Plant Clinics in Bangladesh: Performance and Impacts

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CABI • AAS •RDA • SHUSHILAN

The Global Plant Clinic

The GLOBAL PLANT CLINIC (GPC) is an alliance of plant health and agricultural organisations in Latin America, Africa and Asia and is managed by CABI. The GPC helps to establish independent plant health clinics and strengthen plant health systems which link farmers to extension, research, regulation and input suppliers. There are currently over 90 clinics in nine countries, with expansion to new regions and countries. The GPC trains plant doctors and scientists, introduces quality control systems, monitors impact and does research on plant health services and extension. The GPC alliance maintains vigilance of plant diseases through clinic records backed up by CABI's expert diagnostic service. The aim of the GPC alliance is to create durable plant health services for those who need them most.

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Front cover
Nobir, a farmer in Natore, shows off the brinjal he grew after consulting with the plant clinic in Moukhara. (The wire passing in front of him is tape, set out to scare birds, another unsolved problem).

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Annexes

A one page interview may take 10 or 15 minutes to do

Acronyms

AAS	Agricultural Advisory Society
BADC	Bangladesh Agricultural Development Corporation
BLB	Bacterial leaf blight
BSFB	Brinjal shoot and fruit borer
CABI	-
CPD	Community plant doctor
DAE	Department of Agricultural Extension
DFID	Department for International Development
FDFI	Flower dropping & fungus infection
FDII	Fruit dropping & insect infestation
Fig	Figure
FRD	Fruit reddening & dropping
GPC	Global Plant Clinic
ha	Hectare
kg	Kilogram
PC	Physical capital
PRSV	Papaya ring sport virus
RDA	Rural Development Academy
SE	Standard Error
Shushilan	"Good Practice"
Sig	Significant
SPSS	Statistical Package for Social Science
t	Ton
tk	Taka (Bangladeshi currency, about 67 to the US dollar)
TV	Television
UK	United Kingdom
YVCMV	Yellow vein clearing mosaic virus

Introduction

Agriculture accounts for about 19% of Bangladesh's gross domestic product and about 10 % of export earnings, but provides 45% of total national employment. About 80% of the 150 million Bangladeshis depend on agriculture for their subsistence. Bangladesh now deems itself to be self-sufficient in food grain production. This is a great accomplishment as food security has long been a major part of national policy. Pest losses vary from 10 to 25% of harvest (depending on the crop, year etc.). Bangladesh is lagging behind in the development of efficient, eco-friendly, plant health management. About 49,000 tons of pesticides are used every year in Bangladesh.

About 75% of Bangladesh's farmland is in rice and the other 25% is planted in over 50 crops, including high value vegetables, fruits and spices which have become much more common since 1985, in response to market demand. But these high value crops are now threatened by rising production costs. Pest and disease losses are increasing for rice and other crops. Farmers are increasingly dependent on the frequent use of highly toxic pesticides. Farmers are concerned about pesticide adulteration by wholesalers and retailers, while using pesticides based on advice from local dealers, leading to pesticide abuse. The DAE (Department of Agricultural Extension) does minimal monitoring of pesticide use at the field level. Agricultural research institutes have no role in monitoring. The agro-chemical industry has done little or nothing to police itself. Most farmers want to protect their crop with chemicals, partly due to motivation by DAE, BADC (Bangladesh Agricultural Development Corporation,) agricultural research institutes and pesticide companies since the 1960s. The current low-level of plant protection safety may lead to greater human health risks to consumers and sprayers. Current pesticide use is top-down and gives little consideration to farmers' roles and perceptions. To understand plant health problems, AAS, RDA and Shushilan have established 18 plant clinics in Natore, Bogra and Satkhira districts.

The plant clinic is a centre where investigation and diagnosis of plant health problems can be undertaken and advice on control measure dispensed. It can also provide a base for doing surveys of crop health problems and farmers' needs and as an information centre for extension service providers and farmers. The plant clinic is a new approach for providing effective plant health services on plant health problems to farmers. The approach was introduced for the farmers in Shahjahanpur upazila of Bogra district in 2004, in Baraigram upazila of Natore district by AAS in 2005 and in Kaliganj upazila of Satkhira district in 2006 with funding and technical support from CABI, UK. In view of the objectives of the Global Plant Clinic (GPC—an alliance of CABI and other institutions, which receives funding from DFID), AAS, RDA and Shushilan established a network of model plant health management through 18 permanent plant clinics to ensure better plant health management services to the farmers in Natore, Bogra and Satkhira districts, so they can enhance their crop production, reduce production costs by diminishing the use of chemicals, increase their income and remove the risk of crop failure due to the pest and disease infestation and finally, protect the environment from pollution. Over 36,000 farmers visited the 18 plant clinics, including 14,200 to the 12 AAS clinics in Natore, 4,400 to the three clinics in Satkhira (with Shushilan) and 18,000 to the RDA clinics in Bogra.

Objectives

(i) Assess the plant clinics operated by AAS, RDA and Shushilan.

(ii) Evaluate the performance of the plant clinics.

(iii) Assess the impact of plant clinics on client farmers in Natore, Bogra and Satkhira districts.

Copying some data from the clinic register onto the survey form before starting the interview

Method

The study was designed to assess plant clinic operations, performance and impact in Bangladesh. The design and methods were prepared by Dr. Jeffery W. Bentley of the GPC and Harun-Ar-Rashid of AAS, later tested in the field, and shared with relevant staff of involved organizations before finalizing the design and methods.

The study was conducted with 350 respondents at 18 sites within the areas of influence of the 18 plant clinics of Agricultural Advisory Society (AAS), Shushilan and Rural Development Academy (RDA) (Table1 and Fig 1). A few respondents were interviewed twice, for different crops.

Study team

The study was conducted by Harun-Ar-Rashid, AAS, with staff of AAS, Shushilan and RDA in consultation with Jeffery Bentley, GPC. Field data was collected by Mr. Alok Kumar Biswas, AAS, in collaboration with staff of AAS, Shushilan and RDA. Data were entered and analysed by AHM Asadur Rahman, AAS. The study was conducted from September 2009 to January 2010.

Questionnaire

Before starting to gather field data, Bentley and Harun-Ar-Rashid wrote a single page questionnaire (Annex 1), based on an earlier one the GPC used in Bolivia (Bentley et al. 2010). Just before starting the questionnaire, the interviewer copied some information from the clinic register: the crop queried, diagnosis and recommendations given from the plant clinic. Then the interviewer asked the farmer how he or she used the diagnosis and recommendations, how much it cost to apply the recommendation, over how much land, the subsequent crop yield, sale price.

If there was extra income, and there usually was, the interviewer asked how the farmer spent it. The interview ended with questions about how the person learned of the clinic in the first place and the first and last times they used the recommendation.

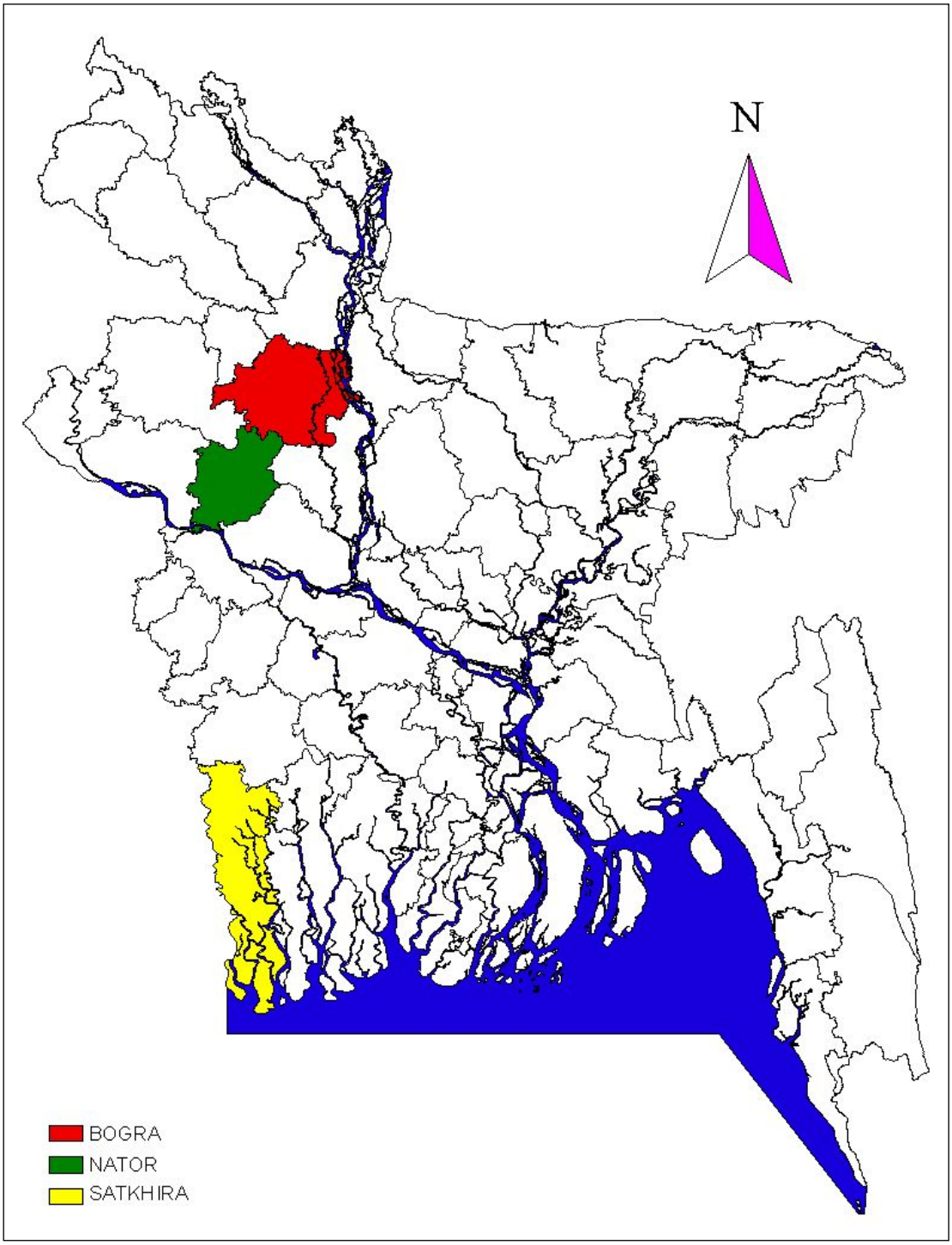
Field data collection: 350 farmers were interviewed: 230 from 12 plant clinics in Natore district with AAS, 60 from three Shushilan plant clinics in Satkhira and 60 from three RDA clinics in Bogra. Farmers were selected opportunistically (because they were available to be interviewed, usually in their home village).

Table 1 Farmers surveyed

Plant Clinic	Farmers	%
AAS (Upazila: Baraigram, District: Natore)		
Ahmedpur	25	7.14
Ramagari	18	5.14
Raynavorot	10	2.86
Merigachhi	18	5.14
Perbagdob	10	2.86
Moukhara	20	5.71
Tirail	31	8.86
Chandai	20	5.71
Rajandropur	18	5.14
Jonail	20	5.71
Parcole	20	5.71
Kachua	20	5.71
Total AAS	230	65.69
Shushilan (Upazila: Kaliganj, District: Satkhira)		
Kushulia	20	5.71
Kalikapur	20	5.71
Zirongacha	20	5.71
Total Shushilan	60	17.13
RDA (Upazila: Shahjahanpur, District: Bogra)		
Maria	20	5.71
Radhanagar	20	5.71
Amrul	20	5.71
Total RDA	60	17.13
Grand Total	350	100.00

Data Analysis: Collected data were entered in MS Excel spreadsheet and analyzed using MS Excel and SPSS. Descriptive statistics, mean, proportion and Students T Test were performed as needed to compare before and after adoption of plant health services.

Fig. 1: Location Map



Profiles of surveyed farmers

Recommendations

The 350 farmers surveyed received recommendations on 41 crops (31 in Nator, 20 in Satkhira and 21 in Bogra). Farmers in Natore visited the plant clinics with problems on rice, mango, pointed gourd, brinjal, country bean, garlic, sugarcane, litchi and 23 other crops. Farmers in Satkhira queried the plant clinics about mango, rice, brinjal, coconut, cucumber, yard long bean, banana, bottle gourd, pointed gourd, cauliflower, potato, red amaranth and eight other crops. Farmers in Bogra brought in problems with brinjal, country bean, pointed gourd, yard long bean, bottle gourd, bitter gourd, guava, jack fruit, rice, cabbage, okra, pomegranate and nine other crops (Table 2).

Rice is the main crop in Bangladesh, so it is not surprising that it tops the list in Nator and comes in second in Shatkira (although it comes in ninth place in Bogra). The main crop os not always the biggest problem. Brinjal (eggplant) is high on the list of clinic queries, along with other fruits and vegetables. Even though the three districts are roughly similar geographically, there are big differences between them in terms of crops queried. Mango is important in both Satkhira and Nator, but low on the list in neighbouring Bogra. Bangladesh is changing rapidly. Crops that were important historically, like jute, are now almost missing, replaced by fresh fruits and vegetables to eat and sell. Farmers bring in these crops, because they have pest problems which the farmers hope to solve at the plant clinic.

Crop-wise diagnosed plant health problems

The farmers surveyed had consulted the plant clinics for five types of crops (vegetables, fruits, spices, cereals and pulses).

Table 2 Forty one crops queried at the clinic by 350 surveyed farmers

Crop	AAS	Shushilan	RDA	Total	%
Rice	43	9	3	55	15.71
Mango	30	9	1	40	11.43
Brinjal	15	7	9	31	8.86
Pointed gourd	18	3	7	28	8.00
Country bean	15	1	7	23	6.57
Garlic	15	-	-	15	4.29
Sugarcane	15	-	-	15	4.29
Jackfruit	9	1	3	13	3.71
Litchi	12	-	1	13	3.71
Yard long bean	-	4	6	10	2.86
Bottle gourd	2	3	4	9	3.43
Coconut	5	4	-	9	2.57
Okra	6	1	2	9	2.57
Banana	4	3	1	8	2.29
Mung bean	8	-	-	8	2.29
Betel leaf	6	-	-	6	1.71
Chilli	3	1	1	5	1.43
Cucumber	-	4	1	5	1.43
Guava	1	1	3	5	1.43
Jujube	5	-	-	5	1.43
Pomegranate	2	-	2	4	1.14
Bitter gourd	-	-	3	3	0.86
Papaya	2	-	1	3	0.86
Red amaranth	-	2	1	3	1.14
Sweet gourd	3	-	-	3	0.86
Ash gourd	1	-	1	2	0.57
Cabbage	-	-	2	2	0.57
Cauliflower	-	2	-	2	0.57
Maize	2	-	-	2	0.57
Potato	-	2	-	2	0.57
Tomato	1	-	1	2	0.57
Betel nut	1	-	-	1	0.29
Carambola	1	-	-	1	0.29
Custard apple	1	-	-	1	0.29
Jute	1	-	-	1	0.29
Knolkhol	-	1	-	1	0.29
Musk melon	1	-	-	1	0.29
Onion	-	1	-	1	0.29
Pummelo	1	--	-	1	0.29
Taro	-	1	-	1	0.29
Turmeric	1	-	-	1	0.29
Total	230	60	60	350	100.00
Total crops	**31**	**19**	**21**	**41**	-

Overview of problems

The 350 surveyed farmers brought in problems mainly for fruits and vegetables. Insects were high on the list, as were unidentified diseases (Table 3)

Vegetables

AAS diagnosed 25 plant health problems on seven vegetable crops in Natore. The most frequent problem was root knot nematode of pointed gourd, followed by brinjal shoot and fruit borer, anthracnose of country bean and insect damage of country bean, insect damage of brinjal, pod borer of country bean and okra YVCMV, red mite of pointed gourd, fruit fly of sweet gourd and root rot of pointed gourd and 15 other health problems (Table 4).

The ideal brinjal, free of fruit and stem borer

Shushilan diagnosed 23 health problems of 12 vegetable crops: brinjal shoot and fruit borer, fruit fly of bottle gourd and aphids on cucumber (and 20 others. RDA diagnosed 27 health problems of 17 vegetable crops: brinjal shoot and fruit borer, fruit fly of cucumber, pod borer of yard long bean, root rot and root knot of pointed gourd, aphids on country bean and 19 others.

The three sets of plant clinics made roughly similar diagnoses. Brinjal shoot and fruit borer is a serious problem and farmers have been using frequent insecticide sprays to try to control it. Farmers are concerned about aphids in several crops. Even though aphids are well-known, cosmopolitan insects, farmers need more information in managing them.

Table 3 Summary of problems brought to clinics

TYPE OF CROP	TYPE OF PROBLEM	AAS	SHUSHILAN	RDA	TOTAL
VEGETABLES	INSECTS AND MITES	31	23	33	87
	BACTERIA	1	0	1	2
	FUNGUS	12	2	6	20
	NEMATODES	10	1	2	13
	PHYSIOGENIC	1	1	0	2
	VIRUS	6	4	2	12
FRUITS (INCLUDING COCONUT)	INSECTS AND MITES	28	7	6	32
	FUNGUS	33	7	2	42
	BACTERIA	1	0	0	1
	VIRUS	3	0	3	6
	PHYSIOGENIC	9	4	1	14
SPICE CROPS	INSECT	4	0	1	5
	FUNGUS	4	1	0	5
	VIRUS	1	1	0	2
	PHYSIOGENIC	6	0	0	6
	NEMATODES	4	0	0	4
CEREALS & PULSES (RICE, MAIZE & MUNG BEANS)	INSECT	29	6	3	38
	FUNGUS	2	0	0	2
	VIRUS	1	0	0	1
	PHYSIOGENIC	17	3	0	20
	NEMATODES	2	0	0	2
	WEED	2	0	0	2
CASH CROPS (BETEL, JUTE, OIL CROPS & SUGAR CANE)	INSECT	8	0	0	8
	FUNGUS	15	0	0	15
TOTAL CROPS		**230**	**60**	**60**	**350**

Table 4 Vegetables—health problems diagnosed at the plant clinics

VEGETABLE	PROBLEM DIAGNOSED	TOTAL
ASH GOURD	Fruit borer	2
BITTER GOURD	Fruit fly	1
	Fruit rot	1
	Leaf curl	1
BOTTLE GOURD	Aphid	1
	Fruit fly	2
	Fruit rot	2
	Fungus	1
	Insect	1
	Leaf curling	1
	Red pumpkin beetle	1
BRINJAL	Brinjal fruit & shoot borer	23
	Fruit rot	1
	Growth reduction	1
	Insect	4
	Root rot	1
	Wilt	1
CABBAGE	Butterfly	1
	Cutworm	1
CAULIFLOWER	Aphid	1
	Insect	1
COUNTRY BEAN	Anthracnose	5
	Aphid	3
	Fungus	1
	Insect	5
	Mite	1
	Pod borer	8
CUCUMBER	Aphid	2
	Fruit fly	1
	Insect	1
	Virus	1
KNOLKHOL	Reduced growth	1
MUNG BEAN	Insect	3
	Aphid	1
	Leaf rolling	1
	Pod borer virus	2
	virus	1
OKRA	Beetle	1
	Cutworm	1
	Okra YVCMV	5
	Pod borer	2
POINTED GOURD	Foot rot	1
	Fruit fly	3
	Fruit reddening & dropping	1
	Insect	3
	Leaf curling	1
	Red mite	3
	Root knot	12
	Root rot	4
POTATO	Late blight	1
	Wilt	1
RED AMARANTH	Insect	2
	Red mite	1
SWEET GOURD	Fruit fly	2
	Leaf deformation	1
TARO	Insect	1
TOMATO	Early blight	1
	Leaf curl	1
YARD LONG BEAN	Aphid	1
	Caterpillar	2
	Fungus	1
	Leaf curling	1
	Pod borer	4
	Virus	1

Fruit

AAS diagnosed 40 health problems of 13 fruit crops: die-back of mango, insect damage of mango, die-back and insect damage of litchi and fruit dropping of coconut, fruit dropping of jack fruit, leaf yellowing of banana and insect damage of jack fruit, flower dropping, fruit bearing problems, mango hopper and 29 other health problems.

Shushilan diagnosed 12 problems of five fruit crops: mango hopper, fruit dropping of coconut and inflorescence discoloration of mango and nine other health problems.

RDA diagnosed nine problems of seven fruit crops: white fly of guava, virus disease of jackfruit and seven others (Table 5).

The AAS clinics received a lot more fruit problems, yet their diagnoses look more like symptoms than diagnosed diseases. Shushilan has a shorter list, but it includes more specific diagnoses. The RDA list was short as well and all of the diagnoses were fairly broad. These diagnoses suggest that the clinic staff need more training, and that they need to send more samples to reference laboratories.

Table 5 Fruit—health problems diagnosed at the plant clinics

FRUIT	PROBLEM DIAGNOSED	TOTAL
BANANA	Beetle	2
	Foot rot	1
	Insect	1
	Leaf yellowing	2
	Sigatoka	2
CARAMBOLA	Fruit dropping & insect	1
COCONUT	Anthracnose	1
	Boron deficiency	1
	Fruit dropping	7
CUSTARD APPLE	Fruit borer	1
GUAVA	Mealy bug	1
	Powdery mildew	1
	Whitefly	3
JACKFRUIT	Ants	1
	Charcoal rot	1
	Fruit borer	1
	Fruit cracking	1
	Fruit dropping	3
	Fungus	1
	Insect	2
	Rhizopus rot	1
	Virus	2
JUJUBE	Die-back	1
	Flower dropping	1
	Flower dropping & fungus infection	1
	Insect	1
	Leaf rust	1
LITCHI	BLB & sulphur deficiency	1
	Die-back	4
	Insect	4
	Leaf blight	1
	Leaf curling	1
	Mites	1
	Red mite	1
MANGO	Anthracnose	1
	Die-back	16
	Flower dropping	2
	Flowering problem	1
	Fruit bearing problem	2
	Fruit rot	1
	Inflorescence discoloration	2
	Insect	4
	Lack of vigour	1
	Leaf hopper	1
	Defoliator	1
	Fruit fly	1
	Hopper	5
	Nutrient deficiency	1
	Stem-end rot	1
MUSK MELON	Leaf curling	1
PAPAYA	Foot rot	1
	PRSV-p	1
	Virus	1
POMEGRANATE	Flower & fruit dropping	1
	Fruit fly	1
	Fruit rot	1
	Insect	1
PUMMELO	Insect	1

Spices

The 18 plant clinics diagnosed 22 plant health problems with four spice crops (19 by AAS and the other three by Shushilan and RDA): garlic was the main spice, with 15 queries (Table 6). As with the vegetables, most of these were also symptom names.

Table 6 Spice crops— health problem diagnosed by the plant clinics

CROP	PROBLEM DIAGNOSED*	TOTAL
CHILLI	Insect infestation	2
	Leaf curling	2
	Leaf yellowing	1
GARLIC	Borer	2
	Clove splitting	1
	Purple blotch	1
	Root rot	1
	Seed-borne disease	1
	Seedlings weakening	9
ONION	Leal curling	1
TURMERIC	Leaf spot	1
TOTAL	11 Problems (4 Crops)	22

*19 of the 22 problems were submitted to AAS clinics, 2 to Shushilan and one to RDA

Cereal

The plant clinics diagnosed 57 plant health problems with two cereal crops (rice and maize); 45 problems were diagnosed by AAS, by Shushilan and 3 by RDA. The most common diagnosis was rice stem borer (22) followed by zinc deficiency (12). AAS found the most zinc deficiency (83%) followed by Shushilan (17%). This might be due to serious zinc deficiency in the soil of Natore district (Table 7).

Stemborer is the big problem with rice. We were interested that farmers brought it in at all, since the stemborer is a large, endemic insect. In Nicaragua farmers rarely came to the clinic with fall armyworm (the large endemic pest of maize, the local staple food (Danielsen et al 2006)). Like farmers in Bolivia who are still worried about Andean potato weevils (Bentley et al 2010), Bangladeshi farmers are aching for a cure for the stemborer in rice.

Shushilan started as a soils lab. In this sample, they diagnosed of two soil problems, which may be common problems in Shatkira, or it may reflect Shushilan's expertise with soils. The AAS diagnoses again include a lot of symptoms.

Table 7 Cereal problems diagnosed by the plant clinics

CROP	PROBLEM DIAGNOSED*	AAS	SHUSHILAN	RDA	TOTAL
RICE	Blast	1	-	-	1
	Brown plant hopper	3	-	-	3
	Dwarfing	1	-	-	1
	Foot rot	1	-	-	1
	Rusty leaf yellowing	1	-	-	1
	Nutrient deficiency	1	-	-	1
	Reduced growth	1	-	-	1
	Young leaf yellowing	4	-	-	4
	Ear cutting caterpillar	1	-	-	1
	Rice stem borer	2	-	-	2
	Rice stem bug	1	-	-	1
	Salinity problem	-	1	-	1
	Stem borer	13	6	3	22
	Weed	2	-	-	2
	White tip	1	-	-	1
	Zinc deficiency	10	2	-	12
MAIZE	Insect	2	-	-	2
TOTAL	17 problems (2 crops)	45	9	3	57

*45 of the 57 problems were fielded by AAS clinics, 9 by Shushilan & 3 by RDA

Causal agents

AAS diagnosed seven causal agents in 61 samples of vegetables with 23 health problems, especially insect damage, fungal infections, nematodes, virus, mites and bacterial infection and physiogenic problems. Shushilan diagnosed six causal agents in 31 samples of vegetables with 14 plant health problems, especially insect damage, virus infection, fungal infection, and mites, nematodes and physiogenic problems. RDA diagnosed six causal agents in 44 samples of vegetables with 21 plant health problems, especially insect damage, fungal disease, nematode, virus, mites, and bacterial infection (Table 8).

Causal agents diagnosed by crop

Most of the 350 diagnosed plant health problems were with insect damage (172) followed by fungal infection (84), physiogenic problems (42), virus (21), nematodes (19), mites (7), bacteria (3), and weeds (2) (Table 9).

The problems are about evenly split between insects and diseases, but there are few weeds. Of course weeds are a problem. Farmers simply do not bring weeds in, because the farmers already know the weeds in their area. As vascular plants, weeds are bigger than insects and disease symptoms (plus weeds stay still). So weeds are easier to observe, making them easier for farmers to identify. The question is, why do farmers bring in stemborers, but not weeds?

Perhaps farmers are unaware that the clinic may have recommendations for weeds. Farmers may simply be resigned to doing tedious hand weeding. The clinic is just one part of a plant health system. Farmers will not refer all problems to it. Others, like weeds, still need research and extension.

Table 8 Causal agents diagnosed in vegetables

CAUSAL AGENT	PROBLEM DIAGNOSED	TOTAL
BACTERIA	Root rot of brinjal	1
	Wilt of pointed gourd	1
FUNGUS	Anthracnose	5
	Early blight	1
	Foot rot	1
	Fruit rot	3
	Fungus	3
	Growth reduction	1
	Late blight	1
	Root rot	4
	Wilt of potato	1
INSECT	Aphid	8
	Beetle	1
	Borer	1
	Brinjal fruit & shoot borer	21
	Butter fly	1
	Caterpillar	3
	Cutworm	2
	Fruit borer	2
	Fruit fly	8
	Fruit rot	1
	Insect	17
	Pod borer	12
	Red pumpkin beetle	1
	Stem borer	4
MITES	Red mite	5
NEMATODE	Fruit reddening & dropping	1
	Root knot	12
PHYSIOGENIC	Leaf deformation	1
	Reduced growth	1
VIRUS	Leaf curl	5
	Mosaic virus	1
	Okra leaf is yellowish colour	2
	Okra yellow vein clearing mosaic	1
	Virus	3

Table 9 Causal agents diagnosed at plant clinics

CAUSAL AGENT	AAS	SHUSHILAN	RDA	TOTAL
BACTERIA	2	-	1	3
FUNGUS	66	10	8	84
INSECT	96	35	41	172
MITES	4	1	2	7
NEMATODE	16	1	2	19
PHYSIOGENIC	33	8	1	42
VIRUS	11	5	5	21
WEED	2	-	-	2
TOTAL	230	60	60	350

Results

This section describes how well farmers remembered the recommendations they received at the clinic, and whether they adopted the recommendations. Next we discuss how the recommendations helped them save money on plant protection costs, and increase their harvests. We calculate extra income and discuss how farmers spent their earnings.

Remembering recommendations

To understand how well the farmers remembered the plant clinic recommendations, the survey team asked farmers what the clinic had recommended, compared this answer with the clinic register and classified each farmer as: remembers nothing, remembers a little and remembers well. Most of the farmers (96.00%) remembered the recommendation well (Table 10).

Table 10 How well respondents remembered the plant clinic recommendations

	AAS		SHUSHILAN		RDA		TOTAL	%
		%		%		%		
REMEMBER NOTHING	5	2.2	4	6.7	1	1.7	10	2.9
REMEMBER A LITTLE	3	1.3	1	1.7	0	0	4	1.1
REMEMBER THE MOST	222	96.5	55	91.6	59	98.3	336	96.0
TOTAL	230	100	60	100	60	100	350	100

Adoption of plant clinic recommendations

The team asked farmers what they did after receiving the recommendation, and compared their answer to the recommendation written in the clinic register, to decide if the farmer had adopted the recommendation or not (and most had) (Table 11).

Table 11 Adoption of plant clinic recommendations by the farmers

	AAS		Shushilan		RDA		Total	%
		%		%		%		
No adoption	7	3.0	4	6.7	1	1.7	12	3.4
Partial adoption	4	1.7	1	1.7	0	0	5	1.4
Full or nearly full adoption	219	95.2	55	91.7	59	98.3	333	95.1
Total respondents	230	100	60	100	60	100	350	100

Cost for crop protection

The study team asked farmers how much money they spent on plant protection. With few exceptions, the costs decreased significantly after adopting plant clinic recommendations, by an average of Tk. 1160 per hectare ($17, or 13.74%). The highest cost reduction was with RDA (Tk. 1412/ha, $21) followed by AAS (Tk. 1321/ha, $20) and Shushilan (tk. 291/ha, $4) (Table 12).

Table 2 Average cost for crop protection before and after adopting the plant clinic recommendations

Plant Clinic	Crop protection cost (Tk/ha)		Mean difference	% Change	t-statistic	Sig.
	Before	After				
Ahmedpur	10620	8689	-1932	-18	-4	0.0003
Ramagari	10087	9172	-915	-9	-2	0.1320
Raynavorot	2717	3942	1225	45	2	0.1242
Merigachhi	7392	6483	-909	-12	-3	0.0088
Perbagdob	4129	3276	-853	-21	-7	0.0001
Moukhara	18305	14516	-3790	-21	-2	0.0351
Tirail	6904	6074	-830	-12	-3	0.0060
Chandi	10622	7937	-2685	-25	-1	0.2234
Rajandropur	9975	9819	-156	-2	0	0.8114
Jonail	11991	9020	-2972	-25	-1	0.1836
Parcole	3925	3379	-546	-14	-3	0.0159
Kachua	4313	4406	93	2	0	0.8655
AAS	8806	7484	-1321	-15	-4	0.0001
Kushulia	5494	4993	-501	-9	-2	0.1434
Kalikapur	8418	8049	-369	-4	-1	0.3715
Zirongachha	6221	6218	-4	0	0	0.9936
Shushilan	6711	6420	-291	-4	-1	0.2041
Maria	8485	7044	-1442	-17	-1	0.2303
Radhanagar	8011	8435	425	5.	0	0.6728
Amrul	9853	6633	-3219	-33	-2	0.0515
RDA	8783	7371	-1412	-16	-2	0.0607
Total	8443	7282	-1160	-14	-4	0.0001

Area under crop protection

The study team asked farmers how much land they devoted to the crop they had consulted at the plant clinics. The idea was that if farmers came to the clinic with a problem on Crop X, and later planted more land to that crop, it was a sign that the farmer now felt more confident in managing it. After farmers went to the clinic for a crop, they tended to plant more of it. Average land area planted in the queried crop increased by about 3.5 decimals (160 square meters) per family (6.27%) (Table 13).

Table 13 Average area devoted to queried crop before and after visiting the plant clinic

Plant Clinic	Crop protection area (decimal*/farmer)		Mean difference	% Increase	t-statistic	Sig.
	Before	After				
Ahmedpur	31.3	32.8	1.4	4.6	1.244	0.226
Ramagari	45.3	45.6	0.2	0.5	1.000	0.331
Raynavorot	39.7	39.7	-	-	-	-
Merigachhi	236.5	240.6	4.1	1.7	1.368	0.189
Perbagdob	36.8	38.0	1.2	3.3	1.000	0.343
Moukhara	89.0	92.7	3.7	4.1	2.111	0.048
Tirail	89.9	106.9	17.0	19.0	1.455	0.156
Chandi	37.8	42.6	4.8	12.7	1.876	0.076
Rajandropur	32.5	32.5	-	-	-	-
Jonail	90.5	99.5	9.0	10.0	1.715	0.103
Parcole	54.8	54.8	-	-	-	-
Kachua	74.7	75.2	0.5	0.7	1.000	0.330
AAS	73.6	78.0	4.4	6.0	2.588	0.010
Kushulia	38.8	39.7	0.9	2.3	1.000	0.330
Kalikapur	22.8	24.1	1.3	5.7	1.412	0.174
Zirongachha	24.4	25.1	0.7	2.9	1.000	0.330
Shushilan	28.6	29.6	1.0	3.4	2.229	0.030
Maria	13.4	14.7	1.4	10.1	2.204	0.040
Radhanagar	9.7	9.8	0.1	1.0	1.000	0.330
Amrul	21.6	27.8	6.3	29.0	1.268	0.220
RDA	14.9	17.4	2.6	17.3	1.542	0.128
Total	55.8	59.3	3.5	6.3	3.023	0.003

*a decimal is one hundredth of an acre, i.e. 40 square meters

Crop Yield

Average yield increased significantly with very few exceptions after farmers adopted plant clinic recommendations, by about 1.43 tons per ha. Farmers visiting the RDA clinics had the highest average crop yield increase (2.41 t/ha) followed by AAS (1.24 t/ha) and Shushilan (1.15 t/ha) (Table 14).

Table 14 Average crop yield (t/ha) before and after adopting plant clinic recommendations

Plant Clinic	Crop Yield (t/ha)		Mean difference	% Increase	t-statistic	Sig.
	Before	After				
Ahmedpur	24	26	2	6.8	5.402	0.0000
Ramagari	26	28	1	5.2	2.183	0.0434
Raynavorot	9	10	1	8.9	2.222	0.0534
Merigachhi	48	49	1	2.8	5.129	0.0001
Perbagdob	15	16	1	7.1	1.895	0.0906
Moukhara	15	17	2	13.7	3.317	0.0036
Tirail	11	11	1	7.6	2.643	0.0129
Chandi	14	15	1	8.5	1.478	0.1559
Rajandropur	13	15	2	12.2	2.834	0.0114
Jonail	10	12	1	13.8	1.611	0.1236
Parcole	8	9	1	11.3	1.435	0.1676
Kachua	15	15	1	4.7	1.636	0.1183
AAS	18	18	1	7.2	7.733	0.0000
Kushulia	10	11	1	7.6	2.723	0.0135
Kalikapur	14	15	2	12.2	3.206	0.0046
Zirongachha	8	9	1	12.9	4.708	0.0002
Shushilan	11	12	1	10.9	5.445	0.0000
Maria	12	17	5	43.9	1.549	0.1378
Radhanagar	14	15	1	10.7	3.330	0.0035
Amrul	13	13	1	4.7	0.843	0.4096
RDA	13	15	2	18.8	2.093	0.0407
Total	15	17	1	9.3	6.292	0.0000

Price of crop products

The average price of crop products increased significantly after adopting plant clinic recommendations, mostly because of increases in market prices, by an average of Tk. 5/kg (22.1%). Farmers at AAS clinics had the highest average crop price increases (Tk. 5.63/kg) followed by RDA (Tk. 4.40/kg) and Shushilan (Tk. 3.31/kg) (Table 15).

Table 15 Average farm gate prices before and after adopting recommendations

Plant Clinic	Crop products price (Tk/kg)		Mean difference	% Increase	t-statistic	Sig.
	Before	After				
Ahmedpur	13	18	5	38	6.008	0.000
Ramagari	24	32	8	33	6.518	0.000
Raynavorot	32	37	5	17	2.657	0.026
Merigachhi	4	7	3	58	1.556	0.138
Perbagdob	21	28	7	31	4.216	0.002
Moukhara	18	20	2	11	2.545	0.020
Tirail	25	30	5	19	2.554	0.016
Chandi	38	44	6	16	4.018	0.001
Rajandropur	29	35	6	21	3.337	0.004
Jonail	50	55	5	10	4.152	0.001
Parcole	41	53	12	30	4.707	0.000
Kachua	20	25	5	22	4.985	0.000
AAS	26	32	6	21	11.459	0.000
Kushulia	16	19	3	20	6.366	0.000
Kalikapur	14	17	3	22	4.392	0.000
Zirongachha	19	23	4	19	5.352	0.000
Shushilan	16	19	3	20	9.123	0.000
Maria	16	20	5	29	5.370	0.000
Radhanagar	16	20	4	27	4.375	0.000
Amrul	16	21	5	28	4.025	0.001
RDA	16	20	4	28	7.928	0.000
Total	23	28	5	22	14.546	0.000

Farmers' gross income

The study team estimated the average gross income of the farmers surveyed after adopting plant clinic recommendations. Farmers' average gross income increased significantly, on average by about Tk. 93,942 per hectare ($1,402, or 37.5%). Farmers who visited AAS clinics enjoyed the highest increase (Tk. 108,151/ha, $1,614) followed by RDA (Tk. 76,346/ha, $1,139) and Shushilan (Tk. 57,069/ha, $852) (Table 16). Unfortunately, as we see in the next section, the AAS farmers have the most land, and the Shushilan farmers the least, so the poorest farmers increased their per hectare earnings the least.

Table 16 Farmers' average gross income (Tk/ha) before and after adopting plant clinic recommendations

Plant Clinic	Gross income (Tk/ha)		Mean difference	% Increase	t-statistic	Sig.
	Before	After				
Ahmedpur	260499	379573	119074	46	7.481	0.0000
Ramagari	532627	750583	217955	41	5.284	0.0001
Raynavorot	170235	220970	50734	30	2.578	0.0298
Merigachhi	149509	189493	39983	27	3.505	0.0027
Perbagdob	216760	320274	103514	48	3.302	0.0092
Moukhara	333897	426936	93040	28	1.980	0.0624
Tirail	283040	364183	81143	29	3.178	0.0034
Chandi	327709	403151	75442	23	2.668	0.0152
Rajandropur	293955	400012	106057	36	4.338	0.0004
Jonail	386789	491030	104241	27	2.684	0.0147
Parcole	353881	565934	212051	60	1.289	0.2128
Kachua	227490	307112	79622	35	2.766	0.0123
AAS	301399	409549	108150	36	6.506	0.0000
Kushulia	132469	176772	44304	33	5.373	0.0000
Kalikapur	172610	235468	62858	36	5.082	0.0001
Zirongachha	175146	239192	64046	37	4.010	0.0007
Shushilan	160075	217144	57069	36	7.877	0.0000
Maria	136603	255329	118727	87	2.359	0.0292
Radhanagar	171082	233367	62285	37	6.713	0.0000
Amrul	129489	177515	48026	37	4.247	0.0004
RDA	145724	222070	76346	52	4.331	0.0001
Total	250485	344426	93942	38	8.211	0.0000

Farm size

The study team estimated average land holdings (decimals/family). Average farm size was estimated at about 226 decimals (0.904 ha) per family. The highest average farm size was with AAS in Natore, followed by RDA in Bogra, and Shushilan in Satkhira (Table 17). Even the larger farms are rarely bigger than one hectare, and are still smallholdings.

Table 17 Average land holdings per family of 18 plant clinics

Plant Clinic	Average land area (decimal/farmer)	
	Mean	SE
Ahmedpur	165.4	45.0
Ramagari	432.4	179.2
Raynavorot	205.5	42.2
Merigachhi	602.7	151.3
Perbagdob	175.1	29.0
Moukhara	207.8	61.6
Tirail	217.4	36.6
Chandi	258.8	42.7
Rajandropur	103.4	14.7
Jonail	450.4	89.0
Parcole	279.0	76.8
Kachua	269.0	81.0
AAS	280.3	25.3
Kushulia	109.2	11.1
Kalikapur	114.6	8.9
Zirongachha	103.5	10.5
Shushilan	109.1	5.8
Maria	124.4	13.2
Radhanagar	77.2	9.4
Amrul	205.7	49.6
RDA	135.7	18.4
Total	226.2	17.4

Earning extra income

94.5% of the farmers surveyed earned extra income through adopting plant clinic recommendation. The highest proportion of farmers earning extra income was with RDA (98.33%) followed by AAS (95.22%) and Shushilan (88.33%).

The team asked farmers what they did with their increased earrings. The most frequent response was children's education, followed by household expenses, buying cattle, planting a fruit orchard, buying land, growing a crop, agriculture, fish culture, repaying a loan and 10 other choices (Table 18).

In other words, farmers tended to invest the money in farming or in education. Hardly any spent it on frivolous consumption. They spent little money on imports, so most of the increase in income stays in their local area.

Spraying less pesticide helps farmers earn a better living

Table 18 How farmers spent the extra income after adopting clinic recommendations

Type of expense	Expense	AAS	Shushilan	RDA	Total
Investment	Agriculture	3 (1.3%)		15 (25.0%)	18 (5.1%)
	Crop cultivation	18 (7.8%)	5 (8.3%)	2 (3.3%)	25 (7.2%)
	Establishing a fruit orchard	6 (13.5%)	1 (1.7%)		32 (9.1%)
	Fish culture	1 (0.4%)	6 (10.0 %)		7 (2.0%)
	Shrimp culture		1 (1.7%)		1 (0.3%)
	Land purchase	27 (11.7%)	4 (6.7%)		31 (8.9%)
	Land lease in	2 (0.9%)			2 (0.6%)
	Cow farming	2 (0.9%)			2 (0.6%)
	Cattle purchase	40 (17.4%)	3 (5.0%)	1 (1.7%)	44 (12.6%)
	Children's education	65 (28.3%)	11 (18.3%)	14 (23.3%)	90 (25.7%)
	Business	1 (0.4%)			1 (0.3%)
Consumption	Household expenses	27 (11.7%)	18 (30.0%)	27 (45.0%)	72 (20.6%)
	Buying clothes	1 (0.4%)			1 (0.3%)
	Buying a TV	1 (0.4%)			1 (0.3%)
	Building a new house	1 (0.4%)			1 (0.3%)
	Sanitary bathroom	1 (0.4%)			1 (0.3%)
Other	Father's medical care	1 (0.4%)			1 (0.3%)
	Repay loan				4 (1.1%)
	Wedding ceremony	2 (0.9%)			2 (0.6%)
	Total	330 (100%)	60 (100%)	60 (100%)	350 (100%)

How farmers heard about the plant clinic

Most farmers learned about the plant clinic directly from their community plant doctors-CPDs, followed by school teachers, shop keepers, local leaders, neighbours, meetings, and miking, which is using a microphone mounted on a bicycle—kind of an electronically enhanced public crier (Table 19).

Table 19 How farmers learned about plant clinics

	AAS		SHUSHILAN		RDA		TOTAL	%
	NO.	%	NO.	%	NO.	%		
MEETING	3	1.3	-	-	12	20.0	15	4.3
MIKING	1	0.4	-	-	-	-	1	0.3
CPD	36	15.7	44	73.3	26	43.3	106	30.3
TEACHER	83	36.1	1	1.7	-	-	84	24.0
SHOPKEEPER	42	18.3	13	21.7	-	-	55	15.7
GROUP COORDINATOR	1	0.4	-	-	4	6.7	5	1.4
NEIGHBOUR	6	2.6	1	1.7	11	18.3	18	5.1
LOCAL LEADER	20	8.7	1	1.7	7	11.7	28	8.0
SERVICE PROVIDER'S REPRESENTATIVE*	16	7.0	-	-	-	-	16	4.6
OTHERS	22	9.6	-	-	-	-	22	6.3
TOTAL	230	100.0	60	100.0	60	100.0	350	100.0

*Staff of the plant clinic's host institution, e.g. shopkeepers, school teachers or NGO staff

Farmers attending the AAS clinics learned about them from teachers and shopkeepers, because AAS holds its clinics in schools and in agro-input shops. Shushilan farmers almost all heard about the clinics from the plant doctor himself. RDA got the word out at meetings and at the plant clinics themselves, because their clinics are linked with the municipal government and are held in villages. No one said they heard about the clinics on the radio or other media, suggesting that advertising might be useful.

First and last used recommendations

The interviewers asked farmers the first and last year they used the recommendation. If farmers last used the recommendation in 2008 they had probably stopped using it (e.g. because they had adopted something else). About half had used the recommendation from 2008 to 2009 (or from 2009 to 2009) had only tried it recently, and it is too soon to tell if they will use it again. But about 40% of the farmers had tried the recommendation for more than one year, and were still using it, suggesting that they found the recommendation useful. See Table 20. Most of the farmers who had adopted the recommendations were still using them.

Table 20 First and last year farmers used the plant clinic recommendations

First & last year of use	Respondents (Nr.)							
	AAS		Shushilan		RDA		Total	%
	Nr.	%	Nr.	%	Nr.	%		
2005-2008	3	1.3	-	-	-	-	3	0.9
2006-2008	12	5.2	-	-	-	-	12	3.4
2006-2009	3	1.3	-	-	9	15.0	12	3.4
2007-2008	15	6.5	-	-	-	-	15	4.3
2007-2009	127	55.2	-	-	7	11.7	134	38.3
2008-2009	70	30.4	60	100.0	23	38.3	153	43.7
2009-2009	-	-	-	-	21	35.0	21	6.0
Total	**230**	**100.0**	**60**	**100.0**	**60**	**100.0**	**350**	**100.0**

Discussion

The farmers bring many crops and problems to the clinics, which is a new way for farmers to express demand for research and extension. Their demands go far beyond what most conventional plant protection projects address, which is usually reductionist, narrowing in on one sliver of expertise (insect pests of rice, for example) when in reality the smallholders' portfolio is more diverse, dozens of crops, each with insect pests, diseases and other disorders.

This diversity of problems taxes the "plant doctors"' ability to diagnose. Some of them are community leaders, volunteers with a drive to learn and serve, but with modest formal education. The community plant doctors do have the backing of qualified agronomists, but they are generalists, not plant protection specialists. The problems thrown at the clinic staff may overwhelm them at times. They need more training. But more than talk and chalk, they need to send samples to laboratories, get specialist diagnoses and learn more about the diverse problems around them.

Yet even if they have room to improve, the clinics are providing a service which can be measured in terms of significant crop yield increases, of savings in agrochemicals and in improved incomes. The farmers tend to apply the recommendations over several crop cycles. They grow more confident growing that crop, and plant more of it. The extra income adds up to $800 per hectare, and farmers invest the dividends in agriculture and in their children's education. They use the money to make a better future for themselves.

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Annex 1: English version of questionnaire used in Bangladesh for impact study

Name		Interviewer	
Code		Date	
Community		Village	
Upazila		District	

Code(s) from the register

Recommendations
from the register

What did the clinic recommend to you?	
What did you do?	
Production costs for pest control ***before***	Production costs for pest control ***after***
Amount of land under the recommendation ***before***	Amount of land under the recommendation ***after***
Amount harvested ***before***	Amount harvested ***after***
Price received per unit (e.g. taka per kg) ***before***	Price received ***after***
Did you earn extra money from the recommendation: Yes No. (If the answer is yes, ask): What did you do with the extra money?	
How much land cultivated land do you have, including farmstead?	
How did you know to go to the clinic? 1 Meeting 2 Miking 3 CPD 4 School teacher 5 Shopkeeper 6 Group coordinator 7 Neighbour 8 Public representative 9 NGO staff 10 other	
The first year you used the recommendation?	The last year you used the recommendation?

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