Geo data for late blight control in potato

Evaluation of decision support service in Bangladesh, 2016-2017

Annette Pronk, Hasib Ahsan, Md. Masudur Rahman, Geert Kessel, Jean-Marie Michielsen, Huib Hengsdijk

GEOPOTATO

External Report 3

The GEOPOTATO project develops and implements a decision support service (DSS) in Bangladesh to control the late blight disease in potato. Satellite data and various models are important aspects of the DSS. GEOPOTATO aims at becoming the preferred agricultural advice service for potato farmers in Bangladesh. GEOPOTATO is financed by the G4AW program of the Dutch Ministry of Foreign Affairs, which is executed by the Netherlands Space Office (NSO).

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GEOPOTATO External Report 3

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Summary

GEOPOTATO is one of the projects funded within the Geodata for Agriculture and Water (G4AW) facility, which improves food security in developing countries by using satellite data. The Netherlands Space Office (NSO) is executing this programme, commissioned by the Dutch Ministry of Foreign Affairs. The GEOPOTATO project develops a decision-support service (DSS) for farmers in Bangladesh for an optimal control strategy of the late blight disease in potato. Late blight (*Phytophthora infestans*) is a highly infectious and destructive fungal disease in *Solanaceae* crops, i.e. among others potatoes and tomatoes. The DSS is provided to farmers through SMS.

The objective of the GEOPOTATO project is to reach 100,000 potato farmers with the DSS after three years. The GEOPOTATO project selected the major potato producing region Munshiganj as the region to pilot the service in the season 2016/2017. The introduction was accompanied with field demonstrations on the DSS. In this report, first findings of the introduction of the DSS in Munshiganj are evaluated and described, and compared with results of the baseline study in Munshiganj.

The objective of this evaluation study is to report on:

- The results of the late blight demonstrations.
- The results of farmers that participated in the DSS pilot.
- Outcome indicators of the DSS of farmers that participated in the pilot.

Late blight demonstrations

In each sub-district of Munshiganj a demonstration was carried out on the control of late blight. Three treatments were included. Treatment differences concentrated on the type of fungicide used and time and number of application:

- Decision Support Service treatment (DSS^+). In this treatment SMS service is followed and a modern preventive + slightly curative fungicide Revus 25 SC is used or a preventive + curative fungicide (Secure 600 WG) when late blight was identified;
- Decision Support Service treatment with common fungicides (DSS). In this treatment the SMS service is followed and the traditional preventive fungicide Dithane M 45 is used;
- Farmers Practice (FP). This treatment is tuned to the local practices and, therefore, differed per sub-district.

Observations on late blight occurrence were done by the field manager before each fungicide spray following a disease occurrence protocol. Input (costs) were registered and yields measured.

With respect to the late blight demonstrations it is concluded that:

- It is difficult to realise a demonstration which compares a DSS for late blight control with a control according to farmers' practice.
- The demonstrations included a number of factors that contributed to the yield differences. This makes it particularly difficult to relate yield differences to treatments.
- Following fertiliser recommendations improves farmers' profits with no negative effects on yield.
- The DSS^+ treatment improved the fungicide use efficiency because from the modern fungicide Revus only small amounts are needed to effectively control late blight.
- Fungicide costs of DSS^+ were higher compared to FP and DSS.
- Fungicide costs increase due to DSS and DSS^+ are small compared to the cost for fertilisers.

Pilot on the SMS decision support alert service for farmers

The piloted late blight alert service in the season 2016/17 consisted of 111 farmers that received an SMS during the growing season each time a risk for late blight outbreak was forecasted by the DSS. The SMS urged farmers to protect the crop within three days with the widely used fungicide Mancozeb.

A questionnaire was developed that focused at the major characteristics of potato production in the 2016/17 season, late blight control by farmers, outcome indicators and at the use of the late blight SMS advice to spray for late blight control. Farmers participating in the SMS service as well as 124 non-participating farmers were surveyed, the latter group served as a control group. Farmers were interviewed between 13 and 20 April 2017.

Based on the survey results it is concluded that:

- Interviewed farmers in Munshiganj cultivate more land compared to the average smallholder farmer in Bangladesh, as the average land size with potatoes of 2.2 ha in this study is much larger than the national average land size of 0.82 ha for smallholder farmers.
- According to most farmers late blight pressure in the potato season 2016-2017 was low.
- Possibly related to the low late blight pressure, yield benefit of SMS-receiving farmers was small and non-significant compared to the control group.
- Nearly all participating farmers in the pilot, 94%, were satisfied with the SMS-alert service.
- The SMS-alert service was most appreciated for the information on the weather forecast, good production and reduced disease pressure.
- On average, each participating farmer shared the SMS information with 13 other farmers.

Outcome indicators

The late blight alert service is evaluated based on the outcome indicators sustainable food production (crop yield, t/ha), input use efficiencies (use of N-fertiliser, kg/t product; use of fungicides, kg product/ha and kg active ingredient/ha), income (costs of late blight control, BDT/ha) and other outcomes (use of Metalaxyl). Data of the farmer's survey were used to calculate the outcome indicators. Results were compared with outcome indicators of the baseline survey.

With respect to the outcome indicators in the evaluation, it is concluded that:

- Crop yield did not change compared to the baseline survey.
- N-fertiliser use efficiency did not change compared to the baseline survey. However, the demonstrations showed that substantial efficiency gains are possible.
- Both the fungicide use efficiency in terms of kg product per hectare and in terms of A.I. per hectare of the participating farmers as well as the farmers in the control group tended to be improved compared to the baseline survey.
- The non-SMS-receiving farmers did tend to use more fungicide products with Metalaxyl than the SMS-receiving farmers. However, the SMS-receiving farmers did not reduce Metalaxyl use compared to the baseline survey.

1. Introduction

GEOPOTATO is one of the projects funded within the Geodata for Agriculture and Water (G4AW) facility, which improves food security in developing countries by using satellite data. The Netherlands Space Office (NSO) is executing this programme, commissioned by the Dutch Ministry of Foreign Affairs.

The GEOPOTATO project develops a decision-support service for farmers in Bangladesh for an optimal control strategy of the late blight disease in potato. Late blight (*Phytophthora infestans*) is a highly infectious and destructive fungal disease in *Solanaceae* crops, i.e. among others potatoes and tomatoes. Especially under favourable weather conditions, i.e. temperatures between 12 and 25°C and a relative atmospheric humidity >85%, the disease spreads very quickly through wind and water and can have devastating effects on the potato crop and production (Hossain *et al.* 2008a). Through development of a decision-support service (DSS) based on a combination of satellite information and models infection periods of late blight can be forecasted. A timely advice through mobile phone for the application of an appropriate fungicide helps farmers to prevent the infection of the potato crop with late blight.

Bangladesh is area-wise the third largest potato producer in Asia after China and India and among the top 10 of the potato producing countries in the world. The harvested potato area in Bangladesh is 449,071 ha (average 2011-2014; FAOSTAT, Figure 1.1) and still growing with approximately 3 to 5% annually, making it the second major food crop in Bangladesh after rice. Rice is mainly grown for subsistence where potato is grown as the major cash crop (Anderson *et al.* 2016) during the dry winter season of Bangladesh (December – March). It is estimated that over 750,000 small farmers in Bangladesh produce a potato crop (Egger 2012). Because of the short growing cycle (approximately 90 days), the returns on investment for farmers are quick and also potentially high compared to other crops that can be grown in the winter season.

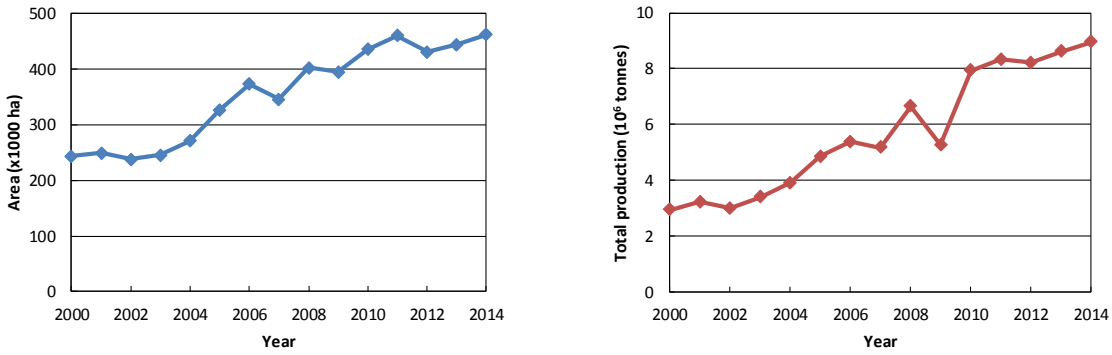

Figure 1.1 *Area (left) and total production (right) of the past 15 years in Bangladesh (FAOSTAT).*

The objective of the GEOPOTATO project is to reach 100,000 potato farmers with the DSS after three years. Major potato production areas are in the Munshiganj district and the area surrounding Rangpur. The GEOPOTATO project selected Munshiganj as region to develop the service in the season 2016/2017. Upscaling of the service to the Rangpur region is foreseen in the season

2017/2018. Baseline studies were carried out in both Munshiganj and Rangpur to understand better the needs, practices and performance of farmers, and the context of potato farming in these regions (Pronk *et al*. 2017). The introduction of the service in the season 2016/2017 is accompanied with field demonstrations on the DSS. First findings of the introduction of the DSS in Munshiganj are evaluated and reported in this report and compared with results found in the baseline study of Munshiganj.

The objective of the evaluation study is:

- To report on the late blight demonstrations,
- To report on the results of farmers that participated in the pilot on the SMS decision support alert service,
- To evaluate outcome indicators of the GEOPOTATO DSS of farmers that participated in the pilot.

The report comprises information from different project activities in 2016 and 2017, ranging from field trips, late blight control demonstrations, trainings of project partners and stakeholders and the service evaluation survey carried out under potato farmers in Munshiganj, information from literature and from stakeholders in the potato value chain. The bulk of this report describes the results of the evaluation of the first introduction of the SMS-alert service compared to a group of farmers who did not receive any information during the potato season 2016/2017. During 2016 and 2017, the Munshiganj district was visited frequently by local and international partners of GEOPOTATO. These visits were used to improve late blight knowledge and control of project partners, were needed to further develop the SMS-service and to design and perform the evaluation study.

The general information on the potato production in the Munshiganj district in not included in the report and we refer to the baseline survey for further reading (Pronk *et al.* 2017). In Chapter 2, the various data and information sources are described. Chapter 3 gives a compilation of the major findings in Munshiganj compared to the results of the baseline study. The information provided in Chapter 3 is twofold: 1) on the late blight demonstrations in each sub-district and 2) on the dedicated evaluation survey carried out under 111 SMS-receiving potato farmers and 124 non-SMS receiving potato farmers as a control group. Finally, in Chapter 4, major findings are discussed and conclusions of this study are summarized.

2. Materials and methods

2.1. Late blight control demonstrations

In each sub-district a demonstration was carried out on the control of late blight. Three treatments were included and field meetings of farmers and stakeholders were organised. Treatment differences concentrated on the type of fungicide used (Figure 2.1), the time of application and the number of applications. The demonstrations also included additional aspects of Good Agricultural Practices (GAP) such as fertiliser application, planting distances and seed handling (cutting or not, for detailed information see Annex II). All activities for the production of the potatoes were registered and a cost analysis for fungicide use between treatments was made.

2.1.1. Treatments

Three treatments were included in the demonstrations:

1. Decision Support Service treatment (DSS^+). In this treatment SMS service is followed and a modern preventive + slightly curative fungicide Revus 25 SC is used or a preventive + curative fungicide (Secure 600 WG) when late blight was identified;
2. Decision Support Service treatment with common fungicides (DSS). In this treatment the SMS service is followed and the traditional preventive fungicide Dithane M 45 is used;
3. Farmers Practice (FP). This treatment is tuned on the local practices and therefore differed per sub-district.

Following the service (DSS^+ and DSS), up to eight sprays with fungicides were applied at different days after planting (

Table 2.2). The farmers practice (FP) treatment applied also up to 8 treatments, using fungicides with different active ingredients, preventive, preventive $^+$ curative and/or curative active ingredients. The curative fungicides used in the farmers practice however, had no effect on Metalaxyl resistant late blight. The application rates applied in the demonstrations were in general in agreement with the recommended dosage although Metataf and Mosum were applied at slightly higher dosages than recommended (Table 2.3). Additional characteristics of fungicides used are presented in Annex I.

Table 2.1 Fungicides used in the different treatments of the field demonstrations on the late blight control service in each sub-district of Munshiganj.

		Spray number, days after planting							
Sub-district	Treatment	1	2	3	4	5	6	7	8
Gozaria	DSS+	Revus	Revus	Revus	Revus	Revus	Revus	Revus	Revus
	DSS	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane
	FP	Metataf	Metataf	Indofil	Indofil	Indofil	Indofil	Indofil	Indofil
Louhazang	DSS+	Revus	Revus	Antracol	Antracol	Melody Duo	Melody Duo		
	DSS	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane		
	FP	Mosum	Mosum	Mosum	Mosum	Mosum	Mosum		
Munshiganj Sadar	DSS+	Revus	Revus	Antracol	Antracol	Melody Duo	Melody Duo		
	DSS	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane		
	FP	Mosum	Mosum	Mosum	Mosum	Mosum	Mosum		
Sreenagar	DSS+	Revus	Revus	Melody Duo	Melody Duo	Melody Duo	Revus	Secure	Secure
	DSS	Dithane	Dithane	Melody Duo	Melody Duo	Melody Duo	Dithane	Secure	Secure
	FP	Dithane	Dithane	Melody Duo	Melody Duo	Melody Duo	Indofil	Secure	Secure
Sirajdikhan	DSS+	Revus	Revus	Revus	Revus	Revus	Revus	Revus	Melody Duo
	DSS	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane	Melody Duo
	FP	Dithane	Dithane	Indofil	Indofil	Indofil	Indofil	Indofil	Indofil
Tungibari	DSS+	Revus	Revus	Revus	Revus	Revus	Revus	Revus	
	DSS	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane	Dithane	
	FP	Gmaxyl	Gmaxyl	Indofil	Indofil	Indofil	Indofil	Indofil	

Table 2.2 Days after planting (DAP) of fungicide applications in the different treatments.

		DAP							
Sub-district	Treatment	1	2	3	4	5	6	7	8
Gozaria	DSS+	32	38	42	47	53	67	73	78
	DSS	32	38	42	47	53	67	73	78
	FP	32	38	42	47	53	67	73	78
Louhazang	DSS+	26	32	39	47	52			
	DSS	26	32	39	47	52			
	FP	26	32	39	47	52			
Munshiganj Sadar	DSS+	32	38	47	55	60			
	DSS	32	38	47	55	60			
	FP	32	38	47	55	60			
Shreenagar	DSS+	30	36	39	46	52	66	72	76
	DSS	30	35	39	46	52	66	72	76
	FP	30	36	39	46	52	66	72	76
Sirajdikhan	DSS+	29	35	38	45	51	65	71	75
	DSS	29	34	38	45	51	65	71	75
	FP	29	35	38	45	51	65	71	75
Tungibari	DSS+	32	38	41	48	54	68	74	
	DSS	32	37	41	48	54	68	74	
	FP	32	38	41	48	54	68	74	
Average		30	36	41	48	54	69	73	76

Table 2.3 Recommended dose rate and application rate of the fungicides used.

Product name	Active ingredient	Recommended dosage	Unit	Application rate	Unit	Type of active ingredient	Price (BDT/kg or L)
Antracol 70 WP	Propineb	2.5	Kg/ha	2.5	kg/ha	Preventive	707
Dithane M 45	Mancozeb	2.2	Kg/ha	2.3	kg/ha	Preventive	600
Gmaxyl 72 WP	Mancozeb (64%) + Metalaxyl (8%)	2.0	g/L[1]	1.2	kg/ha	Preventive + curative	550
Indofil M 45	Mancozeb	2.0	g/L	2.3	kg/ha	Preventive	800
Melody Duo 66.8 WP	Propineb (70%) + Iprovalicarb	2.0	g/L	2.0	kg/ha	Preventive + slightly curative	800
Metataf 25 WP	Metalaxyl	2.0	g/L	2.6	kg/ha	Curative	500
Mosum M 80 WP	Mancozeb	2.0	g/L	2.4	kg/ha	Preventive	457
Revus 25 SC	Mancozeb (50%) + Fenamidone (10%)	1.0	g/L	593	ml/ha	Preventive + slightly curative	3500
Secure 600 WG	Propineb	1.0	g/L	1.5	kg/ha	Preventive + curative	575

[1] spraying liquid

Figure 2.1 Different fungicides used in the demonstrations: Revus used in the DSS⁺, Dithane in DSS, Mosum in FP and Secure in all treatments.

2.1.2. Field layout

Plots of 303 m^2 (7.5 decimal) per treatment were planted with potato variety Diamant in each sub-district between 2 and 9 December 2016 and harvested between 6 and 10 March 2017. Although the demonstration focussed on the late blight control service, GAP were also demonstrated. Therefore, seeds of the DSS⁺ treatments were not cut as the seeds of the other two treatments were cut. The amount of seeds planted was also slightly different, as were the costs for seeds. In the FP treatment cheaper seeds but a larger amount (between 2965 to 3295 kg/ha; 12 to 14.5 kg/decimal) was planted compared to DSS⁺ and DSS (2735 kg/ha; 11 kg/decimal). Furthermore, chemical fertilisation in the DSS⁺ and DSS treatments was in accordance with the fertiliser recommendations for soils with a low fertility status and substantially lower than the chemical fertilisation applied according to farmers practice (Table 2.4).

Other cultivation practices such as irrigation, weed control and the use of insecticides were done according to farmers practices (see Annex II for details).

Results on yield were analysed by a simple ANOVA with GENSTAT 14 with two factors, sub-district and treatment.

Table 2.4 Fertilisers applied in the demonstration in each sub-district of Munshiganj.

Sub-district	Treatment	Organic (kg/ha)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Gozaria	DSS$^+$	0	121	89	138
	DSS	0	121	89	138
	FP	0	349[1]	222	395
Louhazang	DSS$^+$	0	121	89	138
	DSS	0	121	89	138
	FP	0	258[1]	178	297
Munshiganj Sadar	DSS$^+$	99	121	89	138
	DSS	99	121	89	138
	FP	99	258[1]	178	297
Shreenagar	DSS$^+$	3,295	121	89	138
	DSS	3,295	121	89	138
	FP	3,295	273[1]	222	395
Sirajdikhan	DSS$^+$	3,295	121	89	138
	DSS	3,295	121	89	138
	FP	3,295	303[1]	222	395
Tungibari	DSS$^+$	0	121	89	138
	DSS	0	121	89	138
	FP	0	303[1]	222	395

[1] 75 kg N/ha was applied as side dressing 46 days after planting.

2.1.3. Late blight observations

The field manager did observations on late blight occurrence before each fungicide spray. The disease occurrence is evaluated through a protocol (Annex III). A visible assessment is made and fields are grouped into different severity classes ranging from 0% (no late blight) to 100% (crop is destroyed). Depending on the severity class, the fungicide type is chosen. When no late blight was found, a preventive fungicide was used. When late blight was found, a fungicide was chosen with a preventive and curative active ingredient. Care was taken in the DSS$^+$ and DSS treatments to select fungicides that were able to control the Metalaxyl resistant late blight strain.

2.1.1. Cost components

The costs for input products such as seed, fertilisers and pesticides, and of labour for manual weeding and irrigation were collected and used to calculate costs for the different late blight control strategies and GAP.

2.2. The late blight service

The late blight alert service consisted of a SMS send to the participating farmer that indicated a risk for late blight outbreak and the need to protect the crop within three days with the widely used fungicide Mancozeb.

The service was evaluated through a post-season questionnaire for SMS-receiving farmers and non-SMS-receiving farmers (Annex IV).

2.2.1. Selection of farmers

One group of 120 farmers participated in the SMS service on late blight control of which 111 farmers could be reached in the evaluation. Another group of 124 farmers that did not participate in the SMS service was randomly selected by the local Department of Agricultural Extension (DAE) and served as a control group in the evaluation survey. Farmers were equally distributed over the different sub-districts. Survey data were cleaned of outliners and/or incomplete records before being analysed with a simple ANOVA with GENSTAT 14 with sub-district and the service as factors. An interaction between the two factors was also included in the analysis.

2.3. Evaluation of late blight alert service

2.3.1. Questionnaire

A questionnaire was developed that focused at the major characteristics of potato production, current late blight control by farmers, outcome indicators in the 2016-2017 growing season (section 2.4, Annex IV) and at the use of the late blight SMS advice to spray for late blight control (Annex V). As the questionnaire from the baseline survey, this questionnaire required relatively little time and effort from the participating farmers to answer (Pronk *et al.* 2017).

All questions referred to the potato season 2016-2017 and to one potato plot (largest or best performing) of the interviewed farmer.

2.3.2. Enumerators and survey control

The survey was carried out in the same way as the survey of the baseline study (Pronk *et al.* 2017). In short, nine enumerators, three quality control staff and one team leader of the Development Research Institute in Dhaka performed the survey. Programming for a mobile application and translation into English of the survey results were done by mPower. The survey was carried out between 13 and 20 April 2017.

2.3.3. Data processing

Data were cleaned from missing values and some unreliable recordings. In some cases, the total entry of a farmer was dismissed and sometimes records were improved so they could be included in

the results. The questionnaire included the entire list of allowed fungicides for late blight control (218 products in total), which was a major improvement compared to the questionnaires of the baseline survey. All mentioned products were included in the results.
The used fungicides were qualified according to the type of active ingredient: preventive, curative or curative resistance when no effect of the active ingredient is to be expected on late blight control, as late blight is resistant to the active ingredient. The overall use of fungicides of one farmer is subsequently grouped into one of the following four categories:

1. Only use of preventive fungicides,
2. use of preventive and curative fungicides,
3. use of preventive and curative resistance fungicides,
4. only use of curative resistance fungicides.

This grouping is used as a factor in the unbalanced analysis of variance to explore effects of the use of active ingredients on yield.
Furthermore, the answers to question 10 of Annex V SMS-receiving farmers (if yes, why were you satisfied with the SMS?) were grouped into a main reason and a sub-reason:

- Timely spraying
- Good production
    - Reduced disease pressure
    - Training
- Helpful
- Reduced costs
- Reduced disease pressure
    - Reduced costs
- Training
    - Reduced disease pressure
- Weather forecast
    - Timely praying
    - Helpful
    - Reduced disease pressure
    - Training

2.4. Outcome indicators evaluation

The late blight alert service is evaluated based on different indicators. Following the baseline study of Munshiganj (Pronk *et al.*, 2017) outcome indicators have been calculated: sustainable food production, input use efficiencies, income and other outcomes.

The outcome indicator on sustainable food production is:

- Crop yield, t/ha

The baseline survey yield is the basis for this indicator. In subsequent years, yield increase as a result of the service use is calculated.

The indicators on efficiencies are:

- Use of N-fertiliser and
- Use of fungicides.

The use of N-fertiliser is expressed as N-applied (kg N/t product). The use of fungicides is expressed as fungicides applied (kg or L product/ha) and as active ingredient (kg or L/ha). This is done as the expected changes may be on the amount of current products used and/or on the type of products used. Changes on the type of product used may result in lower levels of applied active ingredients where the amount of product is not changing. The improved efficiencies are later on in the project expressed as a percentage improvement also.

The indicator for income is:

- Costs of fungicides used when the service advice is followed compared to the costs of fungicide use when the service is not followed (control group). This is compared with costs for fungicide use of the baseline survey.

The indicator for other outcome is:

- The reduction in the use of curative fungicides containing Metalaxyl when the service is followed compared to the curative fungicides containing Metalaxyl in the baseline survey.

This is evaluated through two indicators. First, the percentage of products mentioned to be used by farmers with curative active ingredients containing Metalaxyl compared to all curative products is identified. This is done as the DSS supports the use of preventive fungicides and reduce the use of curative fungicides and dismisses the use of Metalaxyl containing fungicides (Pronk *et al.* 2017). Second, the percentage of fungicide applications with products containing Metalaxyl compared to all curative applications is calculated. This calculation is done as farmers may use less products but apply one product more often. With these two outcome indicators we can support changes in type of curative product used as well as the number of applications curative products are used.

3. Results

3.1. Late blight control demonstrations

3.1.1. Late blight observations

Hardly any late blight was observed in most demonstration plots. Only in Sreenagar, late blight was found: less than 2% infection rate was found at the third, fourth and fifth fungicide application. This infection was most likely from the neighbouring field, which showed a heavy infection. The mild infection in the demonstration plots DSS$^+$ and DSS were treated with the fungicides applied (Table 2.1). Melody and Secure contained both preventive and curative active ingredients (Table 2.3).

When no late blight was observed at the sixth application, fungicides containing only preventive active ingredients were applied.

3.1.2. Production

The potato yields in the demonstration plots varied between 42.2 and 54.2 t/ha (Table 3.1). The relatively very high yields may be related to the size of the plots, which was small (Figure 3.1). Differences between the different spraying strategies, DSS$^+$, DSS and FP showed that DSS$^+$ and DSS increased yields on average with 8% and 5% compared to FP respectively. The simple statistical analysis shows that these differences are significant (Table 3.1). In addition, yields between sub-districts were different regardless the treatments. Sirajdikhan had the highest yields were Shreenagar had the lowest.

Yields of these demonstration plots were more than 10 t/ha higher than the farmer's yields (*Table* 3.15).

Table 3.1 *Potato yields (t/ha) of the Decision Support Service using (DSS$^+$), Decision support service using Dithane (DSS) and Farmers Practice (FP) in different sub-districts of Munshiganj and the relative increase of yield of DSS$^+$ and DSS compared to FP.*

	Yield (t/ha)				Relative increase (%)	
Sub-district	DSS$^+$	DSS	FP	Average	DSS$^+$	DSS
Gozaria	45.7	45.0	43.6	46.2 b	4.8	3.2
Louhazang	47.0	46.9	44.8	44.8 bc	5.0	4.8
Munshiganj Sadar	46.1	45.2	43.0	44.8 bc	7.1	5.0
Shreenagar	46.1	44.0	42.2	44.1 c	8.9	4.1
Sirajdikhan	54.2	49.4	47.9	50.5 a	14.4	3.4
Tungibari	48.5	48.0	43.7	46.7 b	11.0	9.9
Overall yield/relative increase	47.9 a	46.4 b	44.2 c	46.2	8.6	5.1

[1] Row and column with different letters indicate different yields at the 5% significant level.

Figure 3.1 *The demo plots on late blight control and the harvest.*

3.1.3. Costs for late blight control

The costs for late blight control varied between 6,515 BDT/ha for FP in Louhazang and Munshiganj Sadar to 16,605 BDT/ha for DSS$^+$ in Gozaria (Table 3.2). The high costs for DSS$^+$ are related to the use of Revus, which is an expensive product to buy compared to Dithane or other commonly used fungicides.

Table 3.2 *The number of sprays and cost for late blight control expressed in BDT per ha and BDT per kg potato product in the demonstration plots on the Decision Support Service (DSS$^+$), Decision support service using Dithane (DSS) and Farmers Practice (FP) in Munshiganj and its sub-districts.*

		Costs (BDT/ha)			Costs (BDT/kg product)		
Sub-district	# of sprays	DSS$^+$	DSS	FP	DSS$^+$	DSS	FP
Gozaria	8	16,605	11,070	9,554	0.363	0.246	0.219
Louhazang	6	10,806	8,302	6,515	0.230	0.177	0.145
Munshiganj Sadar	6	10,806	8,302	6,515	0.234	0.184	0.152
Shreenagar	8	13,093	11,017	10,787	0.284	0.250	0.256
Sirajdikhan	8	16,111	11,268	9,686	0.297	0.228	0.202
Tungibari	7	14,529	9,686	7,611	0.300	0.202	0.174
Munshiganj district	7	13,658	9,941	8,445	0.285	0.214	0.191
Max	8	16,605	11,268	10,787	0.363	0.250	0.256
Min	6	10,806	8,302	6,515	0.230	0.177	0.145

The total costs of different cost components (details in Annex II) ranged from 118,829 BDT/ha to 167,499 BDT/ha with an average of 151,955 BDT/ha for the FP, 149,747 BDT/ha for DSS and 153,435 BDT/ha for DSS$^+$ (481 to 678 BDT/decimal; 615 BDT/decimal, 606 BDT/decimal and 621 BDT/decimal, respectively). The cost component chemical fertilisers were considerable reduced when following the recommendations, from 27.5% in the FP to 18.6% and 18.1% in the DSS and DSS$^+$ respectively. This reduction was on average almost 14,000 DBT/ha (55 BDT/decimal). This reduction was almost three times larger than the increased costs for late blight control of the DSS$^+$ and nine times larger than the increased costs of DSS.

3.1.4. Outcome indicators of demonstrations

Improvement in efficiency

The N-fertiliser use of the demonstration plots ranged from 2.2 to 2.8 kg N/t potatoes produced where the farmer plots ranged from 5.8 to 8 kg N/t. The difference between the DSS$^+$ and DSS treatments and FP is large and the difference is significant at the 5% level. But, FP is still lower than the N-fertiliser use found in the baseline survey of 8.9 kg N/t product (Pronk *et al.* 2017), and found in the farmers survey of non- and SMS-receiving farmers (Table 3.29).

Table 3.3 *The N-fertiliser use of the demonstration plots of the Decision Support Service (DSS$^+$), Decision support service using Dithane (DSS) and Farmers Practice (FP) in different sub-districts of Munshiganj.*

Sub-district	DSS$^+$	DSS	FP
Gozaria	2.7	2.7	8.0
Louhazang	2.6	2.6	5.8
Munshiganj Sadar	2.6	2.7	6.0
Shreenagar	2.6	2.8	6.5
Sirajdikhan	2.2	2.5	6.3
Munshiganj district	2.5 b	2.5 b	6.9 a

[1] Columns with different letter indicate different N-fertiliser use at the 5% significant level.

The fungicide use expressed as kg product per ha ranged from 4.2 to 10.1 kg/ha for the DSS$^+$ to 13.8 to 18.4 kg/ha for the DSS to 14.3 to 19.1 kg/ha for the FP (Table 3.4). The product use of the DSS and FP is more than twice the amount of the DSS$^+$ and this difference is significant at the 5% level. The difference is a result of the use of the modern product Revus, which requires only a small amount of product per ha to effectively control late blight. The traditional and older fungicide products require a larger dose per ha to be effective. The same difference is found for the use of active ingredient (A.I.) per ha, on average 3.9 kg A.I./ha is used in the DSS$^+$ whereas 12 and 12.5 kg/ha were used in the DSS and FP respectively. The fungicide use of the DSS$^+$ is the same as was calculated in the baseline survey, 7.7 kg product/ha but the use of A.I. of the baseline survey was higher, 5.6 kg/ha. The late blight advice service reduced the use of active ingredients per ha.

Table 3.4 *The fungicide use as product applied and active ingredient applied (kg/ha) of the demonstration plots of the Decision Support Service (DSS$^+$), Decision Support Service using Dithane (DSS) and Farmers Practice (FP) in Munshiganj and its sub-districts.*

	Product			Active ingredient		
Sub-district	DSS$^+$	DSS	FP	DSS$^+$	DSS	FP
Gozaria	4.7	18.4	19.1	1.2	14.8	12.4
Louhazang	10.1	13.8	14.3	6.4	11.1	11.5
Munshiganj Sadar	10.1	13.8	14.3	6.4	11.1	11.5
Shreenagar	10.7	15.5	15.9	6.2	11.1	11.3
Sirajdikhan	6.1	18.1	18.4	2.4	14.2	14.8
Tungibari	4.2	16.1	13.8	1.0	12.9	10.9
Munshiganj district[1]	7.7 b	16.0 a	16.0 a	3.9	12.5	12.0

[1] Columns with different letter indicate different amounts of product applied at the 5% significant level.

Improvement in income

The costs for fungicide applications according to the standard scenario in the baseline survey was 6,960 BDT/ha. The costs of the DSS^{+} demonstration was on average 13,658 BDT/ha, 9,941 BDT/ha for the DSS and 8,445 BDT/ha for the FP (Table 3.2). The higher costs are related to the modern product Revus but also to the higher doses of common fungicides applied in the demonstrations. Where the official recommended dose indicates to use 2.0 kg product per ha for Metataf 25 WP or Mosum M 80 WP (Table 2.3), the applied doses are higher, 2.6 and 2.4 kg/ha respectively. This contributes to higher costs of FP compared to the standard scenario of the baseline survey.

Other outcome

Indicators for other outcomes are included for reference purposes only in the summary table (Table 3.5), as most are predetermined by the setup of the demonstrations.

Table 3.5 *Products with curative active ingredients (Products, #) or Metalaxyl (#) and applications with products with curative active ingredients or Metalaxyl of the farmers practice in the demonstrations the sub-districts of Munshiganj.*

	Products	Metalaxyl		Applications	Metalaxyl	
Sub-district	#	#	%	#	#	%
Gozaria	1	1	100	2	2	100
Louhazang	0	0	0	0	0	0
Munshiganj Sadar	0	0	0	0	0	0
Shreenagar	0	0	0	5	0	0
Sirajdikhan	0	0	0	0	0	0
Tungibari	1	1	100	2	2	100

3.2. Evaluation late blight alert service: farmer survey

3.2.1. General characteristics interviewed farmers

Table 3.6 shows the number of farmers after data were cleaned in the different sub-districts that did receive a SMS and the control group that did not receive a SMS, as well as the total number of farmers interviewed. In total, nine unreliable recordings were removed. The control group was slightly larger than the SMS-receiving group. The total number of interviewed farmers per sub-district was comparable to the number of interviewed farmers per sub-district of the baseline survey (Pronk *et al.* 2017).

Table 3.6 *The number of interviewed farmers receiving no SMS and a SMS, and the total number of interviewed farmers in Munshiganj and its sub-districts after data cleaning.*

Sub-district	Non-SMS-farmers	SMS-farmers	Total # of farmers
Gozaria	14	9	23
Louhazang	19	10	29
Munshiganj Sadar	16	26	42
Shreenagar	8	10	18
Sirajdikhan	22	29	51
Tungibari	39	25	64
Munshiganj district	118	109	227

In Table 3.7 the minimum, average and maximum land size with potato are presented in decimals and hectares. Non-SMS-receiving farmers in the Gozaria sub-district have the largest average land size (4.3 ha), the SMS-receiving farmers the smallest (0.8 ha). Differences between SMS-receiving farmers and the control group are smaller in the other sub-districts than in Gozaria and on average land sizes are equal. The overall average size of the potato fields is approximately 2 ha which is slightly smaller than the average potato fields in the baseline survey of 2.4 ha (Pronk *et al.* 2017).

Table 3.7 *Minimum, average and maximum land sizes with potato in decimal and hectares of the interviewed farmers receiving no SMS (No) or a SMS (Yes).*

		Land size (decimal)			Land size (ha)		
Sub-district	SMS	Minimum	Average	Maximum	Minimum	Average	Maximum
Gozaria	No	75	1048	3200	0.3	4.2	12.9
	Yes	40	217	450	0.2	0.9	1.8
Louhazang	No	210	443	1540	0.8	1.8	6.2
	Yes	210	423	950	0.8	1.7	3.8
Munshiganj Sadar	No	30	369	2250	0.1	1.5	9.1
	Yes	72	515	1280	0.3	2.1	5.2
Shreenagar	No	42	292	700	0.2	1.2	2.8
	Yes	320	810	1400	1.3	3.3	5.7
Sirajdikhan	No	53	705	4900	0.2	2.9	19.8
	Yes	54	684	2590	0.2	2.8	10.5
Tungibari	No	17	433	1820	0.1	1.8	7.4
	Yes	60	502	3360	0.2	2.0	13.6
Munshiganj district	No	71	548	2402	0.3	2.2	9.7
	Yes	126	525	1672	0.5	2.1	6.8
	All	99	537	2037	0.4	2.2	8.2

Figure 3.2 shows a frequency distribution of the plot size planted with potato in Munshiganj of the control group (left) and the SMS-receiving farmers (right). Differences between the two groups were small although in Gozaria the control group included four farmers with plots larger than 5 ha whereas the SMS-receiving group had none.

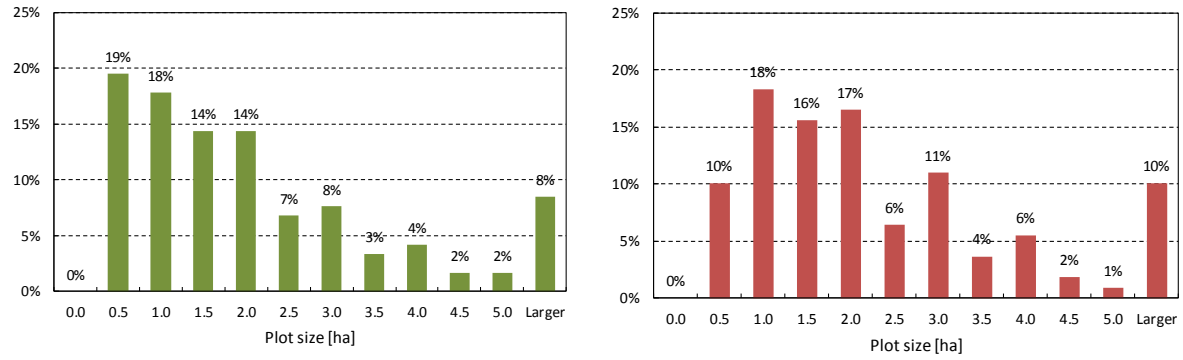

Figure 3.2 *Frequency distribution of the plot sizes (ha) planted with potato in Munshiganj of non-SMS-receiving farmers (left) and SMS-receiving farmers (right).*

The number of farmers that had potato as a previous crop and other crops is presented in Table 3.8. Table 3.8 indicates that 65% of the SMS-receiving farmers in Munshiganj Sadar had potatoes as a previous crop compared to only 3% of the non-SMS-receiving farmers in that sub-district. In the other sub-districts, differences were smaller between the non-SMS-receiving and SMS-receiving farmers. In the Munshiganj district 30% of the SMS-receiving farmers cultivated potatoes as a previous crop compared to only 11% of the non-SMS-receiving farmers. The main previous crop cultivated by the non-SMS-receiving farmers was rice followed by other vegetables. The SMS-receiving farmers also cultivated rice but to a lesser extent and hardly any other vegetables were grown. This indicates that SMS-receiving farmers might have slightly more experience with the cultivation of potatoes.

Table 3.8 *Number (n) and percentage (%) interviewed farmers with potato as previous crop and the number (n) of interviewed farmers with other previous crops per sub-district receiving no SMS (No) or a SMS (Yes).*

		Potato		Rice	Jute	Maize	Vegetables[2]	Mustard
Sub-district	SMS	n	%[1]	n	n	n	n	n
Gozaria	No	2	14	9	1	2	0	0
	Yes	0	0	7	0	2	0	0
Louhazang	No	0	0	12	4	0	3	0
	Yes	0	0	8	2	0	0	0
Munshiganj Sadar	No	3	19	4	1	0	8	0
	Yes	17	65	9	0	0	0	0
Shreenagar	No	3	38	2	3	0	0	0
	Yes	2	20	6	2	0	0	0
Sirajdikhan	No	4	18	15	1	1	0	1
	Yes	6	21	17	4	1	1	0
Tungibari	No	1	3	22	9	2	5	0
	Yes	8	32	17	0	0	0	0
Munshiganj district	No	13	11	64	19	5	16	1
	Yes	33	30	64	8	3	1	0
	All	46	20	128	27	8	17	1

[1] as percentage of farmers in related sub-district and SMS group

[2] Vegetables: Bean, Bitter Gourd, Chili

3.2.2. Planting

Table 3.9 shows an overview of the used potato varieties by the interviewed farmers. Variety 'Diamant' is by far the most used potato variety and there was no difference between the control group and the SMS-receiving farmers. In the baseline study Diamant was also the most frequently used potato variety (Pronk *et al.* 2017).

Table 3.9 The potato variety planted by interviewed non-SMS-receiving (No) and SMS-receiving farmers (Yes) in Munshiganj and its sub-districts.

		Name of potato variety						
Sub-district	SMS	Diamant	Cardinal	Atlantic	Meridian	Atlas	Sagitta	Courage
Gozaria	No	14	0	0	0	0	0	0
	Yes	9	0	0	0	0	0	0
Louhazang	No	19	0	0	0	0	0	0
	Yes	10	0	0	0	0	0	0
Munshiganj Sadar	No	16	0	0	0	0	0	0
	Yes	26	0	0	0	0	0	0
Shreenagar	No	7	1	0	0	0	0	0
	Yes	10	0	0	0	0	0	0
Sirajdikhan	No	21	0	0	0	0	0	1
	Yes	29	0	0	0	0	0	0
Tungibari	No	37	1	0	0	0	1	0
	Yes	19	3	1	1	1	0	0
Munshiganj district	No	114	2	0	0	0	1	1
	Yes	103	3	1	1	1	0	0
	Total	217	5	1	1	1	1	1

Table 3.10 gives an overview of the number of farmers (control group and SMS-receiving farmers) that used an authorized dealer as seed source and those that used farm-saved seed. On most farms, farm-saved seeds are used, only 15% of the control group and 13% of the SMS-receiving group used seeds from an authorized dealer. This is different from the results of the baseline study, where most farmers, 98%, indicated to use seeds from an authorized dealer. Results from the baseline study should be handled with care as the enumerator may have misinterpreted the question and/or answers. Results found in this survey are more in line with literature on seed sources and renewal of seed sources by farmers (Shahriar 2011).

Table 3.10 Overview of seed source of potato varieties used by interviewed farmers receiving no SMS (No) or a SMS (Yes) in the different sub-districts of Munshiganj.

	Non-SMS farmers		SMS-farmers	
Sub-district	Authorized dealer	Farm-saved seed	Authorized dealer	Farm-saved seed
Gozaria	1	13	1	8
Louhazang	5	14	2	8
Munshiganj Sadar	4	12	1	25
Shreenagar	0	8	0	10
Sirajdikhan	10	12	11	18
Tungibari	13	26	16	9
Munshiganj district	33 (15%)	85 (37%)	31 (14%)	78 (34%)

Table 3.11 gives an overview of the earliest, average and latest planting date in 2016 of the control group and SMS-receiving farmers. All farmers cut potato seeds before planting except one SMS-receiving farmer in Tungibari who grew certified Cardinal. The cut potatoes were not further treated with a pesticide. Figure 3.3 shows the weekly frequency distribution of planting dates of the control group (left) and the SMS-receiving group (right) and indicates that more than 50% of the potato fields were planted in the second half of November. Compared to the baseline study, the planting period had narrowed as the earliest planting found in the baseline study was 7 October and in this study 27 October. The latest planting date of the baseline study was 25 December, which was also later than the 20th December found in this study.

Table 3.11 *Overview of earliest, average and latest planting date in the 2016/17 growing season of interviewed farmers receiving no SMS (No) or a SMS (Yes) in the different sub-districts of Munshiganj.*

	Non-SMS farmers			SMS-farmers		
Sub-district	Earliest	Average	Latest	Earliest	Average	Latest
Gozaria	11-Nov	22-Nov	29-Nov	06-Nov	17-Nov	25-Nov
Louhazang	13-Nov	19-Nov	26-Nov	17-Nov	19-Nov	25-Nov
Munshiganj Sadar	10-Nov	21-Nov	29-Nov	08-Nov	23-Nov	29-Nov
Shreenagar	18-Nov	27-Nov	02-Dec	20-Nov	25-Nov	29-Nov
Sirajdikhan	01-Nov	16-Nov	29-Nov	15-Nov	22-Nov	30-Nov
Tungibari	02-Nov	16-Nov	30-Nov	27-Oct	26-Nov	20-Dec
Munshiganj district	01-Nov	19-Nov	02-Dec	27-Oct	22-Nov	20-Dec

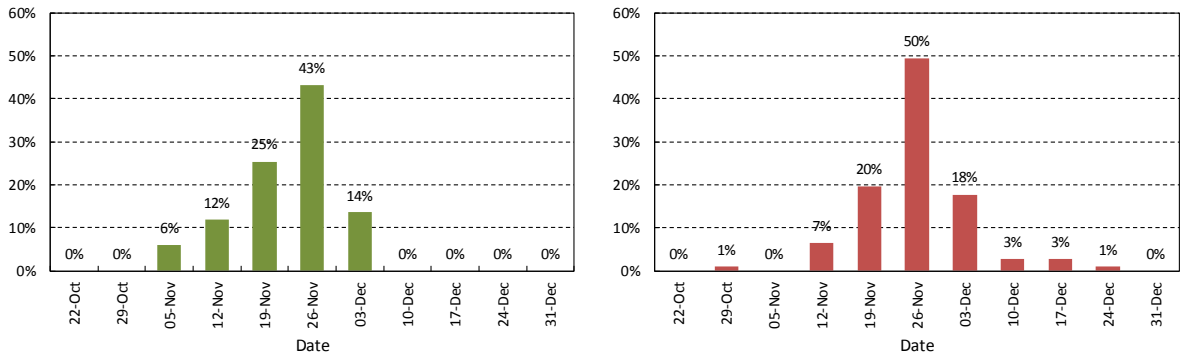

Figure 3.3 *Weekly frequency distribution of the potato planting dates in Munshiganj in the 2016/17 season of non-SMS farmers (left) and SMS-farmers (right).*

Table 3.12 gives an overview of the minimum, average and maximum row and intra-row distance and the calculated plant density of the control group and SMS-receiving farmers. Differences between the two groups of farmers are small and within the variation of farmers. Also, panting distances are in agreement with those of the baseline study (Pronk *et al.* 2017).

Table 3.12 Minimum (min), average (avg) and maximum (max) row and intra-row distance (cm), and the calculated plant density (plants/ha) of non-SMS receiving farmers (left) and SMS-receiving farmers in the Munshiganj and its sub-districts.

		Row distance			Intra row distance			Plant density		
Sub-district	SMS	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Gozaria	No	25	31	45	11	12	15	148,148	273,332	363,636
	Yes	30	30	30	11	13	15	222,222	258,137	303,030
Louhazang	No	30	35	45	10	11	15	148,148	260,161	333,333
	Yes	30	38	45	10	11	11	197,531	247,459	303,030
Munshiganj Sadar	No	30	40	45	9	10	13	177,778	253,479	380,952
	Yes	20	32	45	10	11	15	197,531	285,237	444,444
Shreenagar	No	30	30	30	10	11	13	259,202	298,604	333,333
	Yes	30	34	45	10	12	15	148,148	258,636	333,333
Sirajdikhan	No	30	39	45	8	11	15	166,667	252,603	333,333
	Yes	30	35	45	9	11	13	170,940	275,166	370,370
Tungibari	No	23	36	45	9	11	13	192,308	269,049	386,473
	Yes	23	33	45	10	13	20	142,857	247,588	395,257
Munshiganj district		20	35	45	8	11	20	142,857	265,349	444,444

3.2.3. Fertilisation

Table 3.13 shows the minimum, average and maximum doses of applied urea and triple super phosphate (TSP) fertiliser of the control group and SMS-receiving farmers. The application doses have been converted to hectares instead of acres as in the questionnaire. The minimum, average and maximum applied amounts of urea and TSP have also been converted into the amounts of applied nitrogen (N) and phosphate (P_2O_5), respectively.

The advised doses of fertilisers for potato in Bangladesh for a yield goal of 30 t/ha are 91 to 135 or 136 to 180 N kg/ha, ≈ 50 to – 70 or 71 to 92 P_2O_5 kg/ha and ≈ 110 to - 163 or 164 to 217 K_2O kg/ha, depending on the soil status 'low' or 'very low' according to the soil analysis interpretation, respectively (FRG 2012). Table 3.13 shows that the current average application rates for N (267 kg/ha) and P_2O_5 (247 kg/ha) are much higher than the recommendations but in agreement with application rates found in Munshiganj in 2009 (Rabbani *et al.* 2010).
The subsidised fertiliser costs contribute approximate 8 to 10% to the variable costs (Hossain *et al.* 2008b).
An interaction was found between the group of farmers and sub-district. This shows that in some sub-districts, the average fertiliser use of urea and TSP of non-SMS-receiving farmers was different from SMS-receiving farmers, but in some districts, there was no difference.

Table 3.13 *Minimum, average and maximum applied urea and triple super phosphate (TSP, kg/ha) of non-SMS-receiving farmers and SMS-receiving farmers in Munshiganj and its sub-districts, and the minimum, average and maximum applied N and P_2O_5 (kg/ha) in Munshiganj district.*

		Urea (kg/ha)			TPS (kg/ha)		
Sub-district	SMS	Min	Avg	Max	Min	Avg	Max
Gozaria	No	571	677	816	321	591	914
	Yes	618	750	914	297	541	914
Louhazang	No	494	599	741	494	514	618
	Yes	494	581	741	371	470	618
Munshiganj Sadar	No	247	484	618	247	446	593
	Yes	247	468	618	309	468	687
Shreenagar	No	442	576	793	494	604	707
	Yes	442	557	667	529	586	667
Sirajdikhan	No	393	588	865	351	605	1411
	Yes	227	435	712	227	533	811
Tungibari	No	309	631	1112	247	552	865
	Yes	519	715	1112	371	671	989
Munshiganj district	No	247	600	1112	247	550	1411
	Yes	227	558	1112	227	549	989
	All	227	580	1112	227	549	1411
	kg N / P_2O_5 /ha	105	267	512	102	247	635
Sub-district			***			***	
SMS or Not			n.s.			n.s.	
Sub-district * SMS or Not			***			***	

3.2.4. Production

Table 3.14 shows the harvest time and the number of growing days, i.e. the difference between harvest and planting date of the control group and SMS-receiving farmers. No differences were found between farmers in one sub-district but the number of growing days in Louhazang was significantly larger than the number of growing days in the other sub-districts. There were no interactions between sub-districts and SMS-receiving or non-SMS-receiving farmers.
Figure 3.4 shows the weekly frequency distribution of harvesting dates of the control group (left) and SMS-receiving farmers (right). Differences between the two groups of farmers are small although one may expect the SMS-receiving farmers to control late blight better and thus have a longer growing season that is a higher number of growing days. This, however does not show from Table 3.14. The average number of growing days of 111 in this study was one week longer than the number of growing days of the baseline study of 104 days (Pronk *et al.* 2017). The late blight pressure was indicated to be low this year (Table 3.22) and yields were indicated to be good which may have been related to a slightly longer growing season.

Table 3.14 *Minimum, average and maximum harvest time and number of growing days in Munshiganj and its sub-districts of non-SMS-receiving farmers, SMS-receiving farmers and all farmers.*

		Harvest date			Number of growing days		
Sub-district	SMS	Min	Avg	Max	Min	Avg	Max
Gozaria	No	02 March	10 March	23 March	93	108	119
	Yes	13 February	05 March	16 March	93	108	130
Louhazang	No	15 March	22 March	28 March	116	123	131
	Yes	01 March	18 March	25 March	101	119	127
Munshiganj Sadar	No	27 February	08 March	03 April	92	107	126
	Yes	27 February	08 March	21 March	92	106	121
Shreenagar	No	03 March	14 March	22 March	94	107	124
	Yes	01 March	15 March	25 March	101	110	121
Sirajdikhan	No	09 January	03 March	28 March	69	107	128
	Yes	01 March	11 March	29 March	92	109	128
Tungibari	No	20 February	12 March	26 March	95	116	141
	Yes	25 February	16 March	08 April	80	110	143
Munshiganj district	No	09 January	11 March	03 April	69	113	141
	Yes	13 February	12 March	08 April	80	110	143
	All	09 January	12 March	08 April	69	111	143
Sub-district						***	
SMS or not						n.s.	
Sub-district * SMS or not						n.s.	

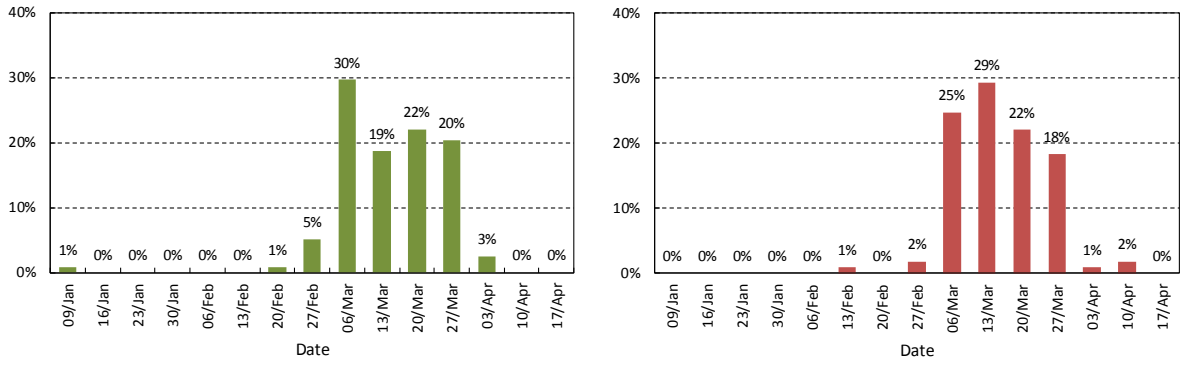

Figure 3.4 *Weekly frequency distribution of the potato harvesting dates in Munshiganj in the 2016/17 season of non-SMS-receiving farmers (left) and SMS-receiving farmers (right).*

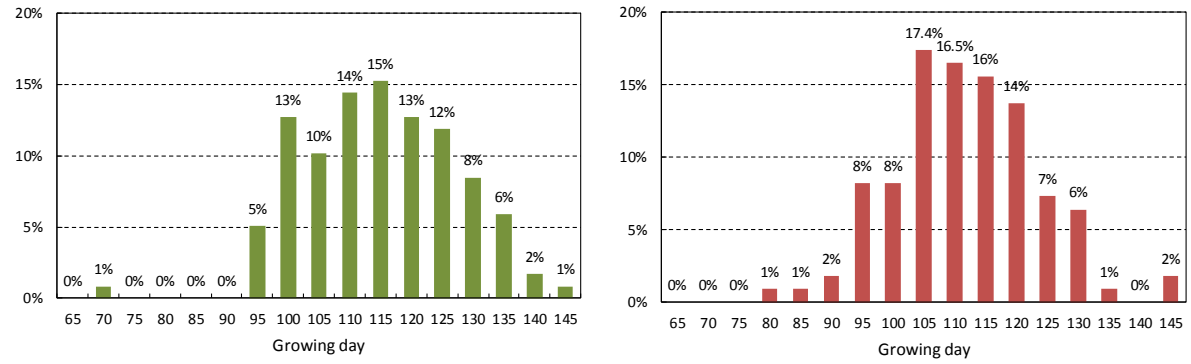

Figure 3.5 *The five-day frequency distribution of the growing period of potatoes in Munshiganj in the 2016/17 season of non-SMS-receiving farmers (left) and SMS-receiving farmers (right).*

The potato yields varied between 12.4 and 46.2 t/ha (*Table* 3.15) with an average yield of almost 30 t/ha. These yields were comparable to yields found in the baseline study (Pronk *et al.* 2017). Differences in yields between sub-districts were found, but not between SMS-receiving or non-SMS receiving farmers. There was an interaction between sub-district and SMS-receiving or non-SMS-receiving farmers. The average yields in the sub-district Munshiganj Sadar from the SMS-receiving farmers was higher than from the non-SMS receiving farmers whereas in Tungibari the opposite was found: yields from the non-SMS-receiving farmers was higher than from the SMS-receiving farmers.

Table 3.15 *Potato yields (in t/ha) in different sub-districts and in Munshiganj in the 2016/17 season of non-SMS-receiving farmers (No) and SMS-receiving farmers (Yes).*

Sub-district	SMS or not	Minimum	Average	Maximum
Gozaria	No	22.2	29.6	37.6
	Yes	24.7	29.6	30.9
Louhazang	No	27.2	30.1	32.1
	Yes	26.7	29.4	32.1
Munshiganj Sadar	No	15.8	28.6	39.5
	Yes	26.4	34.0	39.5
Shreenagar	No	24.7	29.0	34.6
	Yes	22.5	29.8	39.5
Sirajdikhan	No	24.7	30.3	37.6
	Yes	23.5	31.0	46.2
Tungibari	No	15.6	29.4	38.3
	Yes	12.4	25.5	37.1
Munshiganj district	No	15.6	29.6	39.5
	Yes	12.4	30.1	46.2
	All	12.4	29.8	46.2
Sub-district			**	
SMS or not			n.s.	
Sub-district * SMS or not			***	

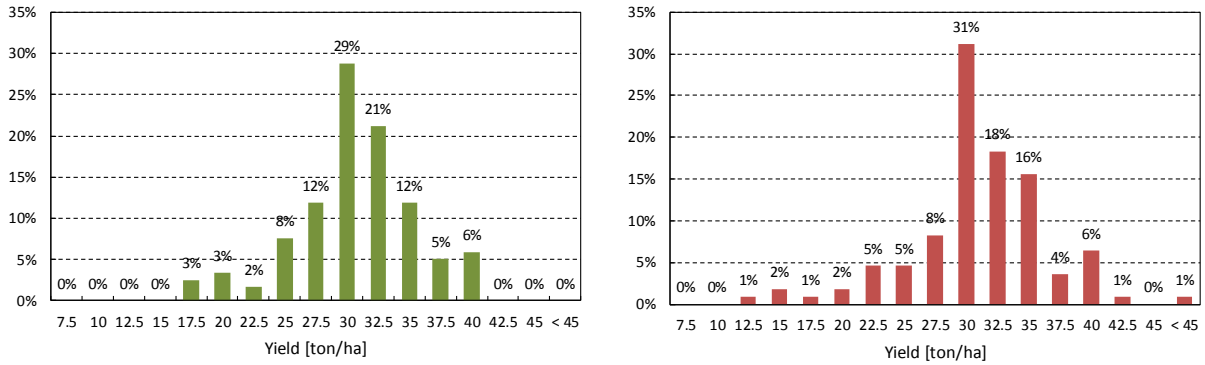

Figure 3.6 *Frequency distribution of potato yields in Munshiganj in the 2016/17 season of non-SMS-receiving farmers (left) and SMS-receiving farmers (right).*

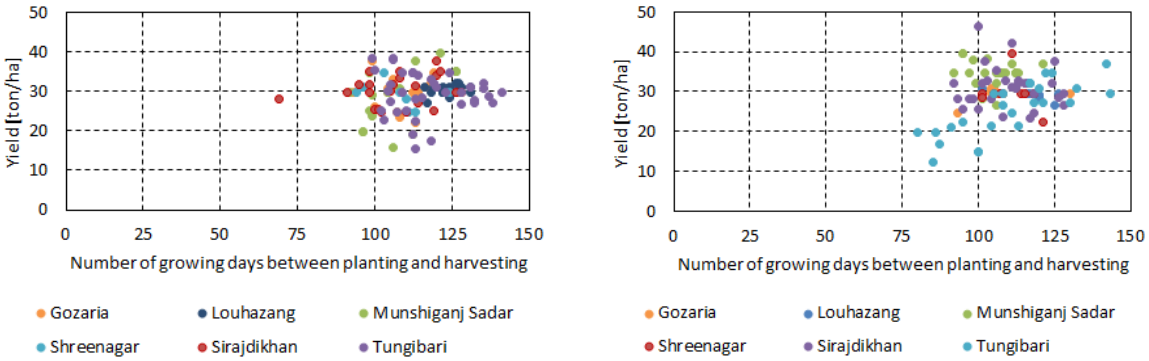

Figure 3.7 *Relationship between the number of growing days and potato yield of non-SMS-receiving (left) farmers and SMS-receiving farmers (right).*

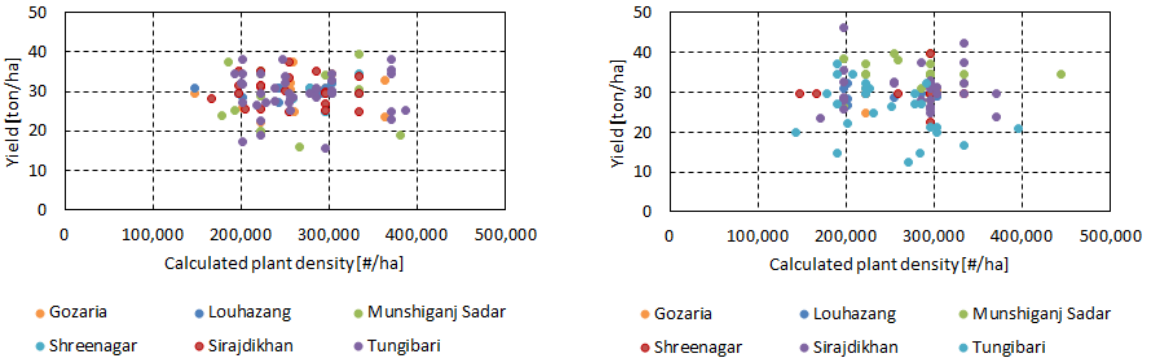

Figure 3.8 *Relationship between the calculated plant density (plants/ha) and potato yield of non-SMS-receiving farmers (left) and SMS-receiving farmers (right).*

Table 3.16 shows the price at which farmers sold their potatoes after harvest. The average price was slightly lower than the average price indicated in the baseline study of 11,940 BDT/t (Pronk *et al.* 2017).

Table 3.16 Sales prices of potatoes (BDT/t) in Munshiganj and its sub-districts of non-SMS-receiving farmers and SMS-receiving farmers.

	Non-SMS-receiving farmers			SMS-receiving farmers		
Sub-district	Min	Avg	Max	Min	Avg	Max
Gozaria	8,000	10,893	15,000	9,000	10,900	12,500
Louhazang	8,000	9,289	10,500	7,500	8,150	9,000
Munshiganj Sadar	7,000	9,681	12,000	8,000	10,231	12,500
Shreenagar	8,000	10,306	11,250	10,000	11,225	12,000
Sirajdikhan	8,000	10,273	12,500	8,000	10,155	12,500
Tungibari	7,500	10,463	18,000	7,000	8,958	10,900
Munshiganj district	7,000	10,168	18,000	7,000	9,875	12,500

3.2.5. Control of late blight

Farmers identified first late blight symptoms approximately 60 days after planting and this was the same for all sub-districts and farmers (Table 3.17). The number of applications ranged from 2 to 10 and was different for non-SMS and SMS-receiving farmers for some but not all districts, as shown by the interaction. The application interval ranged from 2 to 17 days and was 9.4 on average. The application interval of SMS-receiving farmers was shorter than of the non-SMS-receiving farmers. In addition, the interval was different for the different sub-districts. In Louhazang, the interval was almost 13 days as in Gozaria it was only 8 days.

Table 3.17 *The minimum (min), average (avg) and maximum (max) number of days after planting (DAP) that late blight was observed, the number of fungicide applications per season (times per season) and the application interval time (days) for the Munshiganj and its sub-districts of non-SMS (No) or SMS (Yes) receiving farmers, all farmers and the results of the statistical analysis.*

		DAP			# of applications			Application Interval		
Sub-district	SMS	Min	avg	max	min	avg	max	Min	avg	max
Gozaria	No	38	50	66	3	5.3	7	5	8.5	11
	Yes	48	56	61	4	6.1	8	4	8.2	12
Louhazang	No	42	55	76	5	5.4	6	9	12.9	17
	Yes	56	56	56	5	5.8	7	10	12.8	15
Munshiganj Sadar	No	31	63	88	2	5.4	8	3	8.7	14
	Yes	41	63	95	5	5.8	8	5	9.3	13
Shreenagar	No	31	64	78	5	6.3	9	7	9.4	12
	Yes	36	62	85	3	5.2	8	6	8.9	12
Sirajdikhan	No	43	57	71	3	5.9	8	2	8.3	13
	Yes	40	61	97	2	5.8	8	2	9.3	14
Tungibari	No	32	57	92	4	6.2	10	5	9.5	14
	Yes	35	63	84	5	6.8	9	3	8.2	14
Munshiganj district	No	31	58	92	2	5.8	10	2	9.6	17
	Yes	35	60	97	2	6.0	9	2	9.2	11
Munshiganj district	All	31	59	97	2	5.9	10	2	9.4	12
Sub-district			n.s.			**			**	
SMS or Not			n.s.			n.s.			*	
Sub-district * SMS or Not			n.s.			*			n.s.	

All farmers in Gozaria, Louhazang and Munshiganj Sadar and SMS-receiving farmers in Sirajdikhan started the spraying activities before late blight was observed (Table 3.18). This is in agreement with the late blight alert service as this service concentrates on the prevention of the late blight infection. In Shreenagar, approximately 13% of the farmers did apply the first late blight spray after infection was found, no differences between non-SMS-receiving farmers and SMS-receiving farmers. In Tungibari, 26% of the non-SMs-receiving farmers applied the first spray after late blight was found whereas only 8% of the SMS-receiving farmers did so, supporting the view that SMS-receiving farmers acted upon the provided service alert. On average, the farmers sprayed well before the first observation of late blight symptoms.

Table 3.18 *The average day that late blight was first observed, the average day the first fungicide spray was applied and the percentage of farmers that applied the first spray after LB was observed of non-SMS-receiving farmers and SMS-receiving farmers in Munshiganj and its sub-districts.*

	Non-SMS receiving farmers			SMS-receiving farmers		
Sub-district	first observed	First spray	After	first observed	First spray	after
Gozaria	11/Jan/17	27/Dec/16	0	09/Jan/17	21/Dec/16	0
Louhazang	13/Jan/17	20/Dec/16	0	15/Jan/17	15/Dec/16	0
Munshiganj Sadar	29/Jan/17	26/Dec/16	0	23/Jan/17	21/Dec/16	0
Shreenagar	30/Jan/17	02/Jan/17	14	26/Jan/17	01/Jan/17	13
Sirajdikhan	13/Jan/17	10/Dec/16	9	22/Jan/17	25/Dec/16	0
Tungibari	09/Jan/17	21/Dec/16	26	04/Feb/17	29/Dec/16	8
Munshiganj district	14/Jan/17	21/Dec/16	12	25/Jan/17	24/Dec/16	4

Farmers were asked which products they used. The active ingredients of the products used and the type of the fungicide products are shown in Table 3.19, which also identifies the times farmers mentioned to use a product containing a specific active ingredient. The 118 non-SMS-receiving farmers indicated to use 191 products (Table 3.19) and the 107 SMS-receiving farmers used 174 products. Most products contained Mancozeb as the only active ingredient, followed by products containing Mancozeb plus Metalaxyl. Differences between the two groups of farmers in products used are, however small.

Table 3.19 *The number of recordings (#) of farmers receiving no SMS (Non-SMS) or a SMS (SMS) that mentioned to use an active ingredient, the type of fungicide and the percentage total recordings (%).*

		Non-SMS		SMS	
Active ingredient	type of fungicide	#	%	#	%
Chlorothalonil	Preventive	9	4.7	4	2.3
Copper hydroxide	Preventive	2	1.0	0	0.0
Mancozeb (60%) + Dimethomorph (9%)	Preventive + curative	20	10.5	4	2.3
Mancozeb	Preventive	96	50.3	104	59.9
Mancozeb (50%) + Fenamidone (10%)	Preventive + slightly curative	5	2.6	4	2.3
Mancozeb (63%) + Carbendazim (12%)	Preventive	3	1.6	1	0.6
Mancozeb (64%) + Cymoxanil (8%)	Preventive + curative	9	4.7	6	3.5
Mancozeb (64%) + Metalaxyl (4%)	Preventive + curative resistance	39	20.4	29	16.5
Mandipromid	Curative	1	0.5	1	0.6
Metalaxyl	Curative resistance	1	0.5	5	2.9
Propineb	Preventive	5	2.6	14	8.1
Propineb (70%) + Iprovalicarb	Preventive + slightly curative	1	0.5	2	1.2
Total number of active ingredients		191	100	174	100

Table 3.20 shows the type of sprayer used by farmers in Munshiganj district to apply fungicides. About 82 to 89% of the farmers use a manual knapsack sprayer. The rest of the farmers used (also) a

power sprayer to apply the fungicides. The type of sprayers used is in agreement with the type of sprayers used in the baseline study (Pronk *et al.* 2017).

Table 3.20 The number (#) of Munshiganj farmers receiving no SMS (Non-SMS) or a SMS (SMS) and the percentage of Munshiganj farmers that used a specific type of sprayer to apply fungicides.

	Non-SMS		SMS	
Sprayer type	#	%	#	%
Knapsack	105	89	89	82
Power sprayer	9	8	14	13
Both	4	3	6	6

Table 3.21 shows the percentage of farmer in each sub-district that uses Metalaxyl-containing products, either as a single or composite fungicide product or as the percentage of farmers that used one chemical compound only. The use of one chemical compound is different from the use of one fungicide product as many fungicide products contain the same chemical compound. Farmers use many different products, also in sequence, which contain the same chemical compound.
On average, one third of the farmers uses Metalaxyl containing products.

Of all districts, only in Louhazang all farmers mentioned to use more than one chemical compound.

Table 3.21 The percentage of farmers receiving no SMS (Non-SMS) or a SMS (SMS) that use Metalaxyl-containing curative fungicide products and one chemical compound only.

	Non-SMS		SMS	
Sub-district	Metalaxyl (%)	1 chemical compound (%)	Metalaxyl (%)	1 chemical compound (%)
Gozaria	43	43	11	67
Louhazang	26	0	80	0
Munshiganj Sadar	19	56	0	54
Shreenagar	50	38	30	50
Sirajdikhan	41	41	38	34
Tungibari	28	33	32	20
Munshiganj district	32	34	28	37

The statistical analysis showed that the yields were significantly lower when only curative resistant fungicides were used (Figure 3.9, C-res). There was no effect of receiving a SMS and type of fungicide on yield. However, non-SMS-receiving farmers in Munshiganj Sadar that used preventive + curative (P+C) fungicides had the lowest yields of all farmers (Figure 3.9, left).

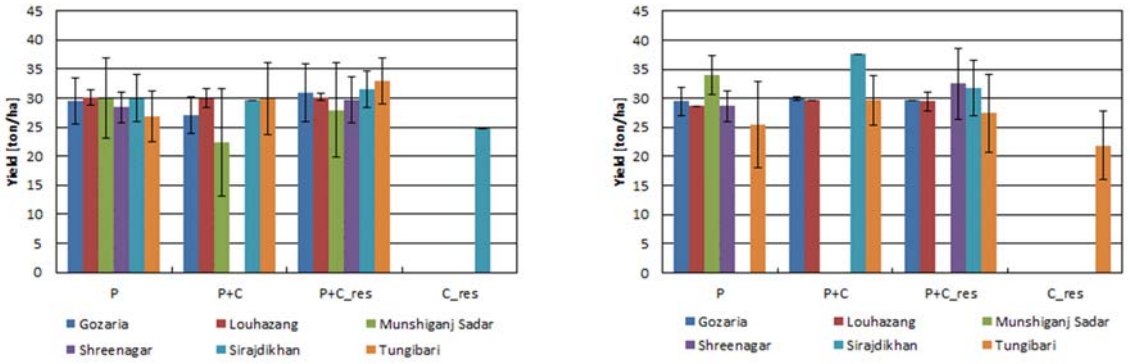

Figure 3.9 *The effect of different types of active ingredient on yield of non-SMS-receiving (left) and SMS-receiving farmers (right) in different sub-districts (P = preventive; P + C = preventive and curative; P + C_res = preventive and curative resistance; C-res = curative resistance).*

3.2.6. Service evaluation

Most farmers indicated that this potato season late blight pressure was low (Table 3.22). In total eight non-SMS-receiving farmers indicated that late blight pressure was medium where none of the SMS-receiving farmers indicated that late blight pressure was medium.

Table 3.22 *The late blight pressure according to non-SMS-receiving and SMS-receiving farmers.*

	Non-SMS			SMS		
Sub-district	n	low	Medium	n	Low	medium
Gozaria	7	7	0	3	3	0
Louhazang	16	14	2	1	1	0
Munshiganj Sadar	4	3	1	9	9	0
Shreenagar	7	7	0	8	8	0
Sirajdikhan	11	10	1	15	15	0
Tungibari	24	20	4	15	15	0
Munshiganj district	69	61	8	51	51	0

All farmers in Gozaria, Louhazang and Shreenagar received the SMS-message (Table 3.23) and on average farmers received 7.4 messages. The majority of farmers (92%) indicated to understand the message, 7% did not and only 1% understood the message partially. Farmers in Munshiganj Sadar, Sirajdikhan and Tungibari had more difficulties with understanding the messages than farmers in the other sub-districts.

Table 3.23 *The percentage of farmers that received a SMS, the average number of SMS's reported by farmers to be received and the percentage of farmers that understood the SMS.*

			Understand SMS (%)		
Sub-district	SMS received (%)	# SMS's	Yes	No	partially
Gozaria	100	7.1	100	0	0
Louhazang	100	8.6	100	0	0
Munshiganj Sadar	88	6.9	83	17	0
Shreenagar	100	7.8	100	0	0
Sirajdikhan	90	6.4	88	8	4
Tungibari	92	8.6	96	4	0
Munshiganj district	93	7.4	92	7	1

It is most important to know if farmers acted upon the SMS-alert and when not, why. Table 3.24 shows that most farmers acted upon the SMS-alert although in Munshiganj Sadar only 65% of the farmers acted on the alert received. Farmer's reasons not to act upon were related to 'not received a SMS due to phone problems', 'no time' or 'just sprayed'. The majority of farmers (43% and 11%) indicated to spray on other times as well.

Table 3.24 *The percentage of farmers that acted upon the SMS advice and reasons why not, and percentage of farmers that sprayed on others times additionally to the advice.*

	Acted upon SMS advice				Sprayed on other time(s)		
Sub-district	Yes	No	Sometimes	Why not?	Yes	No	Sometimes
Gozaria	89	0	11		56	44	0
Louhazang	100	0	0		0	90	10
Munshiganj Sadar	65	13	22	phone was stolen, no SMS; no time; just sprayed	57	52	26
Shreenagar	100	0	0		70	20	10
Sirajdikhan	85	12	4	lost my phone, no SMS; just sprayed	54	42	50
Tungibari	100	0	0		35	57	8
Munshiganj district	87	6	7		43	47	11

Most farmers, 89%, shared the SMS-alert received with other farmers (Table 3.25) and the average number of farmers shared with was 13. In Gozaria and Louhazang, all farmers shared the SMS where between 85 and 90% of the farmers in the other sub-districts shared the SMS with others.

Table 3.25 The percentage of farmers that shared the SMS information with other farmers and the average number of farmers that the SMS was shared with.

	Shared SMS with others (%)		
Sub-district	Yes	No	Average number of farmers shared with
Gozaria	100	0	12
Louhazang	100	0	12
Munshiganj Sadar	87	13	18
Shreenagar	90	10	14
Sirajdikhan	85	15	12
Tungibari	87	13	11
Munshiganj district	89	11	13

Table 3.26 shows that most farmers, 94% were satisfied with the service. Reasons why they were not satisfied were mostly related to phone problems. Farmers have, as turned out, more than one phone. They provided a number for the subscription that sometimes accidentally was the wrong number.

Table 3.26 The percentage of farmers that was satisfied with the SMS service and if not, why.

	Satisfied (%)		
Sub-district	Yes	No	Why not?
Gozaria	100	0	
Louhazang	100	0	
Munshiganj Sadar	91	9	Phone problems, no SMS received; not enough time to spray
Shreenagar	80	20	Fungicide did not work good; had to spray much more
Sirajdikhan	96	4	Phone problems, no SMS received
Tungibari	96	4	Phone problems, no SMS received
Munshiganj district	94	6	

The main reason why farmers were satisfied with the SMS service was information on the weather forecast, 33 times mentioned, and related the effects of knowing the weather forecast such as timely spraying, reduced pest pressure and issues related to the trainings (Table 3.27). Farmers indicated that by receiving the weather forecast, they knew when to apply the fungicides and from the trainings, they learned which fungicides to apply at which application rates. Secondly, farmers indicated to have a good production, 24 times. The good production followed from reduced pest pressure as result of the SMS service, 7 times mentioned, and from trainings, 2 times mentioned. Reduced pest pressure was mentioned 20 times as the reason why farmers were satisfied with the SMS service, reduced costs being mentioned once as additional reason.

Table 3.27 The main reason and the sub-reason of farmers (# times mentioned) why they were satisfied with the SMS service.

Main reason	Sub-reason	Gozaria	Louhazang	Munshiganj Sadar	Shreenagar	Sirajdikhan	Tungibari	Total
Timely spraying		1	0	3	0	3	0	7
Good production		1	8	5	1	2	7	24
	Reduced pressure	0	3	1	0	1	2	7
	Training	0	1	0	0	0	1	2
Helpful		0	0	2	0	0	1	3
Reduced costs		0	0	0	3	1	2	6
Reduced pressure		5	2	3	1	0	9	20
	Reduced costs	0	0	0	0	0	1	1
Training		0	0	0	1	5	1	7
	Reduced pressure	0	0	0	0	1	1	2
Weather forecast		1	0	11	1	16	4	33
	Timely spraying	1	0	4	0	3	0	8
	Helpful	0	0	0	0	0	2	2
	Reduced pressure	0	0	0	0	9	0	9
	Training	0	0	0	0	2	0	2

3.3. Outcome indicators evaluation

The outcome indicators for the evaluation survey are summarized in Table 3.29. The subsequent indicators are evaluated and compared with the outcome indicators found in the baseline study (Pronk *et al.* 2017).

Improvement in sustainable food production

Yields between non-SMS-receiving and SMS-receiving farmers did not differ (*Table* 3.15) and were also not different from the yields in the baseline study (Pronk *et al.* 2017).

Improvement in resource use efficiency

The fertiliser use efficiency between non-SMS-receiving and SMS-receiving farmers did not differ (Table 3.28) and was also not different compared with the fertiliser use efficiency found in the baseline study (Pronk *et al.* 2017).

The fungicide use efficiency expressed as kg product/ha did not show any differences between the non-SMS-receiving or SMS-receiving farmers, or the results from the baseline survey. In addition, little differences were found when the fungicide use efficiency was expressed as kg A.I. per hectare.

Table 3.28 Outcome indicators of N-use efficiency and fungicide use efficiency of non-SMS-receiving and SMS-receiving farmers for Munshiganj and its sub-districts.

		N-fertiliser use	Fungicide use	
Sub-district	SMS	kg N/t product	kg product/ha	kg AI/ha
Gozaria	No	10.7	8.1	5.8
	Yes	11.7	9.6	6.5
Louhazang	No	9.2	6.0	4.1
	Yes	9.1	6.0	4.1
Munshiganj Sadar	No	8.4	7.0	5.4
	Yes	6.5	7.7	6.1
Shreenagar	No	9.2	6.9	5.2
	Yes	8.7	5.7	3.8
Sirajdikhan	No	9.1	7.1	5.3
	Yes	6.5	7.6	5.4
Tungibari	No	10.2	8.7	6.2
	Yes	13.8	7.5	5.1
Munshiganj district	No	9.6	7.5	5.4
	Yes	9.0	7.4	5.3
	All	9.3	7.5	5.4

Improvement in income

Improvement in income was not calculated as the prices of fungicide products (85 different products in total) was not asked in the questionnaire. This will be done in a later phase of the project.

Other outcomes

The number of fungicide products with curative active ingredients mentioned to be used by farmers is shown in Table 3.29. Almost 75% of these products contained Metalaxyl. Not many differences were found between non-SMS-receiving and SMS-receiving farmers, although occasionally less products mentioned by SMS-receiving farmers contained Metalaxyl, for example in Gozaria. However, a striking difference was found in Munshiganj Sadar. None of the SMS-receiving farmers used products with curative active ingredients. These farmers met the ultimate goal of the late blight advice service: only preventive fungicides used and no need for curative fungicides. SMS-receiving farmers in this sub-district also had the highest yields (*Table* 3.15).

The average number of applications per farmer with products containing curative active ingredients was 3.9 and ranged from 0 to 4.8 (Table 3.29). Of these 3.9 applications, 2.9 or 78% contained Metalaxyl. The average number of applications with curative fungicides of SMS-receiving farmers was slightly lower than of non-SMS-receiving farmers, 4.0 compared to 3.8. Additionally, the number of applications with Metalaxyl was also slightly lower for SMS-receiving farmers compared to non-SMS-

receiving farmers, 2.1 and 2.4. This suggests that SMS-receiving farmers used less curative fungicides, which also contained less curative fungicides with Metalaxyl.

Table 3.29 *Products with curative active ingredients (Products, #) or Metalaxyl (#) and applications with products with curative active ingredients or Metalaxyl of the baseline survey and the evaluation of non-SMS-receiving and SMS-receiving farmers in Munshiganj district.*

		Products	Metalaxyl		Applications	Metalaxyl	
Sub-district	SMS	#	#	%	#	#	%
Gozaria	No	9	4	44	4.1	1.8	61
	Yes	4	1	25	4.6	0.6	25
Louhazang	No	7	5	71	2.7	1.4	56
	Yes	10	9	90	4.0	3.7	89
Munshiganj Sadar	No	14	11	79	3.7	2.0	60
	Yes	0	0	0	0.0	0.0	0
Shreenagar	No	6	4	67	4.3	3.9	88
	Yes	4	3	75	2.6	2.6	100
Sirajdikhan	No	13	10	77	3.8	3.5	90
	Yes	10	7	70	4.1	3.5	83
Tungibari	No	11	6	55	4.6	1.6	37
	Yes	11	5	45	3.4	2.2	64
Munshiganj district	No	29	19	66	4.0	2.1	58
	Yes	31	23	74	3.8	2.8	74
	All	41	30	73	3.9	2.4	64

4. Discussion and conclusions

4.1. Late blight control demonstrations

Performing a late blight demonstration and compare the spraying strategy with farmer's practices was a challenge for more than one reason. The main difficulty was that the DSS alert indicated when to apply the fungicide. Most understandably, farm managers will apply fungicides to all treatments, including the farmer's practice. However, farmers in the vicinity and not aware of the alert, may spray at different moments. Therefore, differentiation of the number of applications between the DSS and FP in the demonstrations was difficult and not realized as all treatments at one location received the same number of applications. In the demonstrations, the FP treatment received 7.2 applications (Table 2.1) which was more frequent than observed in the evaluation survey, 5.9 (Table 3.18), and in the baseline survey, 6.3 (Pronk *et al.* 2017).

The fungicides used in the DDS$^+$ were relatively new, modern and sometimes expensive fungicides (Table 2.3). The ideal schedule of fungicide application in the DSS$^+$ treatment was to use each active ingredient two times in a row and then change to a product with the same control but different active ingredient(s), to prevent late blight from adaption and development of resistant strains. This schedule was applied in Louhazang, Munshiganj Sadar and to some extent in Sreenagar. In the other sub-districts, Revus was used for more than two applications in a row which should improve in future demonstrations.

The results of the late blight control demonstrations are furthermore difficult to interpret because the management of the three treatments showed differences as GAP were included into the treatments. Seed cutting was replaced by planting intact (not cut) tubers in the DSS$^+$ treatment as GAP where seeds were cut in the other two treatments (section 2.1.2). The higher price of seeds may indicate that better quality seed was used in DSS$^+$ and DSS treatments as seed quality has a profound effect on yields (Shaheb *et al.* 2016). Chemical fertiliser applications in the DSS$^+$ and DSS treatments were in accordance with the fertiliser recommendations for soils with a low fertility status and substantially lower in both rates and costs, than the chemical fertilisation applied according to farmers practice (Table 2.4). Side dressing was only practice in the FP treatment in one sub-district. The relatively high basal dressing in the FP treatment of on average 312 kg N/ha stimulates aboveground biomass production and this delays tuber bulking (Dyson & Watson 1971). For short season potato production delayed bulking reduces yields which may have contributed to the lower yields found in the FP treatment compared to DSS$^+$ and DSS (Table 3.1). Fertiliser applications of FP may be reduced without any effects on yield or yield losses. This certainly improves the N-use efficiency without compromising yield, the outcome indicator for sustainable food production in GEOPOTATO. Additionally, yields of FP were lower than DSS/DSS$^+$, indicating that intact tubers contribute to good yields and costs of cutting may be saved.

Results of the demonstration showed increased costs of late blight control (Table 3.2) and reduced costs of chemical fertilisers for DSS and DSS$^+$ compared to FP. The reduced fertilizer costs are almost 3 up to 9 times the increased costs for late blight control for DSS and DSS$^+$, respectively. This leads to the conclusion that farmers can financially benefit from following the fertiliser recommendations and that increased costs for DSS or DSS$^+$ are small compared to costs for fertilisers.

With respect to the late blight demonstrations, it is concluded that:

- It is difficult to realise a demonstration, which compares a DSS for late blight control with control according to farmers practice.
- The demonstrations included a number of factors that contributed to the yield differences. This makes it particularly difficult to relate yield differences to treatments.
- Following the fertiliser recommendations improves farmers' profits with no negative effects on yield.
- Costs increase due to DSS and DSS^{+} are small compared to cost for e.g. fertilisers.

4.2. Evaluation late blight alert service

The survey results characterizing the non-SMS-receiving and SMS-receiving farmers indicated that farmers had comparable areas grown with potatoes, that the same crops were cultivated other than potatoes and that the potato variety mostly produced was also comparable. Hence, characteristics of both groups of interviewed farmers were the same. In addition, no substantial differences were found between results of the general characteristics of farmers from the baseline study.

According to most farmers, the late blight pressure in the potato season 2016/17 was low (Table 3.22). Therefore, differences in yield are less likely be related to late blight pressure and late blight control, except for Tungibari where four non-SMS-receiving farmers indicated that the late blight pressure was medium. The SMS-receiving farmers in this sub-district, however, did not indicate a medium late blight pressure. It is therefore understandable that most survey results related to late blight control did not show much difference between the non-SMS-receiving and SMS-receiving farmers.

Yield differences between non-SMS-receiving and SMS-receiving farmers were found in Munshiganj Sadar and Tungibari (*Table* 3.15). In Munshiganj Sadar, yields of SMS-receiving farmers were higher than yields of non-SMS-receiving farmers. As late blight pressure was found to be low according farmers, differences may be related to other production factors. However, the survey results show little differences in production factors between the non-SMS-receiving and SMS-receiving farmers. The only difference found is on the previous crop (Table 3.8). The preceding crop of 65% of the SMS-receiving farmers in Munshiganj Sadar was potato compared to only 19% of the non-SMS-receiving farmers. This may indicate that the SMS-receiving farmers have more experience with the potato production than non-SMS-receiving farmers. More knowledge on the potato cultivation may also have contributed to the less understanding of the SMS-alert message sent compared to the other sub-districts (Table 3.23), as farmers have more background information on production practices to fit in the message received. The message may have raised questions by those better skilled or more aware farmers which than leads to confusion and results in "not understood" as a response. Farmers in Munshiganj Sadar showed also the lowest rates of acting upon the message (Table 3.24) and more than 70% of the farmers sprayed on other times as the advice as well.

Most farmers, 89%, shared the messages with other farmers (Table 3.25). For improving late blight control that is promising, but from a business point of view it may be less desirable if the business model is based on some kind of customer payment model. Also, farmers in Bangladesh live closely together and as happens in general, farmers look at each other. They may even know which farmers

have always good yields and associated cultivation practices may be copied. When they know that a farmer has subscribed for the late blight control service, the neighbouring farmers may also profit from that by following the farmer's actions. This might also have compromised the survey results as SMS-receiving farmers may live in the same village as non-SMS-receiving farmers. During communal meetings and/or other social pathways, farmers may have exchanged information, which may have compromised the survey results. In rural areas densely populated, it is very difficult to guarantee completely independence of participating farmers although much effort is given to avoid cross contamination.

It is most important to know if farmers acted upon the SMS received, if not why and if they applied fungicides at other moments and why (Annex V). The design of the questionnaire was in such a way that that information was asked for. However, the survey did not succeed as planned in this respect, as the questions appeared to leave room for multiple interpretations. Additionally, the number of sprays and type of products was asked for but no exactly as combined questions. For example, a farmer indicated to spray five times and used two different products, which could mean that he used product one just one time and product two four times, but could also mean product one two times and product two three times. In the future questionnaire, the combination of product, dose and price will be asked, as well as the number of times applied.

With respect to the evaluation survey, it is concluded that:

- Interviewed farmers have more agricultural land compared to the average smallholder farmer in Bangladesh, as the average land size with potatoes of 2.2 ha in this study is larger than the national average land size of 0.82 ha for smallholder farmers.
- According to most farmers late blight pressure in the potato season 2016-2017 was low.
- Possibly related to the low late blight pressure, average yield benefit of SMS-receiving farmers was small and non-significant.
- The higher yields of SMS-receiving farmers compared to non-SMS-receiving farmers in Munshiganj Sadar were most likely related to better skilled farmers as the majority of SMS-receiving farmers, 65%, had potatoes as the preceding crop.
- Nearly all farmers, 94%, were satisfied with the SMS-alert service.
- The SMS-alert service was most appreciated for the information on the weather forecast, good production and reduced disease pressure.
- Most farmers shared the received SMS-alert with other farmers.

4.3. Outcome indicators

Yields of the late blight demonstrations were more than 10 t/ha higher than those found in the farmer surveys, even yields of the FP treatment of the late blight demonstration were much higher (Table 4.1). Additionally, the N-fertiliser use efficiencies of the DSS^{+} and DSS treatments were much higher than the farmer surveys and the FP treatment. It is not clear what caused the higher yields of the demonstrations, but such high yields (<40 t/ha) are more often found under more controlled conditions than farmer's practice (BARI (Bangladesh Agricultural Research Institute) 2014; 2015; 2016) and potential yields are estimated at 61 t/ha (Kempenaar *et al.* 2017). One possibility to explain yield differences between the demonstrations and farmer practices is the small field size and

the subsequent attention to harvest practices. Small plots allow harvesting all yield where in larger fields some potatoes may be left in the field undetected and thus not harvested.

The N-fertiliser use varied between 2.5 and 9.6 kg N/t potatoes produced (Table 4.1) and is greatly improved when fertiliser recommendations are followed; see differences between baseline, FP, non-SMS and SMS and DSS and DSS$^+$. Compared to the baseline study, no improvement were found in the evaluation study. The demonstrations, however, show that substantial improvements can be made.

The use of fungicide products per ha of the evaluation survey did not decrease compared to the baseline survey and was of the same order as the DSS$^+$ treatment of the demonstrations (Table 4.1). The DSS and FP used twice as much kg product per ha. This was related to more applications, compare 5.9 times in the farmer's survey (Table 3.18), with the up to 8 times in the demonstrations (Table 2.1), and to the slightly higher dose rates used in the demonstrations. The latter was estimated in the farmer's survey to be the recommended dose rate, which may have been an underestimate of farmer's practice but as the dose rate was not specifically asked for the recommended dose rates were used to calculate the fungicide use in kg product per ha. The much higher use of fungicide products of the FP treatment compared to farmer's practice supports the difficulties mentioned in section 4.1.

As for the fungicide products per ha, the kg A.I. per ha showed the same pattern. However, here the DSS$^+$ had the lowest use per ha, caused by the use of the modern fungicide product Revus. Small doses of Revus provides a good preventive protection. The costs for Revus, however, are much higher than for the more traditional fungicides (Table 2.3) and in this demonstration compensated for by sufficiently higher yields. The demonstration showed that the DSS with traditional fungicides also controlled late blight and resulted in high yields.

The other outcome indicators do not show a shift in products used by farmers yet, or a reduction in the use of Metalaxyl applications compared to the baseline survey. However, the non-SMS-receiving farmers tended to use more fungicide products with Metalaxyl. The SMS-receiving farmers used less fungicide products with Metalaxyl, which may be related to the training, received as part of the pilot and consequently higher awareness on which product to choose for adequate control of late blight.

Table 4.1 Outcome indicators of the baseline survey, the late blight demonstrations and the evaluation survey.

	SFP[1]	Efficiencies			Income		Other outcome	
	Yield	N-fertiliser use	Fungicide use		Costs fungicide applications		Metalaxyl products	Metalaxyl applications
	t/ ha	kg N/ t product	kg product/ ha	kg AI/ ha	BDT/ ha	BDT/ kg product	%	%
Baseline	31	8.9	7.7	5.6	6,960	0.22	50	78
DDS+	48	2.5	7.7	3.9	13,658	0.28	-	-
DDS	46	2.5	16.0	12.5	9,941	0.21	-	-
FT	44	6.9	16.0	12.0	8,445	0.19	44	67
non-SMS	30	9.6	7.5	5.4	[2]		70	79
SMS	30	9.0	7.4	5.3			58	78

[1] Sustainable Food Production

[2] Not available

With respect to the outcome indicators, it is concluded that:

- The outcome indicator sustainable food production of the evaluation survey did not change compared to the baseline survey.
- The outcome indicator on efficiency N-fertiliser use of the evaluation survey did not change compared to the baseline survey. However, the demonstrations show that substantial improvements can be made.
- The outcome indicator on fungicide use efficiency (kg product/ha) of the evaluation survey did not decrease compared to the baseline survey and was of the same order as the DSS^+ treatment of the demonstrations. The use in the DSS and FP were much higher.
- The outcome indicator on fungicide use efficiency (kg A.I./ha) of the evaluation survey did not decrease compared to the baseline survey. Again, the use of DSS and FP was much higher. The DSS^+ treatment improved the fungicide use efficiency as from the modern fungicide Revus only small amounts are needed to effectively control late blight.
- The outcome indicator on costs for fungicides increased when DSS^+ was applied compared to the baseline survey, FP and DSS.
- The outcome indicator on Metalaxyl products and Metalaxyl applications of the evaluation survey were higher than in the baseline survey. Differences between non-SMS-receiving and SMS-receiving farmers were small.
- The outcome indicators for sustainable food production, N-fertiliser use and fungicide use (kg A.I./ha) for the DSS^+ treatment of the demonstration were better than those of the other treatments and the farmer surveys. Indicators related to costs showed, however, the opposite.

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Annex I Characteristics of fungicide products used

Trade name	Active ingredient	Dosage rate/ha (ml/lt/gm/kg)	Unit	Type of fungicide	% active ingredient		Registration holder
Antracol 70 WP	Propineb	2.47	kg	Preventive	70	0	Bayer CropScience Limited
Dithane M 45	Mancozeb	2.2	kg	Preventive	80	0	Bayer CropScience Limited
Indofil M 45	Mancozeb	2	g/L of water	Preventive	80	0	Auto Crop Care Limited
Gmaxyl 72 WP	Mancozeb (64%) + Metalaxyl (8%)	2	g/L of water	Preventive + curative	64	8	Gourab Industries Limited
Melody Duo 66.8 WP	Propineb (70%) + Iprovalicarb	2	g/L of water	Preventive + slightly curative	70	0	Bayer CropScience Limited
Metataf 25 WP	Metalaxyl	2	g/L of water	Curative	25	0	Auto Crop Care Limited
Mosum M 80 WP	Mancozeb	2	g/L of water	Preventive	80	0	Axil Life Sciences Limited
Revus 25 SC	Mandipromid	1	g/L of water	Preventive	25	0	Syngenta Bangladesh Limited
Secure 600 WG	Mancozeb (50%) + Fenamidone (10%)	1	g/L of water	Preventive + slightly curative	50	10	Bayer CropScience Limited

Annex II Details of the demonstration plots in each sub-district

Treatment Farmer Practice (FP)

		Unit	Gozaria	Louhazang	Munshiganj Sadar	Shreenagar	Sirajdikhan	Tungibari
Planting date		date	03/Dec/16	09/Dec/16	01/Dec/16	04/Dec/16	05/Dec/16	02/Dec/16
Seed planted		kg/ha	2,965	2,965	2,965	3,624	3,295	3,295
Tubers planted		#/ha	258,334	276,786	161,459	322,917	258,334	258,334
Seed costs		BDT/ha	65,234	59,303	59,303	72,482	65,892	72,482
Organic fertiliser		date	-	-	25/Nov/16	26/Nov/16	26/Nov/16	-
	Amount	kg/ha	-	-	99	33	33	-
	Costs	BDT/ha	-	-	9884	9884	16473	-
Basel dressing		date	30/Nov/16	06/Dec/17	28/Nov/16	02/Jan/17	27/Nov/16	27/Nov/16
	N-applied	kg/ha	273	258	258	273	303	303
	Costs UREA	BDT/ha	10675	10082	10082	10675	11861	11861
	P_2O_5-applied	kg/ha	227	182	182	227	227	227
	Costs TSP	BDT/ha	11861	9489	9489	11861	11861	11861
	K_2O-applied	kg/ha	329	247	247	329	329	329
	Costs MOP	BDT/ha	10543	8895	8895	10543	10543	10543
	Gypsum	kg product/ha	165	198	198	198	33	198
	Costs Gypsum	BDT/ha	6589	8895	8895	7907	13178	8895
	Zinc	kg product/ha	-	-	-	-	-	-
	Costs Zinc	BDT/ha	-	-	-	-	-	-
	Boron	kg product/ha	-	-	-	-	-	-
	Costs Boron	BDT/ha	-	-	-	-	-	-
Side dressing		date	15/Jan/17	-	-	-	-	-
	N-applied	kg/ha	76	-	-	-	-	-
Weeding	Hand/weeder	date	15/Dec/16	25/Dec/17	-	30/Dec/16	18/Dec/17	-
	Costs	BDT/ha	4942	3295	-	6589	7578	-
	Hand/weeder	date	01/Jan/17	10/Jan/17	26/Dec/16	22/Jan/17	01/Jan/17	01/Jan/17
	Costs	BDT/ha	4942	3295	9884	6589	9884	3295
Herbicides	Application	date	-	-	10/Dec/16	-	-	13/Dec/16
	Product		-	-	Hamar	-	-	Ronstar
	Dose product	ml/ha	-	-	988	-	-	2471
	Costs	BDT/ha	-	-	4942	-	-	3398
Irrigation	Application 1	date	08/Jan/17	29/Dec/16	29/Dec/16	05/Jan/17	10/Jan/17	10/Jan/17
	Application 2	date	-	20/Jan/17	20/Jan/17	08/Feb/17	08/Feb/17	-
Insecticides	Application 1	date	08/Feb/17	08/Jan/17	08/Jan/17	06/Feb/17	08/Feb/17	08/Feb/17
	Product		Confider	n.p.i.[1]	n.p.i.	Confider	Confider	Confider
	Dose product	g or ml/ha	66	659	659	66	66	66
	Costs	BDT/ha	1977	824	824	1977	1977	1977
	Application 2	date	-	20/Jan/17	20/Jan/17	22/Feb/17	22/Feb/17	-
	Product		-	n.p.i.	n.p.i.	Confider	Confider	
	Dose product	g/ha	-	659	659	66	66	-
	Costs	BDT/ha	-	1647	1647	1977	1977	-

[1] no product indicated

Treatment Decision Support Service with standard fungicides (DSS)

			Gozaria	Louhazang	Munshiganj Sadar	Shreenagar	Sirajdikhan	Tungibari
Planting date		date	03/Dec/16	09/Dec/16	01/Dec/16	04/Dec/16	05/Dec/16	02/Dec/16
Seed planted		kg/ha	2,735	2,735	2,735	2,735	2,735	2,735
Tubers planted		#/ha	143,519	143,519	64,583	96,875	143,519	143,519
Seed costs		BDT/ha	76,567	76,567	76,567	76,567	76,567	76,567
Organic fertiliser		date	-	-	25/Nov/16	26/Nov/16	26/Nov/16	-
	Amount	kg/ha	-	-	99	33	33	-
	Costs	BDT/ha	-	-	9884	9884	16473	-
Basel dressing		date	30/Nov/16	06/Dec/17	28/Nov/16	02/Jan/17	28/Nov/16	28/Nov/16
	N-applied	kg/ha	121	121	121	121	121	121
	Costs UREA	BDT/ha	5041	5041	5041	5041	5041	5041
	P_2O_5 applied	kg/ha	91	91	91	91	91	91
	Costs TSP	BDT/ha	4744	4744	4744	4744	4744	4744
	K_2O applied	kg/ha	115	115	115	115	115	115
	Costs MOP	BDT/ha	4448	4448	4448	4448	4448	4448
	Gypsum	kg product/ha	99	99	99	99	99	99
	Costs Gypsum	BDT/ha	4448	4448	4448	4448	4448	4448
	Zinc	kg product/ha	16	16	16	16	16	16
	Costs Zinc	BDT/ha	3295	3295	3295	4942	4942	3295
	Boron	kg product/ha	16	16	16	16	16	16
	Costs Boron	BDT/ha	4942	4942	4942	5930	5930	4942
Side dressing		date	-	-	-	-	-	-
	N-applied	kg/ha	-	-	-	-	-	-
Weeding	Hand/weeder	date	15/Dec/16	25/Dec/17	-	30/Dec/16	18/Dec/16	-
	Costs	BDT/ha	4942	3295	-	6589	7578	-
	hand/weeder	date	01/Jan/17	10/Jan/17	26/Dec/16	22/Jan/17	01/Jan/17	01/Jan/17
	Costs	BDT/ha	4942	3295	9884	6589	9884	3295
Herbicides	Application	date	-	-	10/Dec/16	-	-	13/Dec/16
	Product		-	-	Hamar	-	-	Ronstar
	Dose product	ml/ha	-	-	659	-	-	2471
	Costs	BDT/ha	-	-	3295	-	-	3398
Irrigation	Application 1	date	08/Jan/17	29/Dec/16	29/Dec/16	05/Jan/17	10/Jan/17	10/Jan/17
	Application 2	date	-	20/Jan/17	20/Jan/17	08/Feb/17	08/Feb/17	-
Insecticides	Application 1	date	08/Feb/17	08/Jan/17	08/Jan/17	06/Feb/17	08/Feb/17	08/Feb/17
	Product		Confider	n.p.i.	n.p.i.	Confider	Confider	Confider
	Dose product	g or ml/ha	66	659	659	66	66	66
	Costs	BDT/ha	1977	824	824	1977	1977	1977
	Application 2	date	-	20/Jan/17	20/Jan/17	22/Feb/17	22/Feb/17	-
	Product		-	n.p.i.[1]	n.p.i.	Confider	Confider	-
	Dose product	g or ml/ha	-	659	659	66	66	-
	Costs	BDT/ha	-	1647	1647	1977	1977	-

[1] no product indicated

Treatment Decision Support Service GEOPOTATO (DSS+)

			Gozaria	Louhazang	Munshiganj Sadar	Shreenagar	Sirajdikhan	Tungibari
Planting date		date	03/Dec/16	09/Dec/16	01/Dec/16	04/Dec/16	05/Dec/16	02/Dec/16
Seed planted		kg/ha	2,735	2,735	2,735	2,735	2,735	2,735
Tubers planted		#/ha	143,519	143,519	64,583	96,875	143,519	143,519
Seed costs		BDT/ha	76,567	76,567	76,567	76,567	76,567	76,567
Organic fertiliser		date	-	-	25/Nov/16	26/Nov/16	26/Nov/16	-
	Amount	kg/ha	-	-	99	33	33	-
	Costs	BDT/ha	-	-	9884	9884	16473	-
Basel dressing		date	30/Nov/16	06/Dec/17	28/Nov/16	02/Jan/17	28/Nov/16	28/Nov/16
	N-applied	kg/ha	121	121	121	121	121	121
	Costs UREA	BDT/ha	5041	5041	5041	5041	5041	5041
	P2O5 applied	kg/ha	91	91	91	91	91	91
	Costs TSP	BDT/ha	4744	4744	4744	4744	4744	4744
	K2O applied	kg/ha	115	115	115	115	115	115
	Costs MOP	BDT/ha	4448	4448	4448	4448	4448	4448
	Gypsum	kg product/ha	99	99	99	99	99	99
	Costs Gypsum	BDT/ha	4448	4448	4448	4448	4448	4448
	Zinc	kg product/ha	16	16	16	16	16	16
	Costs Zinc	BDT/ha	3295	3295	3295	4942	4942	3295
	Boron	kg product/ha	16	16	16	16	16	16
	Costs Boron	BDT/ha	4942	4942	4942	5930	5930	4942
Side dressing		date	-	-	-	-	-	-
	N-applied	kg/ha	-	-	-	-	-	-
Weeding	Hand/weeder	date	15/Dec/16	25/Dec/17	-	30/Dec/16	18/Dec/16	-
	Costs	BDT/ha	4942	3295	-	6589	7578	-
	Hand/weeder	date	01/Jan/17	10/Jan/17	26/Dec/16	22/Jan/17	01/Jan/17	01/Jan/17
	Costs	BDT/ha	4942	3295	9884	6589	9884	3295
Herbicides	Application	date	-	-	10/Dec/16	-	-	13/Dec/16
	Product		-	-	Hamar	-	-	Ronstar
	Dose product	ml/ha	-	-	659	-	-	2471
	Costs	BDT/ha	-	-	3295	-	-	3398
irrigation	Application 1	date	08/Jan/17	29/Dec/16	29/Dec/16	05/Jan/17	10/Jan/17	10/Jan/17
	Application 2	date	-	20/Jan/17	20/Jan/17	08/Feb/17	08/Feb/17	-
Insecticides	Application 1	date	08/Feb/17	08/Jan/17	08/Jan/17	06/Feb/17	08/Feb/17	08/Feb/17
	Product		Confider	n.p.i.[1]	n.p.i.	Confider	Confider	Confider
	Dose product	g or ml/ha	66	659	659	66	66	66
	Costs	BDT/ha	1977	824	824	1977	1977	1977
	Application 2	date	-	20/Jan/17	20/Jan/17	22/Feb/17	22/Feb/17	-
	Product		-	n.p.i.	n.p.i.	Confider	Confider	-
	Dose product	g or ml/ha	-	659	659	66	66	-
	Costs	BDT/ha	-	1647	1647	1977	1977	-

[1] no product indicated

Annex III Assessment of Late Blight Severity in 7.5 decimal plots

Severity	Description	Picture	Remarks
Typical Late Blight symptom	Brown lesion (spot) surrounded by a white halo in a wet or drying crop. In a dry crop (later on the day), only the brown lesion is visible.		
0%	Healthy crop, no infections visible.		
0.1%	Average of 2 lesions per **PLANT.** Only visible at close inspection.		Early season, small plants
1%	Average of 10 - 20 small lesions per **PLANT**.		

5%	5% of leaf area **PLOT** destroyed: Plants look healthy but lesions are easily visible at close range.	
10%	10% of leaf area **PLOT** destroyed: Plant looks healthy but lesions are easily visible at medium and close range.	
25%	25% Leaf area **PLOT** destroyed: Plots look green at first but ¼ foliage destroyed.	
50%	50% Leaf area **PLOT** destroyed. Plots look green at first but ½ foliage destroyed.	
75%	75% Leaf area **PLOT** destroyed. Plot looks green/brown. Lower leaf layers completely destroyed.	

90%	90% Leaf area **PLOT** destroyed. Plot looks brown/green. Only top leaves are green, stem infections frequently occur.		
95%	95% Leaf area **PLOT** destroyed. Plot looks brown/green. Only top leaves are green, stem infections frequently occur.		Ignore the water
99%	99% Leaf area **PLOT** destroyed. Plot looks brown. Only a few top leaflets still have green parts. Stems heavily infected or dead.		
100%	100% **PLOT** is destroyed.		

Annex IV Questionnaire of the evaluation study: all farmers

	English	Bangladeshi
1	Select District	জেলা নির্বাচন করুন
2	Write farmer's name	কৃষকের নাম লিখুন
3	Select farmer's gender	কৃষকের লিঙ্গ নির্বাচন করুন
4	Mobile number of interviewed person	কৃষকের মোবাইল নম্বর
5	Level of education	শিক্ষাগত যোগ্যতা
6	Land size of the potato plot (decimel)	আলু ক্ষেতের পরিমাণ (শতাংশ)
7	Previous crop	একই জমিতে পুর্বে চাষকৃত ফসলের নাম
8	Potato variety	আলুর জাতের নাম
9	Source (origin) of Potato Seed	আলুর বীজের উৎস কোথায়
10	Date of planting	আলু লাগানোর সময়
11	Do you use whole potato seed of cut seed at planting?	আপনি কি কাটা আলু না সম্পুর্ন আলু বীজ হিসেবে ব্যবহার করেন
12	Planting distance in row (plant to plant distance, cm)	গাছ থেকে গাছের দূরত্ব কত (সে.মি)
13	Planting distance between rows (row to row distance, cm)	সারি থেকে সারির দূরত্ব কত (সে.মি)
14	Amount of urea used	কি পরিমাণ ইউরিয়া সার প্রয়োগ করেন (কেজি)
15	Amount of MoP used	কি পরিমাণ এমওপি সার প্রয়োগ করেন (কেজি)
16	Amount of TSP used	কি পরিমাণ টিএসপি সার প্রয়োগ করেন (কেজি)
17	Number of fungicide treatments	এক মৌসুমে কতবার ছত্রাকনাশক প্রয়োগ করেন)
18	Fungicide name chemicals used	প্রয়োগকৃত ছত্রাকনাশকের নাম কি কি
19	First application against late blight	আলুর মড়ক রোগ দমনে কখন প্রথম ছত্রাকনাশক স্প্রে করেছেন
20	First observation of late blight by farmer in his plot	প্রথম কখন আলুক্ষেতে মড়ক রোগ দেখতে পান
21	AVERAGE Late blight spray interval	গড়ে কতদিন পর পর মড়ক রোগ দমনে ছত্রাকনাশক স্প্রে করেন
22	Type of equipment used for spraying	ছত্রাকনাশক স্প্রে করতে কি যন্ত্র ব্যবহার করেন
23	Late blight infection level	আক্রান্ত মড়ক রোগের আক্রমণের মাত্রা কেমন
24	Harvest date	কখন আলু জমি থেকে উঠাবেন
25	Yield of plot (kg/decimel)	আলুর ফলন কত (কেজিশতাংশ)?
26	Selling price potato directly after harvest (tk/kg)	আলু জমি থেকে উঠানো পর সাথে সাথে কত টাকায় বিক্রি করেন
27	How much of the yield is/will be stored	ফলনের কতটুকু সংরক্ষণ করেন (কেজি)?

Annex V Additional questions for non-SMS and SMS-receiving farmers

	SMS-receiving farmers	
1	How many SMS did you receive?	আপনি কতটা ম্যাসেজ পেয়েছেন?
2	Did your understand the SMS?	আপনি কি ম্যাসেজ এর ভাষা বুঝেছেন?
3	Did you act according SMS message?	আপনি কি ম্যাসেজ অনুযায়ী কাজ করেছেন?
4	If not, why not?	না হলে, কেন করেন নাই?
5	Did you spray fungicides also at other moments than the message advised?	ম্যাসেজ এর নির্দেশনার বাহিরেও অন্য সময়ে কি স্প্রে করেছেন?
6	Did you share the message with other farmers?	আপনি কি অন্য কৃষকদের সাথে ম্যাসেজ শেয়ার করেছেন?
7	If yes, with how many people approximately?	যদি হ্যাঁ হয়, কতজন কৃষকের সাথে শেয়ার করেছেন?
8	Were you satisfied with the service?	
9	If not, why not?	
10	If yes, why?	
11	Are you willing to pay in the future to receive messages?	আপনি কি ভবিষ্যতে ম্যাসেজ পাওয়ার জন্য টাকা দিতে রাজি আছেন?
12	If yes, how much TK would you be willing to pay?	যদি হ্যাঁ হয়, প্রতি ম্যাসেজ এর জন্য কত টাকা দিতে রাজি আছেন?
13	Any comments about the service?	এই সেবা সম্পর্কে আপনার কোন মতামত?
	Non-SMS-receiving farmers	
1	Did you hear about the SMS service?	আপনি কি মড়ক রোগ দমনে ম্যাসেজ সেবা সম্পর্কে শুনেছেন?
2	Did SMS farmers or DAE staff tell you about the message they had received?	ম্যাসেজ সেবা গ্রহণকারী কৃষক বা ডিএই এর কোন কর্মকর্তা এই সেবা সম্পর্কে কি আপনাকে বলেছেন?
3	If yes, did you spray according the message you receive from the fellow farmer or DAE?	যদি হ্যাঁ হয়, ম্যাসেজ এর নির্দেশনা অনুযায়ী কাজ করেছেন?
4	If no, why not?	যদি না হয়, কেন করেন নাই?
5	Would you like to receive SMS on control of Late Blight spraying in the future?	আপনি কি ভবিষ্যতে মকড় রোগ দমন সম্পর্কে ম্যাসেজ সেবা পেতে চান?
6	If no, why not?	যদি না হয়, কেন পেতে চান না?
7	If yes, would you be willing to pay for it?	যদি হ্যাঁ হয়, আপনি কি ম্যাসেজ সেবা পেতে টাকা দিতে রাজি আছেন?
8	If yes, how much?	যদি হ্যাঁ হয়, প্রতি ম্যাসেজ এর জন্য কত টাকা দিতে রাজি আছেন?