Third Progress report

Study Title: The effect of demonstration plots and the warehouse receipt system on ISFM adoption, yield and income of smallholder farmers: a study from Malawi's Anchor Farms

Thematic Window 4 TW4.1018

PROGRESS REPORT - AGRONOMY COMPONENT

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July 30, 2017

Period covered: 1 May 2015 – 30 June 2017

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LIST OF ACRONYMS/ABBREVIATIONS

BPA	Best practice agronomy
CDI	Clinton Development Initiative
EPA	Extension Planning Area
N	Nitrogen
K	Potassium
P	Phosphorous
S	Sulphur

PROGRESS REPORT ON THE AGRONOMY COMPONENT
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1.0 BACKGROUND

The Clinton Development Initiative (CDI) is implementing interventions in Chibvala and Mtunthama EPA of Dowa and Kasungu districts in central region of Malawi. Mtunthama and Chibvala EPAs lies in the mid altitude agroecological zones with moderate temperatures and annual rainfall ranging from 800-1200mm. Rainfall pattern is unimodal with rainfall season starting in November/December to March/April. The agronomy interventions include on-farm demonstrations on integrated soil management (ISFM) technologies aimed at evaluating performance of maize-legume cropping systems. The legumes include soybean, groundnut, beans and pigeonpea. This report covers activities implemented under agronomy interventions from May 1, 2015 to June 2017. The main activities implemented include soil sampling and characterization, and data collection from on farm demonstration plots on legumes and maize technologies.

2.0 Activities implemented during this period (May 2015-June 2017)

2.1 Soil characterization

A total of 566 composite soil samples were collected at 0-20cm soil depth from farmer plots and demonstration plots in Mtunthama and Chibvala EPAs. A total of 180 soil samples were collected in January 2016 adding to the 386 samples collected prior to planting in December 2014. These plots are located at an elevation of 1138-1402m in Chibvala, and 942-1690m in Mtunthama .The soils were analyzed for pH, extractable nitrate (NO_3^-), active organic carbon, inorganic phosphorus (P), sulfur (S), exchangeable potassium (K) and electrical conductivity (EC). These soils were analyzed at Bunda College Soil and Plant Analysis Laboratory using the Soil Doc kit. The following plot data were collected along with soil sampling: GPS coordinates, cropping history and soil fertility management for the previous three agricultural seasons for the plot that was sampled.

Results of soil chemical characteristics are presented in Table 1. Soil pH (in water) ranged from slightly acidic (4.0) to slightly alkaline (7.8) and a mean of 6.0±0.043 and 6.2±0.03 for Chibvala and Mtunthama, respectively. About 2.3% and 2.78% of the soils in Chibvala and Mtunthama EPA are below the critical pH value of 5.0. The recommended soil pH for most arable crops including soybean, groundnut, maize and beans is the range of 5.5-6.5, although pH values of above 5.0 do not warrant liming, those below pH 5.0 could require liming for acid intolerant crops. About 70% of the fields have optimum soil pH for production of most arable crops. In general, soil chemical properties were highly variable

between farms and this may be attributed to cropping history and inherent fertility. Active carbon was higher in Chibvala (503 mg/kg) with 15.2% of the plots below the critical value compared to Mtunthama (368 mg/kg) with 46% of the plots falling below the critical value of 350 mg/kg. Exchangeable potassium (K) ranged from low to high with a mean =0.85 cmol/kg and 0.49 cmol/kg for Chibvala and Mtunthama EPAs. The most limiting soil nutrient in both EPAs is nitrogen (N) with soil nitrate N ranging from very low to low. The soils are non-saline with mean EC values of 0.54dS/cm and 0.39dS/cm for Chibvala and Mtunthama, respectively. Figures 1 and 2 shows the locations of the different soil sampling points and indicate the nutrient or nutrients that are limiting (below the critical values) for crop production (primarily maize and beans). In Mtunthama, 64% of the soils showed deficiency of NPS, with the next two highest category showing 18% with NS limitations and 9% with NPKS limitation. These three categories account for 91% of the soils sampled. In Chibvala, 39% and 28% with NPS and NS deficiencies, respectively, and an additional 10% showing only N deficiency. The soils of Chibvala appear to be more fertile than those of Mtunthama, which might be corroborated by the higher yields on the control plots in Chibvala (see section below on crop yields) compared to Mtunthama.

Table 1: Soil chemical characteristics in Chibvala and Mtunthama EPAs, 0-20cm soil depth

Location	Variable	N	Mean	Std Error	Minimum	Maximum	Comment	%<critical value
Chibvala EPA	pH in water	241	6.0	0.04	4.5	7.8	Slightly acid to neutral	2.3
	active carbon (mg kg^{-1})	240	503	9.79	91	918.	Low to high	15.2
	nitrate N (mg kg^{-1})	230	6.6	0.534	0.0	97.73	Very low to medium	96.1
	potassium K (cmol kg^{-1})	241	0.85	0.041	0.0	3.18	low to high	
	suphur (mg kg^{-1})	241	8.66	0.177	2.82	19.15	Medium to high	1.5
	Inorganic P (mg kg^{-1})	137	0.93	0.099	0.0	6.96	Low to high	15.6
	soil EC	241	0.54	.0242	0.11	3.71	Non saline to slightly saline	
Mtunthama EPA	pH in water	293	6.2	0.026	4.4	7.6	Slightly acid to neutral	2.7
	active carbon (mg kg^{-1})	291	368	8.87	12	800	Very low to high	45.7
	nitrate N (mg kg^{-1})	282	6.76	0.37	0.00	44.09	Very low to medium	95.7
	potassium K (cmol kg^{-1})	293	0.79	0.034	.00	2.54	Low to high	
	suphur (mg kg^{-1})	292	9.64	0.24	3.63	23.30	Medium to high	1.0
	Inorganic P (mg kg^{-1})	284	0.98	0.00	7.74	0.069	Low to high	17.6
	soil EC	293	0.39	0.012	0.06	1.62	Non saline	

The critical Soil Doc soil test values: pH in H_2O=5.0; K=<10 mg/kg; P= <0.1-0.3 mg kg^{-1} ; Sulphur= <5 mg/kg
NO_3- : <21 mg/kg= very low; 21-42 mg/kg = low; 42-65 mg/kg – medium;
Active carbon: 350 mg C /kg Soil= moderate to poor; ≥ 350 – 700=moderate to good; >700=excellent;

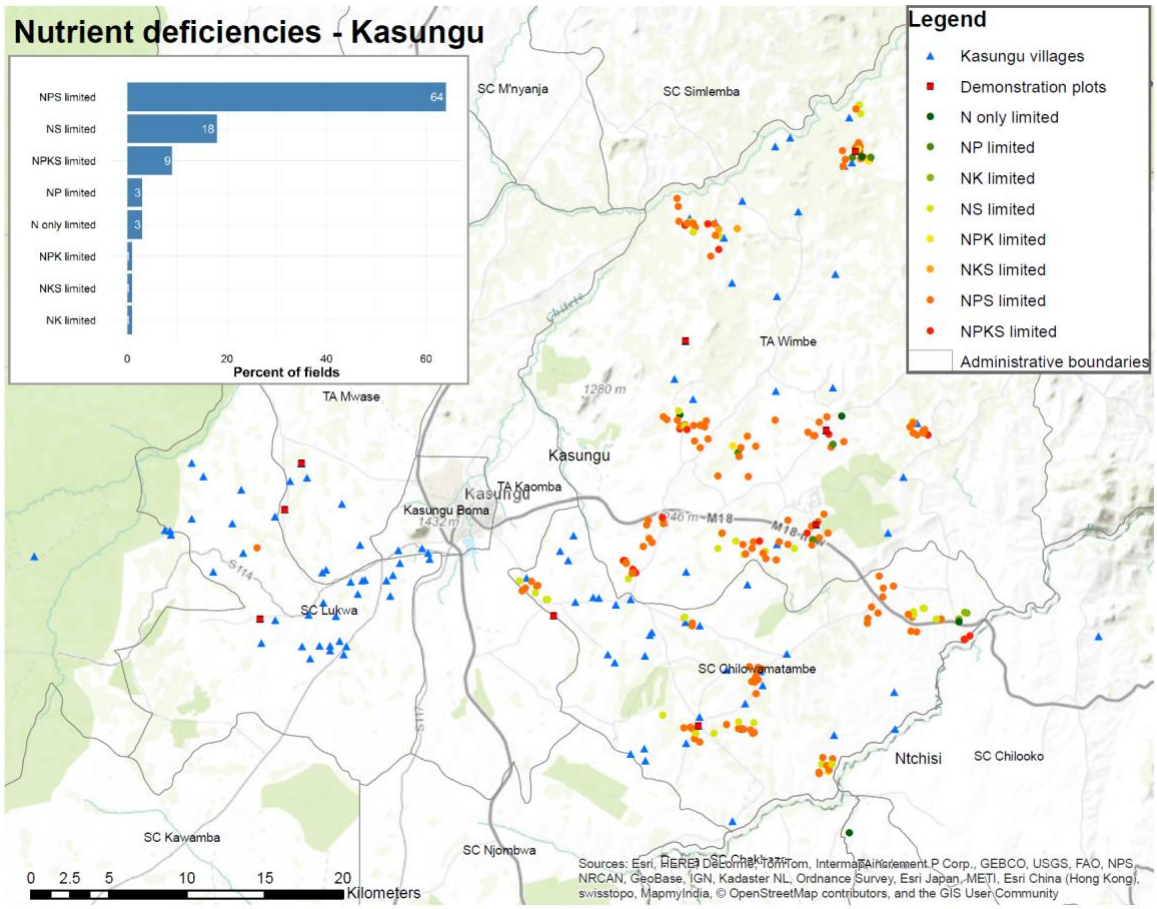

Fig 1: Map of soil nutrient limitations in project sites in Mtunthama Extension Planning Area, Kasungu District

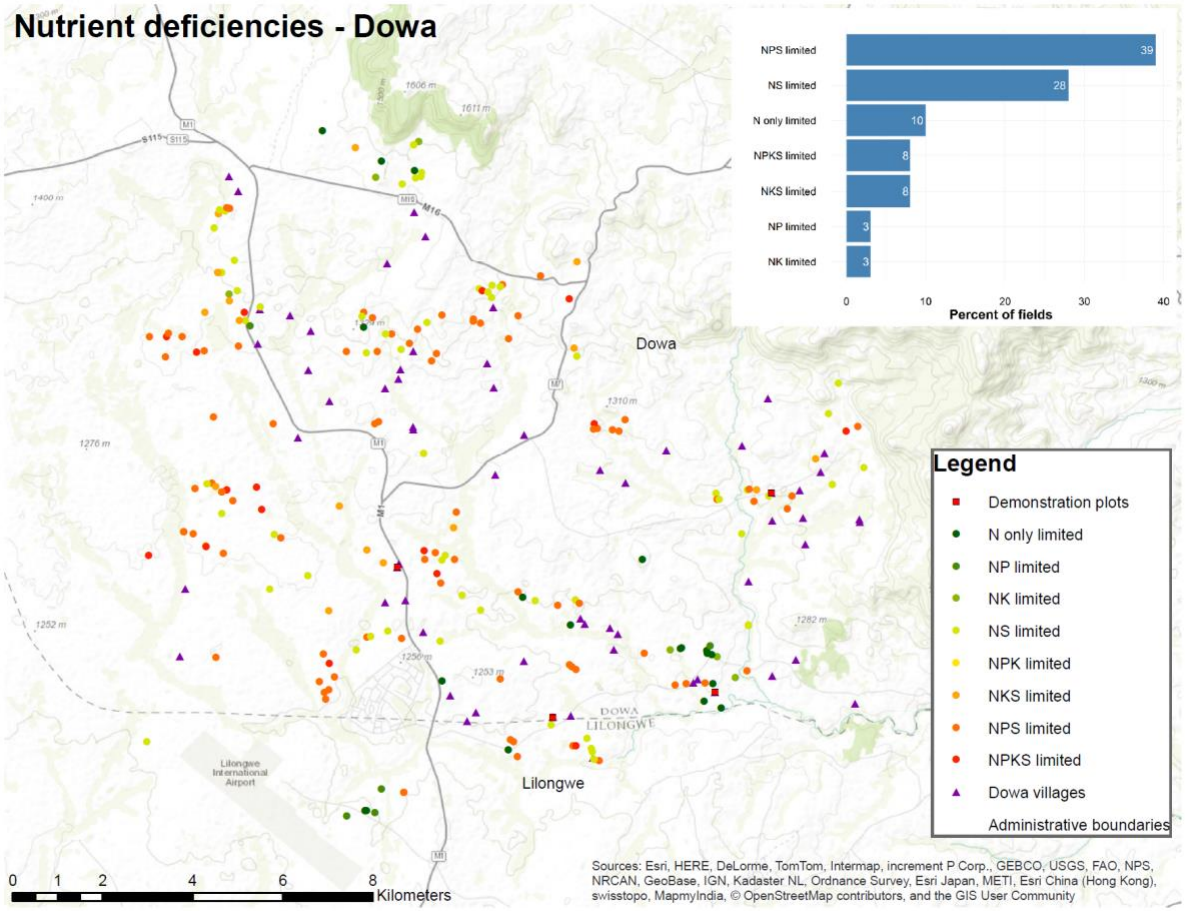

Fig 2: Map of soil nutrient limitations in project sites in Chibvala Extension Planning Area, Dowa District

2.2 Performance of ISFM technologies in demonstration plots in Chibvala and Mtunthama Extension Planning Areas, 2014/2015 to 2016/2017 cropping seasons

2.2.1 Treatments

There are three types of demonstration including the soyabean-maize, groundnut-maize and bean-maize demonstration plots. The varieties planted on the demonstration plots include the following: SC719 maize variety, CG7 groundnut variety, Seranaid soybean variety and Kholophethe bean variety. Table 2 gives a summary of the type and number of demonstration plots from 2014/2015 to 2016/2017 cropping seasons. For each type of demonstration plot, the main treatments include best practice agronomy as defined by the CDI (Appendix 1.1. 1.2 and 1.3) and the control. The best practice agronomy include plant population, soil fertility amendments, inoculation (soybean) and pest (pests, weeds and disease) management. In the first year (2014/2015 season), farmer practice was included as one of the treatments for maize, groundnut and beans. These demonstration plots are managed by a group of farmers that form a club.

Table 2: Summary of types and number of demonstration plots in Chibvala and Mtunthama EPAs

Cropping Season	Type of demonstration	Total number of onfarm demonstrations		
		Chibvala EPA	Mtunthama EPA	Total
2014/2015	Soybean-maize	5	7	12
	Groundnut-maize	1	2	3
	Beans-maize	2	2	4
2015/2016	Soybean-maize	4	7	11
	Groundnut-maize	1	3	4
	Beans-maize	3	1	4
2016/2017	Soybean-maize	2	4	6
	Groundnut-maize	2	1	3
	Beans-maize	2	1	3

Table 3: Treatments for the soybean, groundnut and common bean demonstration plots, from 2014/2015 to 2016/2017 cropping season

Type of demo plot	Treatments	Cropping Season		
		2014/2015	2015/2016	2016/2017
Soybean and maize	Soybean BPA	✓	✓	✓
	Soybean control	✓	✓	✓
	Maize rotation	✓	✓	✓
	Maize BPA+ agroforestry*trees	✓	✓	✓
	Maize control	✓	✓	✓
Groundnut and maize	Groundnut BPA	✓	✓	✓
	Groundnut FP	✓	X	X
	Groundnut control	✓	✓	✓
	Maize FP	✓	X	X
	Maize control	✓	✓	✓
	Maize FP	✓	X	X
Beans and maize	Beans BPA	✓	✓	✓
	Beans FP	✓	X	X
	Beans control	✓	✓	✓
	Maize BPA	✓	✓	✓
	Maize control	✓	✓	✓
	Maize FP	✓	X	X

Treatment included, X= treatment not included ;
*In first season, there was Gliricidia trees as an agroforestry species. In years two and three, these were replaced by pigeonpea. FP=farmer practice; BPA=Best Practice Agronomy. Information on BPA for each crop as provided by CDI (see Appendix 1)

2.2.2 DEMONSTRATION PLOTS AND FIELD OBSERVATIONS, 2016/2017 CROPPING SEASON

Introduction: CDI has been implementing demonstration plots on integrated soil fertility management in Mtunthama and Chibvala EPA since 2014-2015 cropping season. In the current season (2016/2017), there are a total of 12 demonstration plots. In Mtunthama EPA, four of these are soybean-maize demo plots, one for groundnut-maize and the other one for beans-maize demo. In Chibvala EPA, there are six demonstration plots, two of these are soybean-maize, two are for groundnut-maize, and the remaining two for beans.

Table 4 gives a summary of the type of demonstration plots and the locations (villages) in the two EPAs. Compared to the previous cropping season (2015-16), there are two new demonstration plots, one in each EPA. Details of the new demonstration plots are provided in Table 5.

The following crop varieties were planted on the demonstration plots: SC719 maize variety, CG7 groundnut variety, Serenade Soybean variety and Kholophethe bean variety. Best practice agronomy in general include a combination of agronomic practices such as plant density, inoculation of soybean, soil fertility management and weed & pest management. On the control plot, the only new technology introduced was improved seed and no other new technology was applied. However, it was observed that some clubs applied inorganic fertilizer with/or livestock manure to maize control plot.

Field preparation: Crops were planted mostly on ridges with some soybean and maize BPA subplots planted on flat. The recommended ridge spacing for groundnut, maize and bean plots was 75cm. Planting of maize, soybean and groundnut was completed on 6th January 2017.

Compared to last season, there was a change in the research design in that for groundnut and beans demos, the treatments were not replicated on the plot as in soybean-maize demonstration plots where each treatment is replicated twice.

In terms of type of demonstration plots mounted in 2016/17 season, there were no changes in type of demonstration in Mtunthama EPA. However, in Chibvala EPA, changes were reported on two demonstration plots hosted by Simwanjera (from beans to groundnut demonstration plot) and Mwatitha (soybean to beans demonstration plot) clubs.

Leadership of Clubs**:** Each club has an elected chairperson who is responsible for leadership roles. In 2016/2017 season, there were changes in leadership of four clubs in Chibvala EPA (Mango, Kondanani, Tikondane and Mwatitha) and three clubs in Mtunthama EPA (Chikondi, Toyanjane and Tasauka).

Table 4 Type of demonstrations plots and location in Chibvala and Mtunthama EPA, 2016/17 cropping season

EPA	Demo Type	Section	Club Name	Total # of demos
Chibvala	Soybean-maize	Chibvala north	Mtawa	1
	Soybean –maize	Chitunda	Kondanani	1
	Groundnut –maize	Chibvala north	Simwanjera	1
	Groundnut –maize	Chitunda	Mango	1
	Bean-maize	Chibvala north	Mwatitha	1
	Bean-maize	Makande	Tikondane	1
Mtunthama	Soybean-maize	Kasikidzi	Mphamba	1
	Soybean-maize	Mchezi	Chipulumutso	1
	Soybean-maize	Kasikidzi	Maziko	1
	Soybean-maize	Kapinya	Tiyanjane	1
	Groundnut-maize	Mchezi	Tasauka	1
	Bean-maize	Thema	Chikondi	1

Table 5: New demonstration plots in Chibvala and Mtunthama EPAs

EPA	Club Name	Type of demonstration	Section	Village
Chibvala	Mango	Groundnut-maize	Chitunda	Mapondera
Mtunthama	Chikondi	Bean-maize	Thema	Chamwala

2.2.2.1 Field management practices

Planting of maize, soybean, groundnut and beans was done between mid-December 2016 to second week of January 2017. Most of the demonstration plots in Mtunthama were planted in January because of late onset of planting rains, unlike in previous seasons where planting was done in December. There were differences on the seed beds used for planting. It was also noted that pigeonpea was planted late (in the maize + pigeonpea intercrop BPA treatment, about 3-4 weeks after planting maize) and this negatively affected the growth of pigeonpea probably due to interspecific competition. As noted earlier, it was also observed that there are differences between and within subplots in-terms of seed bed for planting in that some treatments were planted on ridges and others on flat beds. Herbicides were applied to the treatments under best practice agronomy to control weeds. Basal

(23:21:0+4S) and top dressing (urea) fertilizers were applied to maize under BPA. However, it was also observed that some farmers applied inorganic fertilizer to the maize control treatment while this treatment was intended to remain unfertilized. Beans and soybean were harvested in April and May 2017, respectively. Maize and groundnut were harvested in May-June, 2017. Grain moisture content was determined using a *Mini-Gac plus* grain moisture meter and yields were adjusted to standard storage moisture content.

2.2.2.2 Participation of club members in field activities on demonstration plots

Table 6 shows results on participation on demonstration plot activities by club members from planting to harvesting. Activities such as fertilizer application were done on subplots planted to maize and beans with best practice agronomy (BPA) except in cases where the control maize treatment was also fertilized (farmer practice). Similarly, use of herbicides was restricted to treatments under BPA. Overall, the results indicate that participation in field activities varied between clubs but did not vary much with the field activity. For instance, in Chibvala EPA, almost all club members participated in planting and fertilizer application to maize and beans under BPA except in one club where only 26% of the members participated in planting of bean-maize demo plot. At harvesting, participation varied among clubs from 50 to 100% (mean=86%).

Table 6: Participation of club members in demonstration plot activities, 2016/17 season

EPA	Club name	Total No. of club members	Demo type	% of club members		
				Planting	Fertilizer application	Harvesting
Chibvala	Kondanani	20	Soya and maize	85	85	100
	Mango	15	G/nut and maize	100	100	93
	Mtawa	20	Soya and maize	100	100	80 (soya) 65 (maize)
	Mwatitha	20	Bean-maize	100	100	40
	Simwanjera	3	G/nut- maize	100	100	100
	Tikondane	19	Beans-maize	25	25	42-53
Mtunthama	Chikondi	25	Bean-maize	52	maize=52; beans =32	48-56
	Chipulumutso	10	Soya-maize	70	60	Soya=60
	Maziko	20	Soya-maize	soya & maize control=55 Maize BPA=20	55	35
	Mphamba	11	Soya-maize	64	100	36
	Tasauka	19	G/nut-maize	68	68	-
	Tiyanjane	20	Soya-maize	70	100	90-100

G/nut=groundnut; Soya=soybean

2.2.2.3 Rainfall, 2016/2017 season

Rain gauges were installed at the demonstration plots and farmers were trained on recording of rainfall data. In 2016/17 season, Chibvala EPA received effective rains from November 2016 and the total annual rainfall averaged 815mm (Fig 3). However, in Mtunthama EPA, the late onset of planting rains led to late planting (January 2017 instead of December 2016), with a total annual rainfall of 654mm.

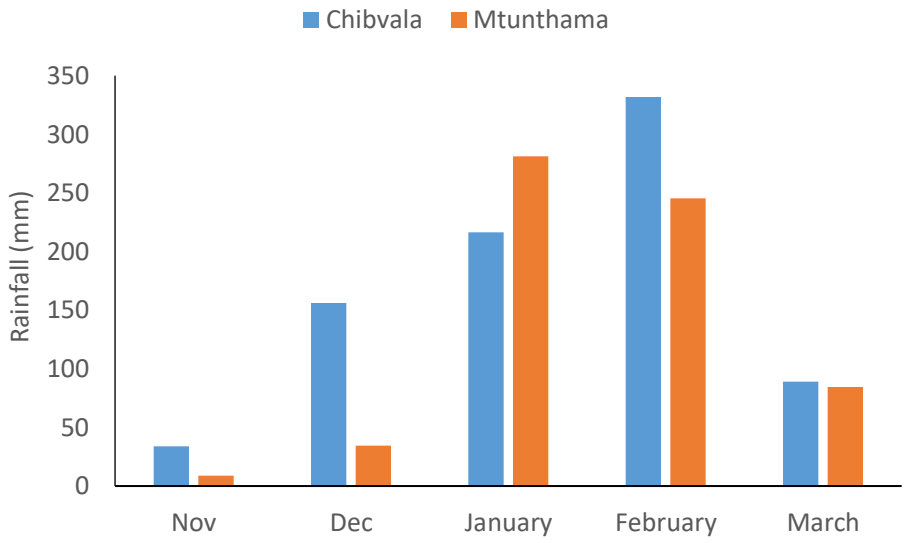

Fig 3: Average monthly rainfall in the demonstration plot villages in Chibvala and Mtunthama Extension Planning Areas

2.2.2.4 Performance of soybean, 2016/2017 season

Germination: Plant population after emergence was variable between demonstration plots ranging from 124000 to 300000 plants/ha for treatments under BPA (Table 7). Germination was 12-27% higher in treatments under best practice agronomy than the control. It was also observed that in both treatments, plant density was higher in Chibvala EPA than Mtunthama.

Table 7: Plant population (plants/hectare) of soybean after germination

EPA	Treatment	Mean	Minimum	Maximum	SE
Chibvala	Soya BPA	274240	219000	340000	25068
	Soya control	241580	153000	305000	35089
Mtunthama	Soya BPA	218340	124000	300000	28154
	Soya control	157750	120000	182000	9905

BPA=Best practice agronomy; SE=standard error

2.2.2.4.1 Soybean yield, 2016/2017 season

In Mtunthama EPA, soybean under best practice agronomy yielded 50% more than the control treatment, p=0.038 (Table 8). However, in Chibvala EPA, there were no significant differences in grain yield of soybean between the control and BPA treatments, with a mean yield of 1490 kg/ha.

According to the farmer's perceptions on crop performance, the main determinants of yields were inoculation, pest and diseases, plant density, time of planting and soil fertility. In a season with good rainfall distribution, good agronomic practices such as inoculation of seed at planting with *Rhizobium*, timely planting and high density increased soybean grain yields. On the other hand, yield reducing factors included pests and diseases, late planting, low soil fertility and low plant density.

Table 8: Soybean grain yield in Chibvala and Mtunthama Extension Planning Areas, 2016/17 season

EPA	Treatment	Yield (kg/ha)
Chibvala	Soya BPA	1604
	Soya control	1374
	F Prob.	0.273
Mtunthama	Soya BPA	1593
	Soya control	1060
	F Prob.	0.038

2.2.2.5 Performance of maize, 2016/2017 season

Plant density is one of the critical factors that determines yield. The results show that in all treatments, there was variation in plant population after emergence between the farms (Table 9): Low plant densities reduce crop yield and also growth resources are optimized. Similarly, high plant population above the optimum density negatively affects crop productivity due to competition for below and above ground resources There was no evidence of treatment effect on germination and plant population averaged 48000 plants per hectare. This is slightly lower compared to the expected density of 53000 plants per hectare.

Table 9. Plant population (plants/hectare) of maize after germination

EPA	Treatment	Mean	Minimum	Maximum	SE
Chibvala	Maize BPA	43633	34100	54400	5892
	Maize BPA + P'pea	46900	46800	47000	100
	Maize control	46250	13400	64700	11534
Mtunthama	Maize BPA	49883	40600	65800	3763
	Maize BPA+P'pea	54010	41800	70500	2450
	Maize control	47571	33500	66700	4805

BPA=Best practice agronomy; maize BPA include plots for maize BPA and maize BPA + pigeon pea. At the time germination data was being collected, pigeon pea was not yet planted and so this subplot treatment was just the same as maize BPA; SE=standard error

2.2.2.5.1 Maize grain yield, 2016/2017 season

Maize grain yield results are presented in Figure 4. In Chibvala EPA, maize yield from the control treatment ranged from 632 kg/ha to 4591 kg/ha. The high grain yield under control (4.6 tons/ha) was as a result of application of livestock manure for soil fertility improvement. However, where no fertilizer was applied, grain yields were below 2000 kg/ha. There were significant differences in maize grain yield between the treatments. Maize under BPA yielded 103% and 56% higher than maize control and maize BPA + pigeon pea treatments, respectively. However, there were no differences in maize yield between the control and maize intercropped with pigeon pea. The 100 seed weight averaged 34g. In Mtunthama EPA, maize BPA intercropped with pigeon pea produced higher grain yield than the other two treatments, but no differences observed between the control and maize + BPA. High yields from control treatment can be attributed to similar reasons as in Chibvala where farmers considered this treatment as "farmer practice" and as such livestock and/or inorganic fertilizer was applied. The 100 seed weight were 31.52g and 38.33g for the control and maize under best practice agronomy, respectively.

A yield assessment survey conducted at harvest time showed that farmers rating of yield ranged from poor to good (for control treatment) to average-very good for maize treatments under best practice agronomy. Farmers indicated that the main factors influencing maize yields were time of planting, soil fertility status and management, rainfall distribution, plant

density. In a season with good rainfall distribution, good agronomic practices such as early planting, optimum density and application of inorganic fertilizers increase maize grain yield.

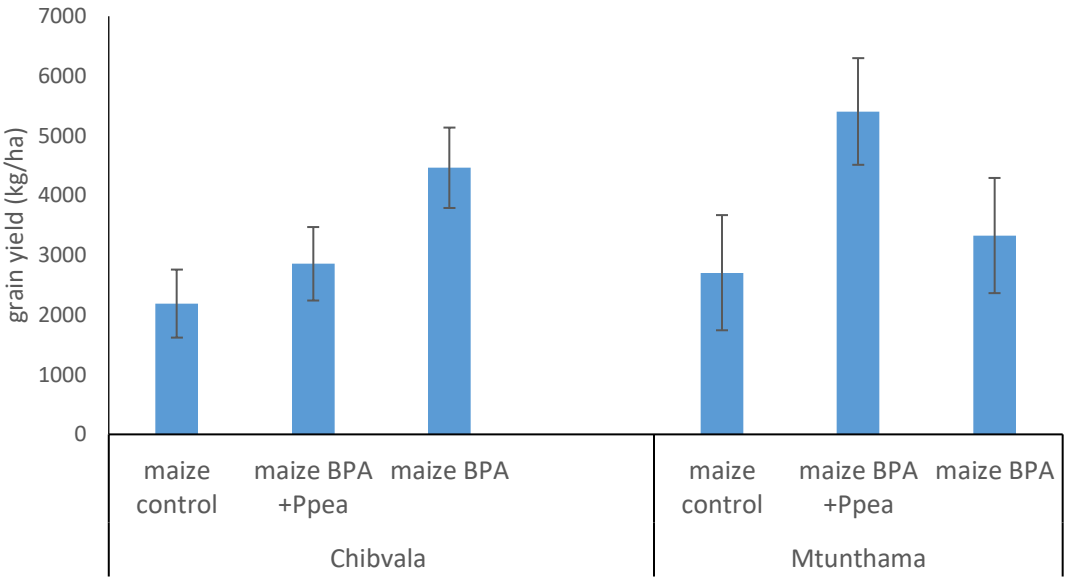

Fig 4: Maize grain yield in Chibvala and Mtunthama Extension Planning Areas, 2016/2017 season

2.2.2.6 Performance of pigeonpea

Pigeonpea was planted at about 4-5 weeks after planting maize. In some plots, the pigeon pea did not germinate or seedling died due to with dry spell; while on other plots, while on other plots, growth of pigeon pea was negatively affected by interspecific competition due to shading by maize. However, farmers continued to express interest in growing pigeon pea.

2.2.3 Crop yields from demonstration plots in 2014/2015 and 2015/2016 cropping season

In the previous reports, we reported on the practices, participation of club members in field activities from planting to harvesting, crop performance from the demonstration plots implemented in 2014/2015 and 2015/2016 cropping seasons in Mtunthama and Chibvala EPAs. There were a total of 18 and 19 demonstration plots in 2014/2015 and 2015/2016 seasons respectively. A summary of the type of demonstration plots in presented in Table 2. Due to limitations of sample size for groundnut and beans demonstration plots, yields are reported for soybean and maize treatments. Detailed reports on crop performance in

2014.15 and 2015/16 cropping seasons were included in previous reports. The key results from the two seasons were as follows:

- productivity of soybean differs with location, and is higher in Chibvala EPA than Mtunthama EPA. This can be attributed to differences in soil fertility, soils in Mtunthama have lower active soil carbon with 60% of the plots below the critical concentration (Table 1). However, yield of maize was not affected by location.
- there is variability in performance of maize and soybean under both control and plots with BPA.
- the use of best practice agronomy practices can help to reduce the yield gap in both soybean and maize.

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APPENDIX 1: DESCRIPTION OF BEST PRACTICE AGRONOMY AS IMPLEMENTED BY THE CLINTON DEVELOPMET INITIATIVE (CDI)

A1.1 BEST PRACTICE AGRONOMY FOR SOYA BEANS

Field Officers Quick Guide (CDI, 30 October 2014)

Parameter	Commercial Farm *(Mechanized; uses tractor drawn planter & sprayer)*	Smallholder Farmer *(Emerging commercial farmer; tills land with tractor & uses knapsack sprayer)*	Smallholder Farmer *(Conventional farmer; tills land with hand hoe and knapsack sprayer)*
Target plant population per hectare	350,000 to 450,000	350,000 to 450,000	350,000 to 450,000
Potential grain yield	3 to 4 t/ha	3 to 4 t/ha	3 to 4 t/ha
Attainable grain yield	2.5 to 3.5 t/ha	2 to 3 t/ha	1.5 to 2.5 t/ha
Ridge spacing	NA	NA	75cm
No. rows per ridge	NA	NA	2
Row spacing	50cm	50cm	25cm
Planting stations spacing	5cm	25cm	25cm
No. seeds per station	1	5	4
Seed rate (large seeded varieties)	80-100kg/ha	80-100kg/ha	80kg/ha
Minimum germination	90%	90%	90%
Plant population per hectare	360,000	360,000	384,000
Seed inoculation at planting	Yes (yield increases by 50%)	Yes (yield increases by 50%)	Yes (yield increases by 50%)
Basal fertilizer at planting (Soya Mix or D Compound)	250-300kg/ha	*None. Benefit from rotation crop residual fertilizer*	*None. Benefit from rotation crop residual fertilizer*
Top dressing with nitrogen fertilizer	*None. Soya fixes nitrogen in soil)*	*None. Soya fixes nitrogen in soil*	*None. Soya fixes nitrogen in soil*
Weed control at planting	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)
Control of insect pests (leaf rollers, leaf eaters)	*(Karate/ Cypermethrin: 400-500mls/ha)*	*(Karate/ Cypermethrin: 400-500mls/ha)*	*(Karate/ Cypermethrin: 400-500mls/ha)*
Control of soya rust at flowering	Folicur: 400-500mls/ha	Folicur: 400-500mls/ha	Folicur: 400-500mls/ha

A1.2 BEST PRACTICE AGRONOMY FOR GROUNDNUTS

Field Officers Quick Guide (CDI, 30 October 2014)

Parameter	Commercial Farm	Smallholder Farmer	Smallholder
Target plant population per hectare	250,000 to 330,000	250,000 to 330,000	250,000 to 330,000
Potential yield *(nut in shell; bunch va r)*	2.0 to 2.5 t/ha	2.0 to 2.5 t/ha	2.0 to 2.5 t/ha
Ridge/Bed spacing	1.3m-1.5m	75cm	75cm
No. rows per ridge	2-3	2	2
Row spacing	15-20cm	20cm	20cm
Planting stations spacing	7-9cm	9cm	9cm
No. seeds per station	1	1	1
Seed rate (large seeded varieties)	100kg	80-100kg	80kg
Minimum germination	90%	90%	90%
Plant population per hectare	a)259,615 *(beds 1.3m x 3 rows x stations 8cm x 1 seed per station)* b)285,714 *(single rows 45cm x stations 7cm x 1 seed per station)*	266,667	266,667
Seed treatment before planting	Moncerene GT/ Seedmate/ Thiram *(1.5lt/100kg seed)*	Moncerene GT/ Seedmate/ Thiram *(1.5lt/100kg seed)*	Moncerene GT/ Seedmate/ Thiram *(1.5lt/100kg seed)*
Basal fertilizer at planting (Single Superphosphate or D Compound)	250-300kg/ha	250-300kg/ha	250-300kg/ha
Apply Gypsum at early flowering	250kg/ha	250kg/ha	250kg/ha
Weed control at planting	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)
Control of aphids (spread Rosette disease)	Single spray of Dimethoate or Acetamiprid (1.0lt/ha)	Single spray of Dimethoate or Acetamiprid (1.0lt/ha)	Single spray of Dimethoate or Acetamiprid (1.0lt/ha)
Control of leaf spots (early & late)	Spray Dithane/ Daconil/ Benomyl/ Bravo at flowering/early pegging	Spray Dithane/ Daconil/ Benomyl/ Bravo at flowering/early pegging	Spray Dithane/ Daconil/ Benomyl/ Bravo at flowering/early pegging

1.3 BEST PRACTICE AGRONOMY FOR BEANS

Field Officers Quick Guide (CDI, 30 October 2014)

Parameter	Commercial Farm	Smallholder Farmer	Smallholder
Target plant population per hectare	180,000-250,000	160,000-250,000	160,000-250,000
Ridge spacing	NA	75cm	75cm
No. rows per ridge	NA	2	2
Row spacing	60cm	30cm	30cm
Planting stations spacing	10cm	10cm	10cm
No. seeds per station	1	1	1
Seed rate	70-80kg	70-80kg	70-80kg
Minimum germination	90%	90%	90%
Plant population per hectare	150,000	240,000	240,000
Seed inoculation at planting	No (little impact on yield)	No (little impact on yield)	No (little impact on yield)
Seed dressing before planting	Thiram	Thiram	Thiram
Basal fertilizer at planting (23:21:0+4S)	100-150kg/ha	100kg/ha	100kg/ha
Top dressing with nitrogen fertilizer at flowering	100-150kg/ha	None	None
Weed control at planting	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)	Harness (0.5lt/ha) and Roundup (1.0 to 1.5lt/ha)
Control of insect pests	*(Control aphids with Dimethoate)*	*(Control aphids with Dimethoate)*	*(Control aphids with Dimethoate)*
Control of diseases: a)Fungal Diseases *(Angular leaf spot, Rust, Anthracnose)* b)Bacterial Diseases *(Blights)* c)Viral *(Bean Common Mosaic* Virus)	a)Fungal diseases *(Daconil or Dithane)* b)Bacterial diseases *(Cultural practices)* c)Viral diseases *(control aphids with Dimethoate)*	a)Fungal diseases *(Daconil or Dithane)* b)Bacterial diseases *(Cultural practices)* c)Viral diseases *(control aphids with Dimethoate)*	a)Fungal diseases *(Daconil or Dithane)* b)Bacterial diseases *(Cultural practices)* c)Viral diseases *(control aphids with Dimethoate)*

APPENDIX 2: CHECKLIST FOR DATA COLLECTION TWO WEEKS AFTER PLANTING

(To be collected for each subplot)

SECTION A: IDENTIFICATION

District		Club name	
EPA		Total No. of club members	
Section		Lead farmer	
TA		Today's date in DD/MM/YY	
GVH		Is this a soy/maize or Groundnut/maize or beans/maize demonstration plot? (*circle correct answer)*	01=Soya-maize 02=Gnut-maize 03= Beans -maize
Village			
Data collected by			

Demo plot location:
Is this a new demo plot location? ……01= Yes; 02= No

If this is a new site for a demonstration this season, record GPS coordinates and elevation.

	WHAT ARE THE GPS COORDINATES OF THE CENTER OF THE PLOT?	GPS: X- COORDINATE (LATITUDE): |___| |___| |___| . |___| |___| |___| |___| |___| N/S GPS: Y-COORDINATE (LONGITUDE): |___| |___| |___| |___| . |___| |___| |___| |___| |___| E/W
	ELEVATION (m)	|___| |___| |___| |___| m
	ACCURACY (m)	±|___| |___| m

Which subplot is this? …….

G/nut (control)	
G/nut (BPA)	
Beans (control)	Maize control
Bean (BPA)	Maize BPA

Hybrid maize Control - R1	Hybrid maize control - R2
Improved Soya control- R1	Improved soya control …- R2
Hybrid maize BPA + P'pea ….- R1	Hybrid maize BPA + P'pea….- R2
Improved soya BPA….- R1	Improved soya BPA….- R2
Maize (soya BPA/maize rotation)- R1	Maize (soya BPA/maize rotation) R2

BPA=Best practice agronomy as recommended by CDI; R=replicate number

Dimensions of this subplot:	Length (m):…… Width (m) : Number of ridges: ……. Ridge spacing (m):

If this location of demo plot is not a new site, what treatment was planted on this subplot last cropping season? ……

01=sole maize, unfertilized (control)
02=sole maize, fertilized
03=inoculated soybean
04= soybean control
05= maize BPA
06= maize + Pigeonpea BPA

SECTION B: DETAILS OF PLANTING:

How many club members were present for this planting?	
How long did these club members engage in this activity? (hours)	
Planting date in DD/MM/YY	
Was CDI staff present at first planting? 01=yes 02=No	
Seed type used 01 = hybrid 02 = local variety	
Seed variety name	
Did you use inoculant ? (for Soybean only) 01 = yes 02 = no	
Plant spacing (spacing between stations) (m)	
Unit Plant spacing (m)	
Number of plants planted per station	
Plant stand count after germination	

SECTION C: DETAILS OF USE OF HERBICIDE

Did you apply herbicides on this subplot plot? 01=yes 02=No *If yes, answer all questions in this section below*	
Date of herbicide application in DD/MM/YY	
Name of herbicide applied 01 = Round-up 02 = Harness 03= Other (*specify*)	
How many club members were present during herbicides application?	
How long did these club members engage in this activity? (hours)	
Was CDI staff present during herbicide application? 01=yes 02=No	

SECTION D: DETAILS OF FERTLISER APPLICATION

Was fertilizer applied on this subplot plot? 01=yes 02=No	
Date of fertilizer application in DD/MM/YY	
How many club members were present during fertilizer application?	
How long did these club members engage in this activity? (hours)	
Name of fertilizer applied 01 = 23:21:0+4S 02 = UREA 03= Other (*specify*)	
Quantity of fertilizer applied per subplot (unit: kg, phazi plate)	Number : Unit :
Was CDI staff present during fertilizer application? 1=yes 2=no	

SECTION E: ANY OTHER OBSERVATIONS ON SUB PLOT

Anything else noteworthy on this subplot? (eg plant growth status, pests, diseases, effects of rainfall distribution or dry spell effects or water logging on plant establishment, plot management in terms of weeding etc)

APPENDIX 3: CHECK LIST FOR DATA COLLECTION AT HARVEST

SECTION A: IDENTIFICATION

District		Village	
EPA		Club name	
TA		Lead farmer	
Section		Total number of club members*	
Date of harvesting		Is this a soy/maize or groundnut/maize or beans/maize demonstration plot (circle correct answer)	01=SM 02=GB 03=BM
Data collected by			
Today's date in DD/MM/YY			

*need to ask this question just in case there are some club members who dropped out during the season

Was CDI agent present during harvest time? 01= yes 02=No

Which subplot is this? …….

G/nut (control)	
G/nut (BPA)	
Beans (control)	Maize control
Bean (BPA)	Maize BPA

Hybrid maize Control - R1	Hybrid maize control - R2
Improved Soya control- R1	Improved soya control …- R2
Hybrid maize BPA + P'pea ….- R1	Hybrid maize BPA + P'pea….- R2
Improved soya BPA….- R1	Improved soya BPA….- R2
Maize (soya BPA/maize rotation)- R1	Maize (soya BPA/maize rotation) R2

BPA=Best practice agronomy as recommended by CDI; R=replicate number

Dimensions of this subplot:	Length (m):…… Width (m) : Number of ridges: ……. Ridge spacing (m):

A3a. HARVEST PROTOCOL FOR SOYABEAN AND COMMON BEAN

(Data to be collected from each subplot at harvest)

1. Record the plot area to be harvested (ridge length, number of ridges and ridge spacing)
2. Count and record stand count at harvest
3. Uproot all plants and record the total biomass weight at harvest
4. Record the fresh weight of leafy biomass (crop residues of soya or beans) at harvest
5. Estimate weight of defoliated leaves
6. Strip off the pods from the plant and record the fresh weight of unshelled pods. Sun dry the pods
7. After shelling the pods, record the weight of grain
8. After weighing the grain yield, take measurements of moisture content of grain using a grain moisture meter. To get readings for moisture content using a grain moisture meter, mix the grain thoroughly and take three readings. Calculate the average moisture content.

9. Randomly select 100 seeds and put in a well labeled envelope. Record the weight of the 100 seeds

A.3B. HARVEST PROTOCOL FOR GROUNDNUT

(Data to be collected from each subplot at harvest)

1. Record the plot area to be harvested (ridge length, number of ridges and ridge spacing)
2. Record stand count at harvest
3. Record the total biomass weight
4. Strip off the fresh pods
5. Record the fresh weight of unshelled pods
6. Record the weight of fresh haulms (groundnut crop residues) (i.e. step 3-step 5)
7. Take a sub sample of fresh haulms to determine moisture content of fresh haulms (as part of ISFM—*assuming these crop residues will be incorporated in the soil on this subplot)*
8. Put the fresh pods for each subplot separately in a well labeled sac bag. Dry the pods separately for each sub plot.
9. After the pods have dried, record the weight of dry unshelled pods
10. After weighing the grain yield, take measurements of moisture content of grain using a grain moisture meter. record the moisture content. To get readings for moisture content using a grain moisture meter, mix the grain thoroughly and take three readings. Calculate the average moisture content.
11. Randomly select 100 seeds and put in a well labeled envelope. Record the weight of the 100 seeds

A3.C HARVEST PROTOCOL FOR MAIZE

(Data to be collected from each subplot)

1. Record the plot area to be harvested (ridge length, number of ridges and ridge spacing
2. Record stand count at harvest
3. Record the total biomass fresh weight at harvest
4. Remove the ears from the maize stalks
5. Record weight of maize ears at harvest
6. Record the weight of stover (maize crop residues) at harvest (i.*e. step 3 - step 5)*
7. Take a sub sample of the maize stover to determine moisture content (as part of ISFM—assuming these crop residues will be incorporated in the soil on this subplot)
8. Measure and record the fresh pod weight at harvest
9. Dry the pods and record pod weight.
10. Shell the pods and record grain weight. Note that if the club chooses to store groundnut in pods, then instead of shelling all pods from sub plot, take 1kg of dried pods, record weight of pods, shells and grain.

11. Measure and record moisture content of grain. To get readings for moisture content using a grain moisture meter, mix the grain thoroughly and take three readings, and then record the average moisture content.

Section C: Farmer assessment of yield from demonstration plot

1. Factors affecting crop performance and grain yield of soybean							
Treatment 1. List all treatments planted on your demo plot *Codes* 01 maize control R1 02 maize control R2 03 maize BPA – R1 04 maize BPA – R2 05 maize BPA + PP intercrop R1 06 maize BPA + PP intercrop R2 07 soya control R1 08 soya control R2 09 soya BPA R1 10 soya BPA R2 11 G/nut BPA 12 G/nut control 13 Beans BPA 14 Beans control	**1B.** How would you rate the yield of this treatment (subplot)? *Codes* 01 Very poor 02 Poor 03 Average 04 Good 05 Very good	**1C.** In general, what are the **three** main factors that might have **enhanced** the performance of this treatment? *Codes* 01 Fertile soils 02 Low soil fertility 03 Good soil texture 04 Certified seed 05 Inoculation of soybean 06 No tillage during land preparation 07 Ground cover with crop residues 08 Timely planting 09 High germination percentage 10 High plant density 11 Timely application of inorganic fertilizer 12 Good rainfall distribution 13 Timely weed management 14 Flat topography 15 Ridge aligned across contours 16 Others (specify)			**1D.** In general, what are the **three** main factors that might have **negatively affected** the yield of this treatment (subplot)? *Codes* 01 Poor germination 02 Low soil fertility 03 Soil texture (sandy or clay soils) 04 No tillage during land preparation 05 Ground cover with crop residues 06 Soybean not inoculated at planting 07 Late planting 08 Heavy rainfall/floods 09 High plant density 10 Dry spells 11 Pests 12 Diseases 13 Witch weed 14 Poor weed management 15 Soil erosion 16 Plot shaded by tree **17** Others (specify)		
		1st	2nd	3rd	1st	2nd	3rd

2. Factors affecting crop performance and grain yield

Treatments 1. List all treatments planted on your demo plot *Codes* 07 Groundnut BPA 08 Groundnut control 09 maize BPA 10 maize control 11	**1B.** How would you rate the yield of this treatment (subplot)? *Codes* 01 Very poor 02 Poor 03 Average 04 Good 05 Very good	**1C.** In general, what are the **three** main factors that might have **enhanced** the performance of this treatment? *Codes* 01 Fertile soils 02 Low soil fertility 03 Good soil texture 04 Certified seed 05 Inoculation of soybean 06 No tillage during land preparation 07 Ground cover with crop residues 08 Timely planting 09 High germination percentage 10 High plant density 11 Timely application of inorganic fertilizer 12 Good rainfall distribution 13 Timely weed management 14 Flat topography 15 Ridge aligned across contours 16 Rotation with legumes 17 Others (specify)			**1D.** In general, what are the **three** main factors that might have **negatively affected** the yield of this treatment (subplot)? *Codes* 01 Poor germination 02 Low soil fertility 03 Soil texture (sandy or clay soils) 04 No tillage during land preparation 05 Ground cover with crop residues 06 Soybean not inoculated at planting 07 Late planting 08 Heavy rainfall/floods 09 High plant density 10 Dry spells 11 Pests 12 Diseases 13 Witch weed 14 Poor weed management 15 Soil erosion 16 Plot shaded by tree **17** Others (specify)		
		1st	2nd	3rd	1st	2nd	3rd