)	223 (2)
Lack of knowledge in preparing organic manure and its role regarding soil fertility and crop production	214 (6)	209 (6)	144 (11)
Inadequate training facilities about ISF and NM system	206 (7)	201 (7)	131 (9)
Lack of knowledge about the beneficial aspects of crop rotation and crop residue management	197 (8)	190 (8)	124 (12)
Use of cow dung and crop residues for cooking due to shortage of bio-fuel	189 (9)	179 (10)	128 (10)
Lack of commitment of extension workers and their biased role	184 (10)	180 (9)	191 (5)
Limited demonstration plots emphasizing balanced fertilization	172 (11)	161 (11)	176 (7)
Scarcity of lands for cultivating green manure crops	184 (12)	183 (12)	184 (6)
Inability to understand the contents of printing materials due to shortage of education	150 (13)	145 (14)	111 (14)
Lack of knowledge about beneficial aspects of legume and cover crops	140 (14)	132 (13)	118 (13)

Figure in parenthesis () indicate the rank order of constraints

categories of resource-poor farmers, landless and marginal farmers are more vulnerable and face more constraints. However, most soil fertility and nutrient management techniques require cash and labor.

As the landless and marginal categories of resource-poor farmers mostly belong to medium and large families, they rarely face labor shortages. Typically they are plagued by financial problems. When small farmers face a financial crisis, they can borrow money from money lenders or from the agricultural bank and face fewer problems because of the resources they possess. Thus, the landless and marginal categories of farmers face more barriers to the purchase of inputs such as chemical fertilizers (Shamsuddoha and Choudhury, 2005).

By creating income-generating opportunities for poor families, those farm families will earn cash that can be used to purchase essential inputs such as chemical fertilizers. Furthermore, the government should strictly control the fertilizer distribution system to ensure honest dealers. Initiative should be taken to increase the knowledge base of poor farm families so that they can think, more carefully about the appropriate use of soil and nutrient management techniques.

Constraints Faced by Resource-Poor Farmers Regarding the Practice of ISF and NM Systems

The productivity and stability of soil depends greatly on the proper management of its fertility by farmers. On the other hand, a higher level of agricultural production requires an increased and/or more efficient use of plant nutrients from both chemical and organic sources. The data in Table 6 shows that based on the CI, the top two constraints for landless and marginal farmers were the lack of knowledge about ISF and NM systems and the lack of financial resources to buy fertilizers in time.

Table 7: Resource-poor farmers' practice of ISF and NM system by level of constraints

	Farmers' percentage by level of practice			
Level of constraints	Regularly	Occasionally	Rarely	No.
Low	40	30	24	6
Medium	18	23	40	19
High	8	15	49	28

On the other hand, the unavailability and unstable market price of fertilizers during crop seasons and the limited initiative by the agricultural extension department to motivate farmers to practice ISF and NM systems were the top constraints on small farmers according to CI, in order.

Because the activities of the agents of the department of agricultural extension are biased, resource-poor farmers are often deprived of the benefits of modern agricultural technology. Most training, demonstrations and other motivational activities of the ongoing soil fertility management project mainly benefit resource-rich farmers (medium and large farmers). On the other hand, due to the poor finances of landless and marginal farmers, they can hardly afford to buy chemical fertilizers from these services. To improve production it is critical to apply fertilizers at the right time in the proper amount. Fertilizer dealers in Bangladesh are often selected based on their political affiliation. After getting selected, they often involve themselves in unlawful marketing that creates artificial crises, resulting in high fertilizer prices during the peak period of cropping seasons. Consequently, resource-poor farmers have difficulty acquiring essential fertilizer at the proper time.

Resource-Poor Farmers' Constraints and the Extent of Their Practice of ISF and NM Systems

The data in Table 7 shows that two-fifths (40%) of the resource-poor farmers practice ISF and NM systems regularly and those who face a low level of constraints do so occasionally (30%). The highest proportion (63%) of farmers practice ISF and NM systems either rarely or occasionally when under medium constraints while about one-half (49%) of farmers practice such techniques rarely and some (28%) do not practice such techniques at all.

Based on the above findings, it is understandable that the extent of the constraints faced by resource-poor farmers and their level of practice of ISF and NM systems has an inverse relationship. The landless and marginal farmers, who constitute about 60% of the farming community, practice ISF and NM systems either occasionally or rarely. Many crop production scientists argue that improper management of soil and plant nutrients, along with the longtime practice of conventional farming systems, are the major reasons for reduced soil fertility and declining crop productivity. By contrast, the regular practice of ISF and NM systems incorporates many technologies (including soil conservation, biological nitrogen fixation and organic and inorganic fertilizer application) that lead to improved soil fertility and crop productivity in a sustainable manner (IFPRI, 2004).

CONCLUSIONS

Among the three categories of resource-poor farmers, the magnitude of the constraints faced by the landless and marginal categories of resource-poor farmers concerning Integrated Soil Fertility (ISF) and Nutrient Management (NM) systems was higher than for the small category of farmers. The resources possessed by the small farmers are greater than for the other two categories. According to the Constraint Index (CI), a lack of knowledge about ISF and NM systems and a lack of financial resources necessary to buy fertilizer in time were the major constraints that landless and marginal farmers face regarding the practice of ISF and NM systems. The unavailability and unstable market price of fertilizers during crop seasons and the limited initiative of the agricultural extension department to motivate farmers to practice ISF and NM systems were the major constraints for small farmers concerning the practice of ISF and NM systems in the study areas. Since an inverse relationship exists

between the extent of constraints faced by resource-poor farmers and the level of practice of ISF and NM systems, measures should be taken to minimize the major constraints on the practice of ISF and NM systems to improve crop production and conserve soil fertility.

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