Determinants of adoption decisions: The case of organic farming (OF) in Bangladesh

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Abstract. The purpose of this study is to investigate the influences on decisions by Bangladeshi farmers regarding whether to adopt organic farming (OF) practices. The study population consisted of all the farmers in three villages (Pirojepur, Kuragasa, and Lokdeo) within the Madhupur sub-district in the Tangail district in Bangladesh. Empirical data were collected from 195 farmers via questionnaires. Among the respondent farmers, the majority (75%) were adopters of OF. The results of a logit regression model showed that perceptions of OF, household access to extension services, number of family labourers and household income were significantly associated with decisions to adopt OF. However, only Non Government Organizations (NGOs) are currently promoting OF in Bangladesh and public sector extension has yet to begin promoting OF. Thus, to encourage the rapid expansion of OF in Bangladesh, it is essential to formulate an OF promotion policy, taking into account the above factors that influence farmers' adoption decisions.

Keywords: Adoption decision, organic farming, Bangladesh

Introduction

Bangladesh is an agrarian country in South Asia with a population of around 150 million, of which 53% live below the poverty line (World Bank 2005). The major source of livelihood is agriculture. The Government of Bangladesh (GOB) is committed to meeting the Millennium Development Goals (MDGs) by halving the level of extreme poverty, protecting the environment, and promoting a global partnership in development by 2015. Special effort is needed to increase the profitability of agriculture in Bangladesh and thereby reduce rural poverty, which requires a 4% growth rate in the agricultural sector (Poverty Reduction Strategy Paper (PRSP) 2005).

Thus, the agriculture sector in Bangladesh is the most important sector in terms of sustaining growth and reducing poverty. However, a lack of adequate nutrient supply, the depletion of organic matter in soils, and soil erosion are major obstacles to sustainable improvements in agricultural production (Ministry of Agriculture 2008). The total amount of fertilizer used in Bangladesh has increased by about 1.55 million tons from 1994–95 to 2006–07, although the use of urea fertilizer has only increased by about 0.95 million tons over this period (Bangladesh Economic Review 2008). The use of pesticides increased from 7,350 metric tons in 1991 to 16,200 metric tons in 2001 (Ministry of Agriculture 2005), more than doubling over the course of a decade. Among this huge amount of pesticides, insecticides accounted for about 90%, and are generally used for vegetables and *boro* rice (UNDP 2006). This huge consumption of chemical fertilizers and pesticides applied to 7.32 million hectares of cultivated land (Bangladesh Bureau of Statistics 2008) represents an over-use of agro-chemicals and a waste of foreign currency reserves, as the country imports most of the applied agro-chemicals, except for urea fertilizers.

Given the challenges that arise from the over-use of agro-chemicals, a key policy intervention for sustainable agriculture is to encourage the adoption of agricultural technologies that rely to a greater extent on local or renewable resources. Organic farming (OF) is one such technology that can reduce the harmful impacts of agro-chemicals, and is considered by many scientists to be the best form of agriculture in terms of maximizing cost-effectiveness and minimizing pollution (Christian et al. 2005). OF in Bangladesh was first introduced by Proshika (a renowned national-level NGO) in the early 1980s to facilitate the growing of varieties of seasonal vegetables in a manner that is sustainable, productive, equitable and conducive to biodiversity (Proshika 2004).

The name 'PROSHIKA' is an acronym of three Bangla words that mean training, education, and action. Proshika, one of the largest NGOs in Bangladesh, started work in several villages within the Dhaka and Camilla districts in 1975, and over the years has created millions of job opportunities for the poor, brought over one million households out of poverty, helped over a million people to become literate and planted nearly a billion trees with the aim of greening Bangladesh.

Human development and empowerment of the poor are central goals of the Proshika program, and the poor are assisted to stand tall in escaping poverty by their own endeavors. Empowerment means that the poor are united and organized, become aware of the causes of their impoverishment, develop leadership among themselves, mobilize their material resources, increase their levels of income and employment, develop the capacity to cope with natural disasters, become functionally literate, take better care of their health, become engaged in environmental protection and regeneration, become elected in local government bodies and community institutions, and have better access to public and common property resources.

Progress in adopting OF has been very slow in many regions of Bangladesh, even though the country has great potential in this regard because of surplus labour, huge crop diversity, and considerable investment by Proshika and other NGOS since the 1980s (Sarker and Itohara 2008). Many studies have been conducted in Bangladesh to examine the determinants regarding the use and resulting economic impact of chemical fertilizer, improved seeds, improved agricultural practices, and Integrated Pest Management (IPM) technology (e.g. Haider et al. 2001; Hoque and Miah 2001; Hossain et al. 2003). However, to the best of our knowledge, no study has examined the determinants that influence the adoption of OF by farmers in Bangladesh. Therefore, the present study was carried out to investigate factors that influence the adoption of OF in Bangladesh.

Adoption of Organic Farming: Conceptual Framework

Rogers (1995) stated that the "adoption of an innovation is related to innovation-decision process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude towards the innovation, deciding to adopt or reject the innovation, implementing the new idea, and confirming the innovation decision".

Adoption models are generally based on the theory that farmers make decisions in order to maximize their expected profits or utility. On the other hand, farmers' utility is dependent on optimizing productivity and minimizing the costs of cultivation to attain maximum profits. Feder et al. (1985) stated that farmers adopt or practice new technologies when they expect a more profitable outcome than that gained from existing technology. Optimizing utility may also include considerations such as health benefits, environmental concerns, food security and risk (Ribaudo 1998; Napier et al. 2000).

The adoption of an innovation can be measured as the extent of its use, producing a continuous dependent variable, or simply the use of the innovation, producing a dichotomous dependent variable. In this study, a dichotomous, dependent variable approach is used, with OF adoption defined as growing crops using organic methods of cultivation in the three cropping seasons of 2007 and previous years. Non-adoption was defined as not using organic cultivation methods in any portion of cultivable land in 2007.

Adesina and Zinnah (1993) emphasized the impact of farmer perceptions on innovation-related characteristics in measuring adoption. The present study is based on the combination of Rogers (1995) innovation-decision paradigm and adopter-perception paradigm proposed by Wossink et al. (1997), whereby farmers are assumed to hold specific perceptions regarding the effects of an innovation, and these subjective evaluations can be significant factors in their adoption decisions.

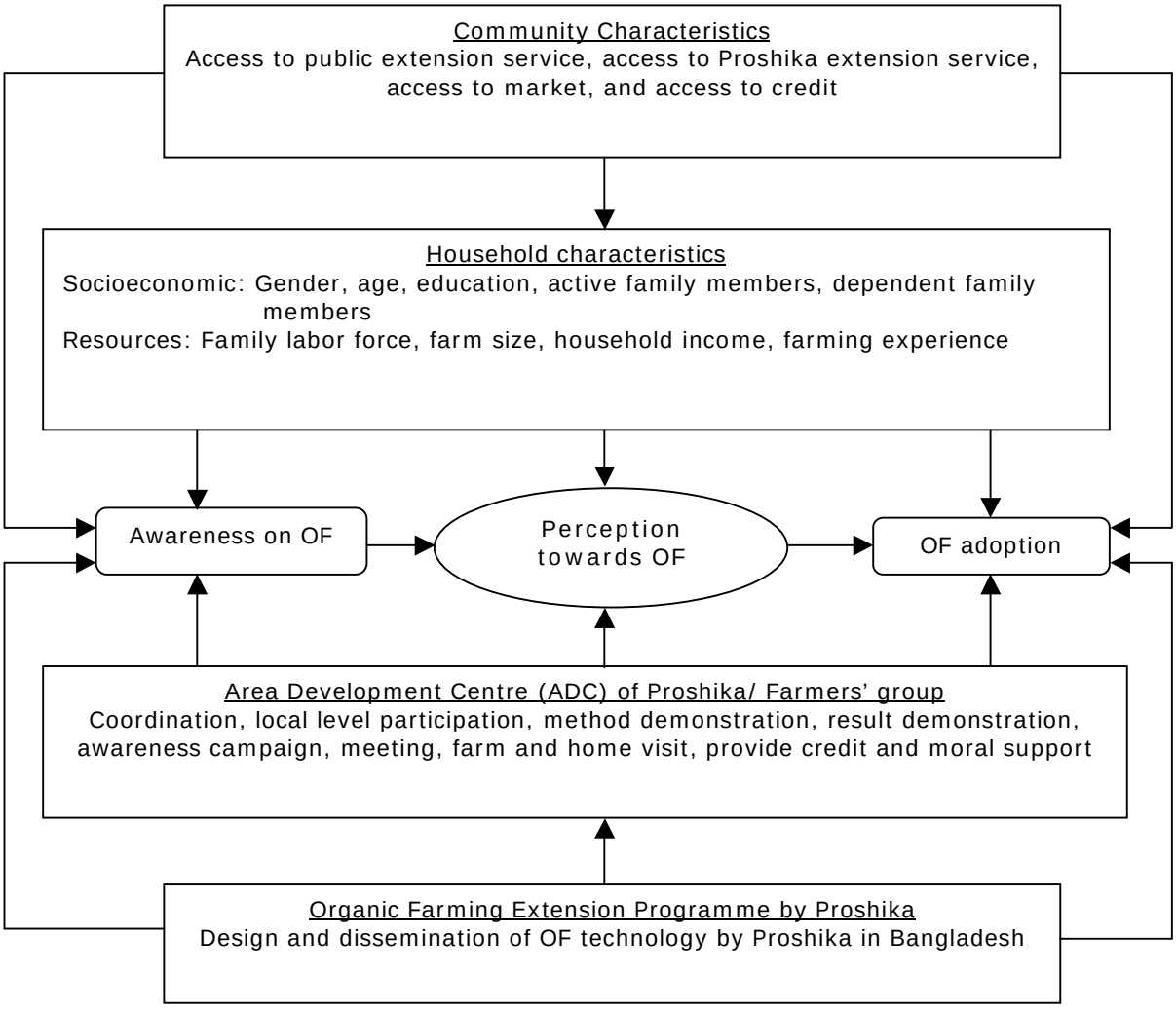
In this study, OF adoption was described as a mental process, farmers go through a stage of being aware or knowledgeable of OF related technology, to forming positive or negative perception towards OF, and ultimately decide whether to adopt or not. This process can be influenced by a wide variety of factors, including household factors (socioeconomic, resource-base), community factors (access to extension, market, credit) and perception towards OF (generally developed by the promotion of Proshika in the studied villages). The framework provided in Figure 1 forms the basis for selecting relevant variables influencing OF adoption in the studied villages.

It is assumed that these subjective perceptions, along with other individual and household characteristics of the farmers, contribute to a farmer's utility of OF. Conceptually, adoption becomes more likely when the subjective utility of adoption (U_{OF}) increases relative to that of conventional farming (U_{CF}), with adoption occurring when $U_{OF} > U_{CF}$. For an individual farmer:

$$P_{OF} = f(h, c, p) \quad (1)$$

where $P_{OF,}$ is the probability of OF adoption; *h* is a vector of the variables related to household characteristics; *c h* is a vector of the variables related to community characteristics and *p,* is a vector of the variables related to the farmer's perceptions of the effects of OF.

Figure 1. OF adoption framework



A dichotomous logit regression model, using maximum likelihood methods, was employed to estimate the probability of OF adoption. When the dependent variable is binary, the linear probability model (LPM), logit and probit can be used (Ramnathan 1998; Greene 2000). Logit and probit models are quite comparable, however the logistic has slightly flatter tails. Thus, the choice between the two is one of convenience and ready availability of computer programs. On this score, the logit model is usually used in preference to the probit (Gujrati 1995). However, logit model have been widely used in order to explore the factors affecting farmers' decision in adoption studies (Jarvis 1981; Feder and O'Mara 1982; Rogers 1983; Adesina et al. 2000; and Vandeveer 2001). The statistical package SPSS version 17 was used for the analysis, and the logit regression assumed a cumulative probability function; consequently, the model can be described as follows:

$$P_{OF} = \frac{1}{1 + e^{-f(i,h,p)}} \qquad (2)$$

Methods

Study area

The Madhupur sub-district, within the Tangail district of Bangladesh, was selected for analysis because Proshika has been promoting OF (non-certified) among farmers in this area for around a decade. Proshika's technical workers try to communicate with all farmers and provide information regarding OF techniques. Farmers who show interests in the OF program are included in the OF group and provided with training, credit, and other logistical support to assist them in adopting OF. Moreover, Proshika's technical workers manage demonstration plots on the land of adopter farmers, thereby motivating neighbouring farmers to adopt OF. Three

villages (Pirojepur, Kuragasa, and Lokdeo) were selected as study villages. Excluding the OF project villages managed by Proshika and several other NGOs, there exists no formal OF in Bangladesh. These three villages were selected because Proshika is promoting OF at all three sites. The majority of the people in these villages are farmers who grow a variety of vegetables and rice following both conventional and organic methods. However, a significant portion of the smallholder farmers in these villages is growing organic vegetables according to Proshika's guidelines.

Population and Sample

The population analyzed in this study consisted of farmers from the three selected villages who grew vegetables or rice in 2007. Lists of the farmers within the villages were collected from the relevant Sub-Assistant Agricultural Officers (SAAO) of the Department of Agricultural Extension (DAE). From the three lists, a total of 195 farmers were randomly selected and interviewed. Table 1 summarizes the distribution of the sample across the three villages.

Table 1. Summary of the sample size

District & Sub-district	Study villages	Number of sample farmers
Tangail	Pirojepur	66
Madhupur	Kuragasa	60
	Lokdeo	69
	Total	195

Prior to data collection, a pilot survey was undertaken to pre-test the questionnaire, targeting 15 farmers from the three villages not on the interview list.

Data collection

The empirical data analyzed in this study were collected by personal interviews conducted with the respondent smallholder farmers from 10th December 2007 to 12th January 2008. The authors and three trained data collectors conducted the interviews.

Statistical analysis

An unequal individual sample t-test was used to test for differences between the socio-economic profiles of the adopter and non-adopter organic farmers. Logistic regression analysis was used to identify the significant determinants that influence the decision to adopt OF.

Measurement of dependent and explanatory variables

The dependent variable was dichotomized with a value of 1 if a farmer was an adopter of OF and 0 if otherwise. The explanatory variables of the study were classified into three groups: individual-level, household-level, and perception-related variables.

Individual-level explanatory variables were the gender, age, education level, and farming experience of the household head. Household-level variables were the number of active family members, number of dependent family members, number of family labourers, farm size, household income, households' access to credit, households' access to market, households' access to public extension services, and households' access to Proshika extension services. The sole perception-related variable was the farmer's perception of OF. Table 2 lists definitions of the variables and measurement methods.

Results and Discussion

Descriptive statistics

The characteristics of respondent farmers are listed in Table 3. The average age of the household head was 35.89 years, with 65% of the household heads being male. The average education of the household head was very low (3.3 years of schooling); average farming experience was around 20 years. The average farm size was small (0.7 ha). There was an average of 2.93 active members (aged 15–60 years) in each household, and an average of 1.75 dependent members (aged < 15 years or > 60 years) per household. Each family contained an average number of 2.08 labourers.

Table 2 Description of the variables used in the logit model

Variable	Type	Measurement
Dependent variable		
Y_i	Dummy	1 if farmer has adopted OF, otherwise 0
Explanatory variables		
Gender	Dummy	1 if household head is male, otherwise 0
Age of household head	Continuous	Age of the household head (years)
Education of household head	Continuous	Formal education of the household head (years of schooling)
Farming experience of household head	Continuous	Farming experiences of the household head (years)
Active members	Continuous	Number of active (aged 15–60 yrs) members in the family (persons)
Dependent members	Continuous	Number of dependent (aged <15 or >60 yrs) members in the family (persons)
Family labor size	Dummy	Number of family members working on the family farm (persons)
Farm size	Continuous	Amount of land under cultivation (ha)
Household income	Continuous	Amount of money earned by the family members in a year ('000 BDT)
Households' access to credit	Dummy	1 if at least 1 family member has access to formal credit, otherwise 0
Households' access to market	Dummy	1 if household has access to buy organic inputs and sells organic produce at a local market, otherwise 0
Households' access to public extension services	Dummy	1 if at least 1 family member has access to DAE's extension services, otherwise 0
Households' access to Proshika extension services	Dummy	1 if at least 1 family member has access to Proshika extension services, otherwise 0
Perception on OF	Dummy	1 if the household head perceives that OF can improve income, improve the supply of healthy foods, and reduce environmental pollution caused by agro-chemicals, otherwise 0

Table 3. Descriptive statistics of explanatory variables by adopter and non-adopter groups

Variable (units)	Mean			SD (all farmers)	t-statistic
	All farmers	Adopters	Non-adopters		
Individual variables					
Gender (0/1)	0.65	0.74	0.38	0.48	4.5*
Age of household head (yrs)	35.89	40.16	22.43	17.22	4.93*
Education of household head (yrs)	3.30	3.85	1.57	3.51	5.43*
Farming experience (yrs)	20.42	22.92	12.55	13.35	1.79*
Household variables					
Active members (persons)	2.93	3.86	1.51	1.88	9.79***
Dependent member (persons)	2.08	1.71	3.23	1.61	-5.06**
Family laborers (persons)	1.6	1.89	0.7	1.03	9.15***
Farm size (ha)	0.7	0.31	1.95	1.81	-3.73**
Household income ('000 BDT)	72.91	87.68	26.38	54.65	9.6***
Household access to credit (0/1)	0.38	0.44	0.21	0.49	2.88**
Household access to market (0/1)	0.34	0.34	0.34	0.47	0.0
Household access to public extension services (0/1)	0.77	0.68	0.72	1.02	-1.89*
Household access to Proshika's extension services (0/1)	0.57	0.70	0.19	0.51	7.29**
Perceptions variable					
Farmer's perception of OF (0/1)	0.72	0.92	0.21	0.45	11.83***

Note. ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level

The average household income was around 73,000 BDT (Bangladeshi currency; 1USD = 70 BDT as of October 2009). The average household access to credit was similar to the average access to market (about 0.35). Households had greater access to public extension services than to NGO (Proshika) extension services. The average perception of respondent farmers regarding the benefits of OF was 0.72. There were significant differences between adopter and non-adopter farmers of OF in terms of all socio-economic factors, except household access to market. Table 3 shows that, adopter farmers of OF have less access to public extension services and more dependent family members compared with non-adopters. For other factors, adopter farmers fared better than did non-adopters. It is evident from Table 3 that the average farm size of the non-adopter was 1.95 ha while, it was only 0.31 ha in the case of adopters.

Status of OF adoption

Among the respondent farmers, 77% were adopters of OF and 23% were non-adopters. Among the three study villages, the rate of adoption was highest at Kuragasa village (80%). The rates of adoption at Pirojepur and Lokdeo villages were 79% and 72%, respectively.

Table 4 shows that among the respondent farmers, only one (from Kuragasa village) had adopted OF 9 years ago (when OF was launched in this sub-district). After observing the success of this innovator of OF, neighbouring farmers also started to adopt OF. This argument is supported by the findings of Sarker (2007) that confirmed that a majority of the farmers in the Madhupur sub-district were motivated to adopt OF by the success of the neighbouring farmers. The results show that 19% of farmers adopted OF during the early years of OF promotion (6–8 years ago); the majority of farmers (44%) adopted OF 4–5 years ago, and only 13% adopted OF less than 3 years ago.

Table 4. Status of organic farming adoption among the farmers of the study villages

Adoption decision	Study village						Total	
	Pirojepur		Kuragasa		Lokedeo			
	f	%	*f*	%	*f*	%	*f*	%
Not adopt (0)	14	21.21	12	20.0	19	27.54	45	23.08
Adopt (1)	52	78.79	48	80.0	50	72.46	150	76.92
Innovators (9 yrs)	0	0	1	2.08	0	0	01	0.7
Early adopters (6–8 yrs)	12	23.08	10	20.83	7	14.0	29	19.3
Early majority (4–5 yrs)	27	51.92	20	41.67	19	38.0	66	44.0
Late majority (3 yrs)	09	17.30	12	25.0	20	40.0	41	27.3
Laggards (<3 yrs)	04	7.69	5	10.42	4	8.0	13	8.7

Logit analysis of organic farming adoption

An important purpose of this study was to explore the important factors that influence farmers' decisions to adopt OF. To this end, we performed logit regression analysis (Table 5). The obtained log likelihood ratio is 46.37 and the chi-square statistic for the goodness of fit of the model is 169.01, significant at the 1% level. The pseudo R^2 value of the model is 0.58. Thus, the overall model is significant and the explanatory variables used in the model are collectively able to explain the farmers' decisions regarding the adoption of OF.

The results demonstrate that farmers' perception of OF is very significant in terms of OF adoption decisions. It is logical to expect that if a farmer has a positive perception of OF (i.e., that it is able to improve his income, has the potential to supply safe food, and is the best way to minimize environmental pollution caused by agro-chemicals compared with conventional framing), then the farmer is likely to decide to adopt OF. Another study of Sarker and Itohara (2009) showed that among the OF adopters 62% had perception that Proshika's organic agriculture extension programme is effective in improving their income, supplying more amount of safe food and reducing environmental pollution caused by agrochemical. The findings of Neupane et al. (2002) also support that farmer's positive perceptions towards a technology (agroforestry) have significantly positive effects on adoption decision.

Next to the perception to OF, household income was an important factor in terms of adoption decisions. This finding reflects the fact that farmers with higher income are more likely to adopt risky technology compared with those with a low income (Batz et al., 1999; Kivlin and Filegel, 1966). The other important factor in terms of decisions to adopt OF was the use of public and Proshika extension services. The use of Proshika (NGO) extension services was significant at the 5% level, while the use of public extension services was significant at the 10% level. This

finding reflects the fact that Proshika OF promotion has some influence to increase OF adoption in the three studied villages. Though, every farmer has access to public extension service, it has no program to promote OF. However, public extension in Bangladesh promotes IPM which is an important component of OF.

Table 5. Logit regression model estimates of coefficients associated with OF adoption

Parameter	Estimate	Std. Error	Z	Significance
Gender	.665	.873	.762	.446
Age of household head	.006	.032	.177	.860
Education of household head	.064	.101	.632	.527
Farming experience of household head	-.024	.035	-.687	.492
Active members	.156	.251	.622	.534
Dependent members	-.339	.194	-1.748	.080*
Family laborers	.759	.402	1.888	.059*
Farm size	.207	.186	1.117	.264
Household income	.034	.012	2.816	.005***
Households' access to credit	-.022	.746	-.029	.977
Households' access to market	-.804	.735	-1.095	.274
Households' access to Proshika extension services	1.356	.601	2.257	.024**
Households' access to public extension services	.682	.443	1.541	.123*
Perception of OF	2.104	.607	3.466	.001***
Intercept	-3.868	1.597	-2.423	.015
χ^2 statistic with 14 df	169.01 ($P<0.000$)			
Pseudo R^2	0.58			
Log likelihood ratio	46.37			

Note. ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level

OF requires more manual labourers than does conventional farming; consequently, households with a larger number of family labourers are more likely to adopt OF. This hypothesis is supported by the findings of Feder et al. (1985) and he reported that large number of family members able to join on-farm activities enable farmers to adopt a labour intensive technology. Conversely, households with larger numbers of dependent members are more vulnerable to food insecurity; consequently, the number of dependent members shows a negative relation with OF adoption.

Conclusions and Recommendations

The results of the present study demonstrate that farmers' perception of OF is a very important factor in decisions to adopt organic farming. Farmers perceive that organic farming systems lead to improved income, improved supply of safe food, and reduced environmental pollution. These beliefs are based on the logic that expensive agro-chemicals are not used in organic farming; consequently, the cost of production is relatively low and the price premium attained by organic produce leads to increased profit. Thus, it is essential to make farmers aware of the benefits of organic farming via intensive education campaigns. The present results also revealed that both public and NGO extension services are important in terms of farmers' decisions regarding the adoption of organic farming. Thus, it can be concluded that the adoption of organic farming systems is an information-intensive process and that there are likely to be opportunities for providing extension programs and localized information to increase the use of organic farming by Bangladeshi farmers. Finally, to rapidly increase the rate of adoption of organic farming in Bangladesh, it is essential for the Government of Bangladesh to formulate a National Organic Farming Promotion Policy, taking into account the determinants found to be influential in the present study.

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