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Adoption Monitoring Survey Analysis of Conservation Agriculture (CA), Southern Region, Ethiopia

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ABSTRACT

Conservation agriculture includes on-farm exploratory trials, regarding maize and haricot bean varieties by planting sole and intercrop for both crops. Maize is considered as the main staple crop of the study area and common bean cash crop and protein source of the farmers in many low lands and mid altitude zones of Ethiopia. The country's export earnings from haricot bean exceed that of other pulses such as lentils, horse bean and chickpea. Low production and productivity, which are mainly associated with poor adoption of improved technologies and poor marketing system, were among the major problems. Adoption of improved technologies is one of the most promising ways to reduce food insecurity in Ethiopia. However, the adoption and dissemination of these technologies is constrained by various factors. To this end, the aim of this study was to empirically examine the adoption rate and intensity of adoption of improved conservation technologies vs conventional agriculture in the study area. The snow ball sampling procedures was followed to select sampled households for the study. Six rural kebeles per district were considered as beneficiaries of the CA, and for the three districts, 353 household heads were selected randomly using probability proportional to size sampling. Structured interview schedule was developed, pre-tested and used for collecting the essential quantitative data for the study from the sampled households. Secondary data were collected from relevant sources such as the district office of agriculture and rural development published and unpublished.

The result of the study indicated that majority of farmers in the study area preferred conservation agriculture vs conventional ones regarding their profitability. Moreover, farmers' practice was found largely to deviate from research and extension recommendations. Hence, the adoption monitoring survey result recommended to promote most adopted ones and to modify those activities such as inputs considered as constraints to the reach of farmers by establishing an agribusiness modelling based on the existing farmers' organizations for sustainability of conservation agriculture in the study area.

1. INTRODUCTION

More than 85% of the Ethiopian population, which resides in the rural area, is engaged in agricultural production as a major means of livelihood (World Bank, 2006). The agricultural production system is mainly rain - fed and traditional, which is characterized by low input of improved seeds, fertilizer, pesticides and other technologies (Legesse, 2004). Moreover, the ever increasing population pressure led to a decline in land holding per household that eventually resulted in low level of production to meet even the consumption requirement of the households (Bezabih and Hadera, 2007).

Increasing agricultural production at the household level is vital to achieve food security (Degnet and Belay, 2001). On the other hand, any marketable surplus could be sold to the non-farming and even to the farming communities (Hailu, 2008).Therefore, increasing the production and productivity in a sustainable manner could address the problem of food shortage **(**Habtemariam, 2004**)**. As one of the approaches to ensure households food security, the Ethiopian rural development policy and strategy document has given weight to follow diversification and specializations in production systems along with improved access and the use of agricultural technologies (Hailu, 2008).In general, raising agricultural output and productivity on a sustainable basis necessitates large scale adoption and diffusion of new technologies (Mohamed *et a*l., 2009).

1.1 Significance of the Study

Adoption studies can provide research and extension staff, rural development institutions, and policy makers with valuable information that improves the efficiency of communication among them in promoting available technologies. Apart from this, acquired information from such studies could enhance the efficiency of agricultural research, technology transfer, input provision, and agricultural policy formulation. All development partners including extension educators, technical assistants, NGOs and other development agents involved in agricultural development must be aware and understand the factors affecting the level of adoption of recommended varieties and agronomic practices for maize-common bean intercropping in order to target and prorate appropriate technologies to farmers.

Sustainable Intensification of Maize-Legume system for Food Security in Eastern and Southern Ethiopia (SIMLESA) program was launched in Ethiopia in March 2010 with the objective of improving the livelihood and eco-system of maize-bean growing smallholder farmers. To this effect the first of the five objectives of the project deals with the characterization of maize-legume production and input and output value chain systems and impact pathways, and identifies broad systemic constraints and options for field testing. An early adoption monitoring survey was designed to capture the adoption process regarding SIMLISA technologies in the intervention areas. This study provides primary information regarding the status of adoption of these technologies and its implications.

SIMLESA promotes CA-based cropping system:

- Minimum soil disturbance (ideally, zero tillage)
- Soil surface cover (retention of crop residues or live mulches)
- Crop rotation/intercropping involving legume
- Weed control

1.1 Objective

- To estimate the economic benefits from the adoption of CA technologies

2. LITERATURE REVIEW

2.1 Definition of Adoption

Feeder et al. (1985) defined adoption as the degree of use of a new technology in a long-run equilibrium when a farmer has all of the information about the new technology and its potential. Therefore, adoption at the farm level describes the realization of a farmer's decision to implement a new technology. On the other hand, aggregate adoption is the process by which a new technology spreads or diffused through a region. Thus, a distinction exists between adoption at the individual farm level and within a targeted region. If an innovation is modified periodically, however, the equilibrium level of adoption will not be achieved. This situation requires the use of econometric procedures that can capture both the rate and the process of adoption. As the new technology is introduced, some farmers will experiment with it before adopting. The "rate of adoption" is defined as the proportion of farmers who have adopted a new technology at a specific point in time (e.g., the percentage of farmers using fertilizer). Furthermore, the "intensity of adoption" is defined as the level of adoption of a given technology, for example, by the number of hectares planted with improved seed or the amount of fertilizer applied per hectare.

2.2 Theoretical Background

The history of adoption and diffusion research can be dated back to the early 1940s beginning with the study of Hybrid maize diffusion in Iowa, USA, by the rural sociologists Ryan and Gross (1943). Although the period indicated was taken as an important period with respect to a modern type of adoption and diffusion, there are evidences showing that studies were undertaken on the subject prior to that period. A review of the literature on the adoption of high-yielding seed varieties (Ruttan and Binswanger 1978) suggested that neither farm sizes nor farm tenure has been a serious constraint on adoption. Although different rates of adoption by farm size and tenure have been observed, the available data implied that within a few years of introduction, the lags in adoption due to size or tenure have usually disappeared. Of course, the non-adopters would have foregone the potential gains of early adoption and may already have suffered as a consequence. However, these conclusions have not been altered by more recent researches.

Moreover, the results from past studies can be briefly summarized as insight of the adoption of agricultural technologies and its determinants. Research on the diffusion of innovations suggested that the distribution (frequency of adopters over time) tends to follow a bell-shaped curve resembling the normal distribution (Rundiquist, 1984). In its cumulated form, the normal distribution forms the logistic curve which looks like the S-shaped curve often found in adoption studies. Griliches (1957) Mansfield (1961), Mahajan and Robert (1985) and Feeder et al (1985) have discussed the S-shape of the cumulative adoption frequencies plotted over time.

Feder et al. (1985) attributes the diffusion path of aggregate adoption of new technologies to the dynamics of the spread of information. In explaining and interpreting the S-shaped diffusion curve, Mansfield (1961) hypothesized that the rate of adoption is a function of the extent of economic merit of the technology, the amount of investment required to adopt the technology and the degree of uncertainty associated with the technology. Hagerstand (1967) meanwhile, offered an information transfer explanation. In contrast, Sahal (1981) employed a learning perspective when explaining diffusion patterns.

3. METHODOLOGY

3.1 The study area and sampling

The two study districts were in Sidama zone and the third district was Hallaba special district and these districts were characterized as moisture stress areas and to resolve the problem conservation agriculture was one of the interventions by SIMLESA project since 2012.

The sample size was 353 households for the three districts. Out of these households, 3.3% were host farmers, 15.8% second generation, 19.4% third generation and 61.5% scale out host farm households. The snowball sampling methods were used to sample the farm households from three districts. The enumerators interviewed the selected household farmers in the SIMLESA program sites. In each district, six peasant associations participated in the program. The analytical technique used for this study is descriptive statistics such as mean, percentage and standard deviation. Descriptive statistics helps to assess and analyze farmers' responses and their implications for adoption of improved maize/common bean varieties.

4. DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS

4.1 Demographic characteristics

The mean age of the households ranged from 38 to 42 years old for the three districts. The proportion of female households were 9 (6.3%), 24 (17.9%) and 2% (2.4) in the study area respectively. The education status of sampled farmers was categorized as literate and illiterate. Hence, the type of sampled farmers that participated in the early adoption monitoring formal survey were host farmers, second generation, third generation adopters and scale out host (Table 1).

Table 1: Demographic characteristics

Characteristics	Lockabaya		Borecha		Hallaba	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Age of hhs (yr.)	39.40	9.57	42.28	7.44	38.41	9.33
	No. of farmers	**% of farmers**	**No. of farmers**	**% of farmers**	**No. of farmers**	**% of farmers**
Gender of respondent						
- Female	9	6.3	24	17.9	2	2.4
- Male	133	93.7	110	82.1	83	97.6
Education status of the household head						
- **Literate**	11	8.1	77	57.5	11	13.3
- **Illiterate**	125	91.9	57	42.5	72	86.7
Type of farmers in SIMLISA technology adoption						
- Host farmer	7	4.9	5	3.7	-	-
- Second generation adopter	18	12.7	39	29.1	-	-
- Third generation adopter	35	24.6	35	26.1	-	-
- Scale out host	82	57.7	55	41	85	100

Source: Sample survey, 2014

4.2 Socioeconomic Characteristics

Table 2 shows the land allocation to different enterprises by district. The average total farm size holding ranged from 3 to 4 timad for the three woredas. Similarly, average land allocated under sole maize (hectare) for Hallaba (2.27) was significantly larger compared to Borecha farmers (0.61) and Lockabaya (0.43). While total land under maize legume (hectare) during 2014 cropping season was significantly larger for Lockabaya farmers (0.58) than Borecha farmers (0.33). Total land under maize rotation (hectare) during the cropping season was significantly larger for Hallaba (1.19) than both lockabaya and Boarecha farmers.

Table 2: land allocation in Lockabaya, Borecha and Hallaba study area

Characteristics	**Lockabaya**		**Borecha**		**Hallaba**	
	Mean	Standard deviation (S.D.)	**Mean**	Standard deviation (S.D.)	**Mean**	Standard deviation (S.D.)
Total farm size holding (timad)	4.44	2.82	3.07	2.16	5.99	3.72
Average land allocated under sole maize (hectare)	0.43	0.44	0.58	0.61	2.27	1.64
Average land allocated under legume (hectare)	0.16	0.17	0.33	0.35	1.45	1.15
Total land under maize legume (hectare) during 2014 cropping season	0.74	2.10	0.33	0.36	0.73	0.51
Total land under maize rotation (hectare) during 2014 cropping season	0.13	0.18	0.13	0.19	1.19	1.71

Source: Sample survey, 2014
One timad: 0.25ha

4.2.1 Livestock production

Livestock are the main sources of income and also used as draught power. Farmers in Hallaba significantly owned more number of cows and oxen's (5.18) than both Lockabaya (4.10) and Borecha farmers (3.24). Farmers in Hallaba owned more number of sheep and goat (4.34). Borecha owned more number of chickens (8.75) than both Hallaba (6.82) and Lockabaya (5.47).

Table 3: The mean number of livestock in the study area

Characteristics	**Lockabaya**		**Borecha**		**Hallaba**	
	Mean	**Standard deviation (S.D.)**	**Mean**	**Standard deviation (S.D.)**	**Mean**	**Standard deviation (S.D.)**
Number of cows and ox	4.10	2.64	3.24	1.92	5.18	3.64
Number of bulls and heifers	1.59	1.79	1.62	1.15	1.23	1.27
Number of sheep and goat	2.96	3.12	4.03	3.65	4.34	3.79
Number of horses, mules and donkeys	0.21	0.89	0.31	0.69	1.42	0.96
Number of chickens	5.47	3.06	8.75	6.06	6.82	3.66

Source: Sample survey, 2014

5. ADOPTION OF CA TECHNOLOGIES

Farmers who were aware of activities conducted by SIMLESA program as shown in Annex 1 indicate, 98.6% for Lockabaya, Borecha 85.8% and Hallaba 98.8%. Those farmers hosting SIMLISA demonstration were 9.7, 54.2 and 98.8 percent for the three districts respectively. While those that participated in members innovation platform accounted to 43% for Lockabaya and 43.6 % for Borecha. During the survey, the innovation platform not established in Hallaba due to budget constraint. Those that participated in visited demonstration, participated in attended field days, participated in exchange visits also pinpointed in the Annex table one.

The types of technologies adopted were maize-bean intercropping as of 35.9%, 77.4% and 65.9% for the three districts accordingly followed by minimum/zero tillage 47.2% for Lockabaya, 15.8% for Borecha 24.7% for Hallaba. The sources of information, SIMLESA demonstration/host farmers 63%, 54 % and 5 3 % for the three districts followed by extension workers as of 24%, 38% and 33% of the sampled farmers in the respective districts.

Sampled farmers who expanded their plots beyond SIMLESA demonstration estimated as 76%, 44% and 97% for the three districts. The share of knowledge on the technology was 76%, 82% and 100%. This is a good indicator for the enhancement of adoption of improved SIMLESA technologies which are further to be scaled up/out based on early adoption monitoring survey results and the profitability study. The percentage change in yield due to the technology, 63%, 44% and 8% accordingly for the three districts.

Profitability of conservation agriculture

The profitability study was based on the exploratory trials conducted in the land of farmers selected voluntary in the three districts. The summary of the total cost of the different treatments were depicted in Annex table 2.

Table 5 shows the gross margin of conservation and conventional tillage practice and the profitability analysis; it showed that CA has a net benefit of 48% compared to the conventional tillage (Intercropping of MZ +CB1+CB2). All the other treatments for the conservation have been profitable. The agronomic practices were herbicide application before planting, minimum tillage using ripper for sowing of the maize and common bean seed intercropped, one to two supplementary weeding, after harvest mulching the field with maize stocks (75%). Common bean also relay cropped as B2).

Table 5: Gross margin of Conservation Vsc Conventional tillage practices, 2014.

Treatment		Mean yield qt/ha	Cost Birr/ha	Benefit Birr/ha	Profit Birr/ha
Conservation Agriculture	***Sole Maize (MZ)***	69.34	6306	34,670	**27,984**
	Sole Common Bean (CB1 + CB2)	20.37/18.41	3528.25	31,024	**27,495.75**
	Intercropping (MZ + CB1+ CB2)	70.09/26.71	9106	56,413	**47,307**
	Intercropping (MZ+CP1+CP2)	69.57/23.76	9984.25	53,793	**43,808.75**
	Rotation (MZ)	72.78	6356	36,390	**30,034**
Conventional Agriculture	***Intercropping (MZ + CB1+CB2)***	64.33/18.46	14244.25	46,933	**32,688.75**

Source: Own manipulation

6. CONCLUSION

The monitoring adoption survey has provided primary information regarding CA technologies awareness, adoption and its dis-adoption. Based on the results, it is advisable to promote most adopted ones and to modify those activities such as inputs considered as constraints to reach a considerable number of farmers. Hence, this shortcoming should be resolved through the establishment of small farmers groups (youths) to deliver inputs to the respective peasant kebele's through agribusiness model to be capacitated by SIMLESA program to attain the sustainability of conservation agriculture in the study area based on the existing farmers' organizations. Therefore, policy and development interventions should give emphasis to institutionalizing the successful SIMLESA technologies and agronomic practices to accomplish wider adoption, increased productivity and income to small scale farmers.

7. APPENDICES

Annex 1. Awareness, Adoption and dis-adoption of SIMLESA technologies

Characteristics	Lockabaya		Borecha		Hallaba	
Are you aware of SIMLESA technologies in your area?	N of farmers	% of farmers	N of farmers	% of farmers	N of farmers	% of farmers
- Yes	28	98.6	72	85.5	84	98.8
- No	2	1.4	2	1.5	1	1.2
If yes hosting SIMLESA demonstration						
- Yes	28	9.7	72	54.2	84	98.8
- No	114	80.3	61	45.9	1	1.2
Participated in member of innovation platform						
- Yes	61	43	58	43.6	-	-
- No	81	57	75	56.4	85	100
Participated in visited demonstration						
- Yes	128	90.1	99	74.4	82	96.5
- No	14	9.9	34	25.6	3	3.5
Participated in attended field days						
- Yes	96	67.6	93	69.9	81	95.3
- No	46	32.4	40	30.1	4	4.7
Participated in exchange Visit						
- Yes	45	31.7	7	5.3	64	75.3
- No	97	68.3	126	94.7	21	24.7
Participated in others, extension activities						
- Yes	78	61.2	51	38.3	11	12.9
- No	97	68.3	126	94.7	21	24.7
Characteristics	**Lockabaya**		**Borecha**		**Hallaba**	
	N of farmers	**% of farmers**	**N of farmers**	**% of farmers**	**N of farmers**	**% of farmers**
Technologies adopted						
- Maize bean Intercropping	51	35.9	103	77.4	56	65.9
- Minimum/zero tillage	67	47.2	21	15.8	21	24.7
- Shalla	13	9.2	2	1.5	-	-
- Ripper	2	1.4	-	-	6	7.1
- Others (BH 540, HawassaDume, Sole maize, maize bean rotation)	7	4.9	3	2.3	-	-
Source of information						
- SIMLESA demo/host farmer	87	63	77	54	45	53
- Extension workers	33	24	54	38	28	33
- Other fellow farmers	18	13	12	8	12	14
If stopped, using it gave main reason						
- Unavailability of herbicide	127	90	106	79	85	85
- Lack of seed	8	5	24	18	9	9
- Livestock feed shortage	6	3	5	3	6	6
Name of technology liked most						
- Minimum/Zero tillage	40	29	36	26	22	30
- Maize/bean intercropping	9	7	9	6	43	58
- Maize bean rotation	1	0.5	2	7	3	4
- Sole maize cropping	0	-	18	13	5	6
- Shalla	8	6	39	28	1	2
- BH-540	67	48	0	-	0	-
- Gebi	1	0.5	1	3	0	-

Characteristics	Lockabaya		Borecha		Hallaba	
- Ibado	13	9	22	16	0	-
	N of farmers	**% of farmers**	**N of farmers**	**% of farmers**	**N of farmers**	**% of farmers**
Expanded plot beyond SIMLISA demonstration						
- Yes	25	76	44	44	72	97
- No	8	24	56	56	1	3
If not expanded? First reason						
- Lack of seed	-	-	41	67	10	100
- Livestock feed shortage	1	100	9	15	-	-
- Lack of herbicide	-	-	5	8	-	-
- Fuel wood shortage	-	-	6	10	0	-
Share knowledge on technology						
- **Yes**	25	76	77	82	74	100
- **No**	8	24	17	18	-	

Characteristics	**Lockabaya**		**Borecha**		**Hallaba**	
	Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
Area (hectare) under SIMLESA technology before	0.21	0.13	0.20	0.11	0.53	0.36
Area (hectare) under SIMLESA technology after	0.44	0.40	0.75	0.98	0.86	0.31
Percent change in yield due to technology	9.94	62.59	163.28	43.76	34.28	7.86

Source: Sample survey, 2014

Annex 2: Summary of the total Cost that vary/hectare, for Hawassa ,Borecha and lockabaya districts, 2014

Operational activities	**Conservation agriculture**							**Conventional Agriculture**	
	Maize	**CB1& CB2**	**Intercropping**			**Rotation**		**Intercropping**	
			Maize	**CB1&CB2**	**CP1&CP2**	**Maize**	**CB**	**Maize**	**CB1&CB2**
Land preparation	0	0	0	0	0	0	-	2400	2200
Raw spacing (rippers)	600	600	600	600	600	600	-	0	0
Seeds	930	1200	930	1200	600	930	-	930	1200
Labor for planting	400	400	350	300	300	350	-	300	250
Chemical fertilizer (DAP &Urea)	2426	628.25	2426	0	628.25	2426	-	2426	628.25
Labor for Fertilizer application	400	-	350	-	-	350	-	300	250
Weeding	800	700	800	700	700	800	-	1760	1600
Herbicide	450	-	450	-	450	450	-	0	0
Labor for herbicide spraying	200	-	150	-	-	150	-	-	-
Total Cost	**6306**	**4178.25**	**6356**	**2800**	**3678.25**	**6356**	**-**	**8116**	**6128.25**

Note: CB1= Common bean planted in Belg; CB2= Common bean planted in Meher; CP1= Cow pea planted in Belg and CP2 = Cow pea planted in Meher

Annex 3: Average prices of agricultural inputs

Inputs	Price In Birr
Abaraya/qt	3800.00
Common bean –HawassaDume/qt	1600.00
Fertilizer Maize – DAP/100kg - Urea/100kg	1377.48 1101.68
Herbicide – 1 lt /ha (Round up)	180.0
Insecticide: 1lt/ha (Karate)	400.00

Source: Woreda Agricultural Offices, 2015

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