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Dissemination, Adoption and Impacts of Multi-Crop Threshers in Ethiopia: Experiences of Sasakawa Global 2000

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Dissemination, Adoption and Impacts of Multi-Crop Threshers in Ethiopia: Experience of Sasakawa Global 2000

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ACRONYMS

DA	Development Agent
EA	Extension Agent
FAO	Food and Agriculture Organization
FTC	Farmers Training Centre
GTP	Growth and Transformation Plan
HH	Household
qtl	Quintal (1 quintal = 0.1 tons)
LDCs	Least Developing Countries
MCTs	Multi-crop Threshers
MELS	Monitoring, Evaluation, Learning and Sharing
PHAP	Postharvest and Agro-processing
PHELP	Postharvest Extension and Learning Platform
SG2000	Sasakawa Global 2000
SNNPR	Southern Nation Nationality People Region

EXECUTIVE SUMMARY

Sasakawa Global 2000 (SG2000) has worked in Ethiopia for over 20 years, and played an important role in enhancing the agriculture extension delivery of the country. Its successes in the promotion of improved technologies is integral to the food security goal of the country. SG2000 has promoted improved postharvest technologies such as maize shellers, multi-crop threshers, improved storage structures and others in different parts of the country. This study was initiated to assess the adoption, dissemination and impact of multi-crop threshers (MCTs) in selected SG2000 project sites, and to draw lessons from successful adoption of the technology.

The study was conducted in selected SG2000 project sites where multi-crop threshers were promoted. Survey was conducted in Arsi Negele, Shashemene and Siraro Woredas of West Arsi Zone in 2013. And in 2014, another survey was conducted to assess lessons from successful promotion and adoption of the MCTs. For this, two types of sites were selected: sites that successfully adopted the MCTs, e.g. Shashemene and Siraro Woredas; and sites where much work is still required to promote the use of threshers, such as Ada'a, Dejen and Lemmo Woredas. Structured questionnaires were administered to 180 farmers in West Arsi Zone. Key informant interviews were also conducted with Woreda crop experts, DAs, and staff of SG2000.

Results indicated high rate of adoption and use of multi-crop threshers in West Arsi Zone, and that brought significant change in postharvest operation. In Shashemene Woreda, except few farmers in the periphery, almost 100 percent of teff producing farmers were using the threshers. Similarly, almost all kebeles in Siraro Woreda utilized MCTs for threshing teff. The study further showed that the use of the MCTs was one of the major reasons for the shift in cropping pattern in Shashemene, Siraro and Arsi Negele Woredas. More land (about 50 percent) was covered by teff in these Woredas in 2014 as compared to previous years.

In contrast to traditional methods, threshing using multi-crop threshers were found to be economical with several benefits. Use of the MCTs saves time and labor, reduces crop loss and improves quality. It was estimated that when teff is threshed with MCT the loss is around 2.5 kg per quintal (100kg) while in the traditional method the loss is 8.3 kg per quintal (100kg). These benefits of the machines were also valued by both farmers and thresher owners.

Results showed that investment on the machine is worthwhile assuming efficient capacity utilization. With a constant cash flow and 10 percent discount rate, the Net Present Value (NPV) was positive (29,130.2 Birr) and the machine can return its investment within one and half years. The successful use of MCTs in West Arsi (Shashemene and surrounding areas) was a result of the benefits along with specific factors such as availability of better sources of income, access to road, plain topography, and mainly the crucial role of private entrepreneurs in service provision.

With the exception of West Arsi Zone, there was low use of multi-crop threshers in other parts of SG2000 project sites. High initial investment of the MCTs and lack of maintenance services were some of the major reasons for low use of the technology. Vulnerability of the machine to breakage worked against effective adoption and use. Respondents also reported lack of spare parts, poor transportation, shortage of skilled operators and laborers.

The success of adoption and dissemination of the MCTs was highly affected by sites specific factors. These include: i) opportunity cost of labor, ii) threshing season and rainfall pattern, iii) Social values, iv) presence of cash crop, iv) local topography, v) availability of maintenance services and others. For MCTs to work effectively improved awareness of farmers, agricultural experts and policy makers on the use and benefits of MCT is crucial. Further, private entrepreneurs need to be encouraged to buy with affordable loans for successful dissemination and promotion of the technology. Provision of simple and easily transportable threshers and access to spare parts and trained operators are also important.

I. Introduction

Crop production in Ethiopia is small-scale. It is non-mechanized and well known for its large amount of human and animal power requirements. Traditional animal threshing in Ethiopia remains to be a major component of postharvest activities. Traditional methods of threshing by live animals and humans result not only in significant quantity and quality losses but are also time consuming and arduous (Asfaw et.al, 2011). Despite the important benefits of improved technologies to farmers, their use is limited in the Ethiopian agriculture. This imply a need for an improved technology to curtail this practice.

Sasakawa Global 2000 - Ethiopia (SG2000) has introduced and promoted locally fabricated mechanical threshers in Ethiopia to overcome the constraints in traditional threshing. The mechanical threshers are expected to reduce crop losses and improve quality. Crop losses are normally associated with traditional threshing which is caused by trampling of grain, scattering and spoilage. Mechanical threshers also protect grains from mixing with sand and other foreign matters. Thus, the machine improves the quality of crop processed and its use will also drastically reduce drudgery.

SG2000 promoted multi-crop threshers in more than 30 Woredas in Ethiopia. Adoption rates are valid criterion for measuring the success of improved technologies. This study attempts to capture actual dissemination and adoption rates and its impact on farmers' livelihoods. Additionally, this study looks into lessons from SG2000 extension models as pathways for wider dissemination and adoption of mechanical threshers.

Thus, the main objective of this study is to assess adoption, dissemination and impact of improved postharvest handling using multi-crop threshers. The study also attempts to draw lessons from successful promotion and adoption of the multi-crop threshers.

This report is organized as follows. The first part provides a brief discussion of threshers promoted by SG2000, their design and adaptation, followed by a section on study methodology. The main body of the report is divided into two sections. The first section deals about adoption, dissemination and impact of the MCTs. The second section discusses on the lessons from successful promotion and adoption of the thresher. The final part of the report discusses policy implications and concludes the study.

2. Promotion of Multi-crop Threshers by SG2000

Threshing is one of the postharvest operations that is mainly done in a traditional way in Ethiopia. Harvested teff, for example, is threshed using oxen or by beating the crop with a stick. This way of processing results in high losses and low quality produce as grains get mixed with sand and other impurities (Dejene and Wondwossen, 2008). Moreover, time and labor required to thresh teff are high and farmers regard this activity as arduous but yet unavoidable.

These problems can be addressed by using mechanical or improved threshers such as teff threshers. Over the years, SG2000 - Ethiopia has attempted to enhance value addition of food crops through its postharvest interventions such as the promotion of multi-crop threshers. This includes teff threshers which were introduced in the Shashemene area of Southern Ethiopia in 2003.

In light of its attempt to reduce postharvest loss and in due course to increase income, SG2000 - Ethiopia has worked to promote improved postharvest technologies. In addition to the multi-crop threshers, SG2000 is also promoting other technologies, such as the maize shellers, rice mills, winnowers and grain cleaners. The organization is currently introducing and promoting these technologies in more than 36 Woredas across the country.

Figure 1. Traditional threshing using oxen and mechanical threshing using MCT

Description of the Multi-crop Thresher

The Multi-crop thresher (MCT) is an engine-powered and portable mechanical "throw-in type" crop thresher equipment developed by the International Institute of Tropical Agriculture (IITA) in Nigeria and adapted by SAA in collaboration with the Selam Technical and Vocational College (STVC). Most of its parts are locally fabricated except for its power drive, a petrol/gasoline engine. The thresher can be used to thresh crops such as teff, wheat, barley, sorghum and millet, with a simple adjustment in the engine throttle to adjust the speed of the threshing drum. This application feature of the MCT is very critical in capacity utilization and profitable use of the thresher (Asfaw, 2012).

During threshing, the multi-crop thresher is placed on a level ground covered by a large canvas to collect grains that can spill during threshing. The thresher can be loaded on donkey carts and can move from farm to farm. Outside a village, it can be transported from place to place in trucks and pick-up cars. It is, nevertheless, difficult to transport threshers to remote areas where the roads are not accessible to trucks or carts.

The thresher machine has two outlets: the outlet for teff straw and the outlet for grain. The chaff with teff grain needs further sieving and winnowing to get clean teff grain. This is done with locally produced winnowing baskets. Two people (usually women) can be employed to do this. Currently, the thresher does not combine threshing and winnowing which is technically an area for future improvement.

The multi-crop thresher has a rated capacity of 300-500 kgs (3-5 quintals) of grain per hour and has fuel consumption of 1.5 liters per hour. However, the threshed output of teff depends on the experience of operators and the moisture content of the teff. The operator's experience shapes the speed involved in feeding sheaves of teff to the thresher and the removal of chaff and grain from the thresher. A decrease in the moisture content of teff sheaves also increases the output. It is recommended to check the engine every 2 hours with a cooling period of at least 30 minutes between operations. This will help to maintain its efficiency and prevent serious damage to the engine and the machine. The thresher has a service life of about five to seven years depending on care and maintenance.


Figure 2. A Multi-crop thresher and transporting it on donkey cart

3. METHODOLOGY

In order to address the study questions the team carried out a literature review (analysis of existing data and reports) and intensive field survey. A combination of literature review and field survey; a thorough desk review and an in-depth field assessment was conducted to address the study objective.

3.1 Desk Review

SG2000 (particularly the MELS Theme) has at different stages compiled information, data and reports (Asfaw, et. al, 2010 and Dejene, et al., 2008) which are relevant to this study. We reviewed previous studies and analyzed the data to answer some of the study questions. Comparative analysis was mostly undertaken to see the differences in variables that are perceived to affect the utilization and adoption of the machines. This exercise helped to answer some of the questions raised particularly related to wider adoption and dissemination of the technology.

3.2 Study Sites

The study covered SG2000 sites (regions, Woredas and Kebeles) where multi-crop threshers were particularly promoted. Representative samples of Woredas, Kebeles and households were selected based on the dissemination and adoption of the teff thresher. The study was mainly conducted in three Woredas in West Arsi Zone; Arsi Negele, Siraro and Shashemene to assess adoption and impact of the MCTs. In these sites, SG2000 introduced the technology in 2003 (in Shashemene Woreda, particularly), and after 2007 it disseminated to the other Woredas.

Further, to assess lessons from successful promotion and adoption of the threshers, the study also incorporated other sites where SG2000 promoted the technologies. Two types of sites were selected for this purpose: i) sites that successfully adopted threshers, e.g. Shashemene and Siraro Woredas, where the dissemination of the technologies showed positive change/promising results; and ii) sites such as Ada'a, Dejen and Lemmo Woreda s, where much is still required to promote the use of the threshers.

3.3 Data Collection

Both quantitative and qualitative methods were used. However, emphasis was placed on the quantitative data using structured questionnaires both at the household and the kebele/Woreda levels. Questionnaires were administered, in 2013, to 180 farmers (150 adopters and 30 non-adopters) in Arsi Negele, Siraro and Shashemene Woredas in West Arsi Zone. Qualitative information was further collected from relevant government bodies at the sampled Woredas and kebeles. Field observations and key informant interviews were used mainly to assess the reasons behind high or low adoption/use of PH machines in different Woredas. The key informants included Woreda agricultural experts, SG2000 staff, farmers, thresher owners, operators, and repair and maintenance service providers.

During the field survey, the major focus was on the research questions which were left unanswered by existing data and literature regarding the use and adoption of machines. The study assessed the use of threshers to the area in relation to variables like size of land, infrastructure and proximity to repair and maintenance services. Key informants were also asked to assess and compare the impacts of the threshers on farm income and other variables.

The survey collected valuable information on several factors including household composition and characteristics, land and non-land farm assets, livestock ownership, household membership in different rural institutions, crop variety choices and area planted. Costs of production, yield for different crop types, indicators of access to infrastructure, household market access, household income sources and major consumption expenses were also important components of the survey. The economic traits and preferences for different methods of threshing (traditional method and the multi-thresher) and reasons for adopting the mechanical thresher were investigated.

Information gathered from qualitative sources is summarized and presented in forms of narratives and was triangulated with quantitative findings. The collected data were analyzed and detailed interpretation was provided. The descriptive quantitative method helped to identify profitability of a thresher and to determine the percentage of people who are benefiting from the service of threshers.

3.4 Description of Sampling

A multi-stage sampling procedure was used to select Woredas, Kebeles and farm households. In the first stage, Woredas were selected followed by Kebeles from each Woreda. Selection was based on the extent of dissemination and adoption of the teff thresher.

Table 1. Sample sites and thresher owners covered in the study

Woredas	Farmers/Thresher/owners	Kebeles/FTCs
Shashemene	Farmers and owners	Idola Burka, Alache Erebete and Awasho kebele
Arsi Negele	Farmers and owners	Ali Woyo and Gorbi Derera
Siraro	Farmers and owners	Fande Ejersa, Lencha lama
Ada'a	Thresher owners and farmers	Dhankaka
Dejen and Awabel	PHELP and groups/farmers	Enebi chifar and Borebor
Lemmo	PHELPs and users/farmers	Semen Belesa
Leka Dullecha	PHELPs and users/farmers	Horda Qawisa, Bandira, Digga Fododo
Ada'a Bargaa	PHLEP and users/farmers	Haro Boro, Ula Boro
Debre Libanos	PHELP and users/farmers	Dirre Jibbo and Wakkene

A random sampling of 30 farm households were selected from each Kebele from three Woredas (i.e., Shashemene, Arsi Negele and Siraro). A total of 180 farmers were interviewed from these Woredas.

Table 2: Sampling for the household survey

Woreda	Sampled Kebele	Sampled Household Size		Total number of households sampled
		Adopter hhs	Non-Adopter hhs	
Arsi Negele	Ali Woyo, Gorbi Derera	50	10	60
Shashemene	Idola Burka, Alache Erebete	50	10	60
Siraro	Fande Ejersa, Lencha lama	50	10	60
Total	10	150	30	180

4. RESULTS AND DISCUSSIONS

4.1 Dissemination, Adoption and Impacts of the MCTs

4.1.1 Descriptions of Study Households

Threshing of cereal crops in West Arsi Zone are mainly done by animals and/or with multi-crop threshers. Small and marginal farmers with insignificant amount of production use traditional methods of threshing. These methods are expensive, time consuming and heavily result in loss of grains. In recent years, farmers with larger quantity of production normally follow mechanical methods which are less time consuming, generate better quality of grains, are less expensive and reduce the loss of grain in the threshing operation.

The characteristics of study participants in the household survey are described in Table 3. The average experience in farming activity of the sampled households is 20 years. The mean area cultivated is 1.3 hectares. Less than 1% of the interviewed farmers rented land in or out, or are involved in share-cropping arrangements indicating farmers' reliance on own farm land.

Table 3: Average Farm Experience (in years) and area cultivated (in hectare)

Description	All Woreda	Arsi Negele	Shashemene	Siraro
Experience in primary occupation, in years	20.01 (11.2)*	22.93 (10.64)	19.03 (12.28)	18 (10.29)
Dominant Primary Occupation	Farming	Farming	Farming	Farming
Total Cultivated Land	1.148 (0.82)	1.27 (0.9)	0.93 (0.63)	1.23 (0.87)
Owned Land	1.33 (0.86)	1.5 (086)	1.01 (0.76)	1.46 (0.86)
Rented in land	0.13 (0.35)	0.12 (0.36)	0.15 (0.3)	0.12 (0.37)
Rented out land	0.013 (0.08)	0.02 (0.11)		0.02 (0.09)
Crop Shared in Land	0.09 (0.42)	0.08 (0.22)	0.15 (0.67)	0.03 (0.15)
Crop Shared out land	0.01 (0.06)	0.02 (0.09)		0.01 (0.06)

*The figures in parenthesis are standard deviations

Source: Survey 2013

The sample households have about 2 oxen on average, which is less than the national average[1]. Furthermore, only 120 out of 180 interviewed households indicated that they have oxen. This indicates the relative shortage of domestic animals in the area. This has contributed to the quick dissemination of multi-crop threshers in the area. Average holding and estimated value of different livestock types are indicated in Table 4.

Table 4: Number and total value of livestock by type

Description	Livestock ownership, average per hhs	Estimated Mean Value (BIRR) per hhs, in 2013
Ox (n=120)	2 (0.77)*	7248.33 (5153.93)
Cow (n=114)	2 (2.11)	5174.56 (4849.37)
Bull (n=47)	1 (0.46)	2440.43 (1525.39)
Heifer (n=56)	1 to 2 (0.66)	2223.21 (1268.93)
Calf (n=77)	1 to 2 (0.73)	1499.35 (1587.54)
Donkey (n=101)	1 (0.55)	1760.89 (1273.88)
Sheep (n=30)	2 to 3 (1.43)	1225.33 (566.76)
Goat (n=45)	3 to 4 (2.44)	1803.33 (1465.92)
Horse (n=4)	1 to 2 (1)	3500 (1914.85)
Mule (n=1)	1 (0.0)	8000 (0.00)
Chicken (n=72)	5 to 6 (4.02)	314.17 (520.73)

*The figures in parenthesis are standard deviations

Source: Survey 2013

The mean distance travelled to the nearest all weather road is 1.4 km. Farmers, on average, travel 3.9 km to sell or buy products in the nearest market, and about 3.8 km on average to reach the nearest Woreda town. The distance to the nearest FTC among the sampled households is 1.8 km.

Table 5: Average distance in KM to access nearest road, market, Woreda town, FTC and threshers

Distance	All Woreda	Arsi Negele	Shashemene	Siraro
To the nearest all weather road	1.43 (1.53)*	1.31 (1.32)	1.25 (1.08)	1.75 (2.02)
To the nearest market	3.86 (1.8)	4.47 (1.56)	3.63 (1.90)	3.48 (2.26)
To the nearest Woreda	3.82 (1.91)	4.37 (1.24)	3.42 (1.90)	3.67 (2.30)
To the nearest FTC	1.82 (1.79)	1.08 (0.99)	2.17 (2.02)	2.23 (1.98)
To travel to rent a thresher	1.63 (1.26)	2.27 (1.56)	1.37 (1.19)	2.14 (0.95)

*The figures in parenthesis are standard deviations

Source: Survey 2013

[1] The national average holding of oxen per household is roughly higher than 2 (CSA, 2012).

Production and productivity is enhanced when farmers utilized improved variety of crops with a potential of producing high yield per hectare of land. In this study, only 25 % of teff growers used improved teff varieties, and for wheat, it is 48%, while 68 % of the farmers interviewed indicated that they used improved maize varieties. Given the predominance of maize production in the area, a wide adoption of improved maize varieties is expected (Figure 3).

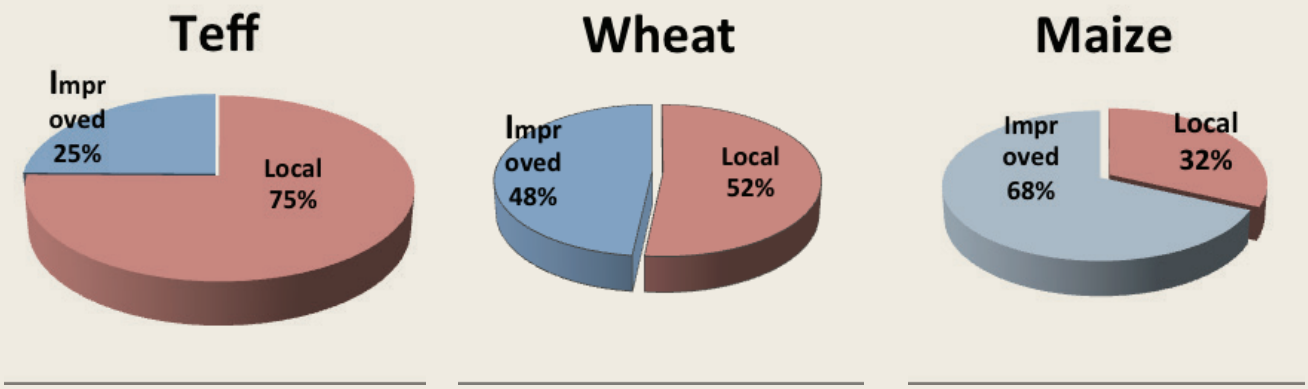

Figure 3. Crop variety cultivated by the sample households

Source: Survey 2013

Teff and wheat are the most marketable cereals in the survey area and are also produced over the two seasons. While roughly 20 - 25% of teff and wheat production are consumed at home, significant proportion of teff and wheat are produced for marketable purposes. In the case of maize, more than 50% of the production is utilized for home consumption.

Table 6: Average area cultivated, production, sale and consumption by household in 2012/13

Description	Teff -Meher (n=139)	Teff - Belg (n=139)	Wheat - Meher (n=88)	Wheat -Belg (n=88)	Maize -Meher (n=118)	Maize -Belg (n=118)	Barley -Meher (n=7)
Area cultivated (ha)	0.38(0.46)*	0.13 (0.28)	0.66 (0.65)	0.03 (0.14)	0.60 (0.364)	0.01 (0.08)	0.32 (0.30)
Output Produced (qtl)	3.40 (3.81)	1.31 (2.89)	15.35 (13.37)	0.32 (2.28)	15.01 (10.71)	-	3.43 (0.78)
Amount consumed (qtl)	1.43 (2.30)	0.53 (1.27)	3.74 (3.20)	0.20 (1.52)	8.06 (5.66)	-	3.28 (0.95)
Amount Sold (qtl)	1.88 (2.64)	0.85 (2.14)	9.72 (12.31)	0.27 (2.03)	6.13 (7.35)	0.03 (0.37)	0.14 (0.37)

*The figures in parenthesis are standard deviations

Source: Survey 2013

4.1.2 Dissemination of the Multi-Crop Threshers

Multi-crop threshers are widely disseminated in West Arsi area. Almost every farmer recognized the benefits of multi-crop threshers in the area. SG2000 introduced the technology in West Arsi area in 2003, and it took less than a year to get farmers' acceptance, particularly in Shashemene Woreda. Private ownership was the main reason for fast adoption and use in the area. In Shashemene, the number of threshers increased to 144 in 2013, owned by 121 households . These threshers provided services not only in Shashemene but also to farmers in nearby villages like Arsi Negele, Wendo, Siraro, Shala, Bale and Borena[2].

MCTs are popular beyond Shashemene and West Arsi areas. Currently, SG2000 is promoting MCTs to more than 36 Woredas in the country. In Semen Belesa Kebele of Hadiya Zone in SNNP, the machine was so popular that farmers were queuing to get their produce threshed. The machine operated in adjacent kebeles as well and farmers expressed their satisfaction with the efficiency and quality of MCTs processing. The same trend was also observed at Enebi Chifar and Borebore kebeles of Amhara region. The youth in the visited areas were also interested to form a group to run a threshing business.

In all the kebeles in Shashemene, Arsi Negele, Siraro, Semen Belesa, Awabel and Dejen, the farmers are now aware of the importance of MCTs. This study interviewed 180 farmers on their awareness about the MCTs and about 94% of them heard about the availability and use of MCTs from fellow farmers. Around 72% of the interviewed households indicated that teff threshing with MCT fetches a premium price.

At Awabel Woreda, the study observed the benefits of the threshers. The price of oxen was on the rise and many interviewed farmers kept their oxen away from threshing so that they gain better fattening and dairy outputs. The crop productivity of the area was also very high and hence potentially profitable for private thresher service providers.

Almost all interviewed farmers in West Arsi, Semen Belesa, Awabel and Dejen areas indicated that they prefer to use MCTs instead of the time consuming and labor intensive traditional method. Saved time will allow them to do other agricultural activities. They nevertheless cannot get timely and efficient service due to the shortage of machines. Many therefore still depend on oxen threshing although readily willing to use the machines.

For kebeles that are recently introduced to the machines, there is a periodic growing demand for MCTs. At Enebi Chifar, farmers in the neighboring kebeles like Duche, Lega and Wegel have demanded machine servicing. A similar request was also made by farmers living in Semen Belesa Kebele of SNNP. Demand growth of Enebi Chifar Kebele of Awabel Woreda is exhibited in Table 7 as an illustrative case.

Table 7: Farmers used MCTs by year at Enbi Chifar Kebele at Awabel Woreda

Year	Number of farmers used thresher
2011	36
2012	84
2013	171

Source: Records from Crop Expert DA at Enbi Chifar Kebele

[2] According to MoA Crop Expert in Shashemene, 2013

In some other SG2000 project Woredas the dissemination was not as fast as the case in West Arsi area. Primarily, early introduction, availability of market for spare parts, maintenance and entrepreneurs to invest on the machines clarifies the success in West Arsi than elsewhere. Motivation of extension agents, productivity of the area and farmers' willingness to test new technologies also influenced the success of dissemination.

Figure 4. A Thresher owner transporting MCT from Shashemene to nearby woredas, to Siraro and Arsi Negele

4.1.3 Postharvest Extension Learning Platforms (PHELPs)

The Postharvest Extension and Learning Platform (PHELP) are physical structures equipped with a relevant package of postharvest handling technologies. A PHELP comprise one thresher or sheller, grain cleaner, a donkey cart, a drying canvas (tarpaulin). Using the facilities, a series of trainings and demonstrations are conducted to create farmers' awareness on the utility, management and benefit of the MCTs.

SG2000 promoted the Multi-crop Threshers in almost all regions of the country by establishing Postharvest Extension and Learning Platforms (PHELPs) in selected FTCs. The MCTs were placed at the FTCs/kebeles and a series of trainings and demonstrations were conducted to popularize the machines. These promotions were effective as increasing number of farmers were using the MCTs, and that also made private threshing services attractive with good profit.

The PHELPs created demand for the machines. More than 60% of farmers in the surveyed kebeles got information on improved technology for threshing from the PHELPs. In the study sites, a number of farmers were registered and were waiting for the threshing services. In Semen Belessa, Horda Qawisa, Enebi Chifar and Dirre Jibo kebeles, at least 30 farmers were registered for the service. In Enebi Chifar

kebele, 351 farmers registered and 172 farmers received service in 2012. Burt, in 2013, 506 farmers registered and only 38 farmers used the thresher as the machine was not working properly.

In kebeles where the machines stayed longer, farmers' exposure was also higher. However, the promotion and provision of services by PHELPs in some kebeles like Dhankaka, Wakkene, Ula Boro, Haro Boro was limited and hence only few farmers either knew about the machines or received services.

Table 8: MCT Demonstrations and promotions at FTCs (PHELPs) and kebeles of SG2000 project sites

Region	Woredas	FTC/Kebeles where there are Multi-cop threshers
Amhara	Chilga	Chandiba, Sertia, Zala Shumugie, Negade Bahar and Chalia
	Yilmana Densa	Adet Zuria, Mesobo, Kilit and Abika
	Gagusa Shukudad	Zagera, Wonjela, Gusha Shunkurta, Baguna
	Dibay Tilat Gin	Kuyi Zuria, Jeremis, Deberyesus, Yedema, Debit, Nabera Yebelat
	Awabal	Enabi Chifar
	Dejen	Borebor and Yetenora
	Bure	Zarema
Benishangul Gumuz	Dibate	Perzeit and Zigih
Harari	Dire Teyara	Dire Tierra and Myiayi
Oromia	Leka Dullecha	Bandira, Horda Qawissa, Bedho, Diga Fododo, Gute Jarte, Gerecho, Karu, Negeso and Bollo
	Debre Libanos	Wakene, Dirre JIbo, Sone, Goro Wirtu and Salle
	Ada'a Berga	Ula Gora, Haro Boro, Ejere Negewo and WareIlu
	Arsi Negele	Gubete Arjo, Keraro, Rafu Hargisa, Ali Woyo and Gorbi Derera
	Shashemene	29 Kebeles
	Ada'a	Dankaka
	Siraro	Fande Ejersa and Lencha lama
SNNP	Gumer	Aselecha, Bordena Denber, Jomboro, Abikie and Arekit
	Aleta Wondo	Gerbicho Kell
	Lemmo	Semen Belessa
Tigray	Medebay Zena	Adikemale, E. Tsadi, Kulu Feriha
	Hintalo Wajirat	Hewane, Adigudom and Andiwoyane
	Tsegede	Dedebit
	Alamata	Garjele
Somali	Shinille	Berak
	Tulu Guled	Tulu Guled
Gambela	Dima	Koy
Afar	Awash	Refoda

Source: SG2000 Ethiopia, Postharvest Theme, 2014

This study indicated that there was limited use of the MCTs that were stationed at FTCs outside Shashemene and the surrounding Woredas. Since 2011, about 442.8 tons of crops were processed by 22 threshers in different kebeles (FTCs) and provided services for about 801 farmers. This means that the machines threshed only 8% of their expected capacity assuming that each machine should operate for 320 hours in one season (see Table 9). In other words, each machine threshed only 20 tons from a possible of 168 tons in two seasons. Therefore, the 22 machines operated for only 1,214.7 hours (9.9%) out of the expected 12,160 hours over the two seasons. Frequent breakdowns of machines were one of the main reasons that contributed to this performance. For example, out of 17 machines visited in September 2013, only 8 were functional while the rest (9) needed maintenance.

Table 9. Performance of threshers in visited project kebeles (2011-2013)

S.No	Kebele (owner)	Year Given	Quantity threshed (ton)	No of Farmers used	Rated/Potential capacity (in ton)
1	Dhankaka	2010	6.2	13	336
2	Semen Belessa	2010	22	65	336
3	Bandira	2011	12	68	640
4	Horda Qawisa	2012	0.5	13	112
5	Digga Fododo	2012	0.4	5	640
6	Badho	2012	5.4	12	640
7	Jarso Gute	2012	0.8	5	224
8	Dire Jibo-thresher	2012	52.6	15	224
9	Wakkene-thresher	2012	0.5	4	224
10	Salle-thresher	2012/13	0.3	3	112
11	Enebi chifar-thresher	2010	120	283	336
12	Burdana Dembor	2011/12	25.4	48	224
13	Ula Gora	2013	10.4	8	112
14	Haro Boru	2013	9.2	27	112
15	Adega	2013	34	58	112
16	Wanjella	2011/12	12.4	37	224
17	Guasha	2012/13	12.9	15	112
18	Zagra	2012/13	0	0	112
19	Debre yesus	2012/13	94.5	86	112
20	Kuy Zuria	2011/12	1.2	2	224
21	Sertia	2012/13	11.2	17	112
22	Chandiba	2011/12	10.9	17	224
	Total		**442.8**	**801**	**5504**

Source: Field survey in September 2013 and monitoring reports in February 2013

Encouraging private entrepreneurs to acquire the machine is very crucial for improved dissemination and promotion of the MCTs. Some of the owners indicated that operating and maintaining was a huge challenge once they acquired the machine. Therefore, providing maintenance training and availability of spare parts is also vital.

Some of the major problems reported by users regarding the MCTs included:

- Lack of adequate trained operators: SG2000 provided training for operators but there was a high turnover of trained operators.
- Lack of user-guide manual: It is useful to have a manual guide as well as a document in local languages on basic maintenance.
- Lack of skilled individuals to maintain the machines and limited access to spare parts.
- In some areas, machines are hauled by thin metal wheel drives and it is recommended that standard car wheels be used for easy transportation by donkeys.
- Lack of awareness: Awareness can be facilitated by a government body.
- Initial acquisition price of the machine: It is better if acquisition of the machine is facilitated via credit

Figure 5. Demonstration of the MCT

4.1.4 Adoption of the Multi-Crop Threshers

The adoption of improved agricultural technologies is often recognized as a critical aspect in addressing rural development. This study indicated that there is high rate of adoption of the threshers in the study sites. About 81% of teff producers in Shashemene, Arsi Negele and Siraro Woredas used the MCTs. Twenty nine of the 37 kebeles in Shashemene Woreda use MCTs for threshing. The eight kebeles, which do not use the MCTs, produce teff in little quantity but produce wheat, barley, maize, and potato. In Arsi Negele and Siraro Woredas where two-third of the farmers grow teff, multi-crop threshers are used. In Arsi Negele Woreda, all (43) except nine kebeles use MCTs. It was observed that the nine kebeles who do not use MCTs do not grow teff as a main staple. They instead produce wheat, barley, maize and potatoes. Similarly, in Siraro Woreda, all the kebeles (28) utilize MCTs for threshing. Many farmers in Siraro began producing teff only recently. Introduction of threshers in the area is one of the major factors for farmers in this area to produce teff since the MCTs had assured them that threshing can be done on time.

Demand for MCTs threshing service is on the rise. In SG2000 intervention Woredas of Amhara and SNNP Regions, there is an increase in multi-crop thresher use by smallholder farmers. Interview with key informants (farmers and experts) concur on the increased acceptance of threshers in Semen Belesa, Borebore and Enebi Chifar kebeles and in adjacent kebeles of Amhara and SNNP Regions. There are also inclinations by private individuals in these Regions to run the business for profit.

The main reasons indicated by the study households for adopting MCTs were as follows:

- Speed of threshing which saves time – four hours of threshing that used to take about 3-4 days under traditional methods;
- Labor cost is significantly reduced – only four persons are required unlike the traditional method which requires a larger number (about 8 persons) for effective threshing of similar amount of cereals;
- The quality of crop threshed is highly enhanced as there is no mixing with sand, soil, urine and dung of animals as was the case in the traditional method;
- The crop loss in the threshing process is highly reduced due to effective threshing which reduces un-threshed seeds, produce eaten by animals, losses in earth cracks in the threshing areas and spillovers and;
- The absence of animals in the threshing process. Animals instead become marketable products generating income for farmers.

Among the surveyed households, 67% indicated their full satisfaction with multi-crop threshers and only 0.6% of the households indicated dissatisfaction (Figure 6).

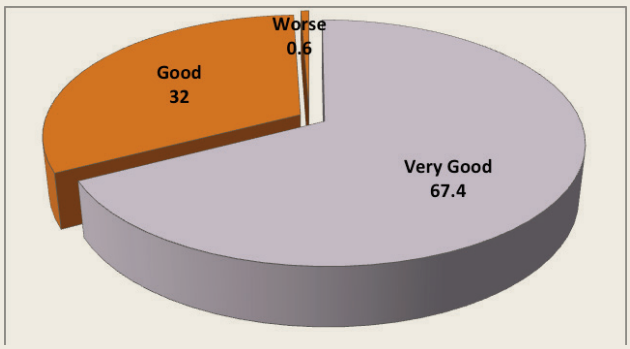

Figure 6. Farmers' perception regarding multi-crop threshers

Source: Survey 2013

Most households have indicated that they use the MCTs for threshing teff[3]. Over 81% of the sampled households use MCTs for teff threshing, but in the case of Shashemene, more than 90% of the farmers use MCTs for threshing teff . About 10% used MCTs for wheat. A majority of wheat producers in Arsi Negele use combine harvester which allows them to harvest and thresh wheat at the same time. They indicated that MCTs are not good for wheat threshing as threshing results in grain breakage and makes the wheat unsuitable for seeding purposes.

Farmers accessed the multi-crop threshers either by calling the owner or by travelling to the owners' houses or by renting. Most (64%) farmers indicated that they use mobile phones to rent the thresher. This indicates the importance of mobile phones in business relations among farmers. Multi-crop thresher owners move from house to house to deliver threshing services. However, due to the limited number of threshers with the increasing demand for threshing services necessitated the setting up of appointments.

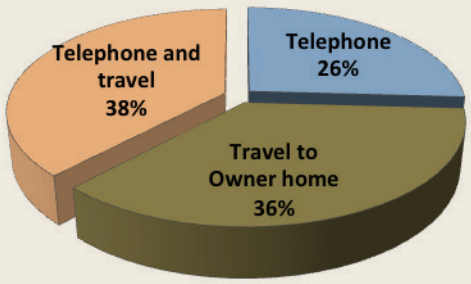

Figure 7. Method of accessing MCTs

Source: Survey 2013

4.1.5 Impacts of the MCTs

How has the adoption of threshers affected livelihoods of poor people in the study area? The question is not easily answered, both for conceptual and practical reasons. From a theoretical point of view, the concept of well-being is slippery that can be measured in many different ways (e.g., in terms of wealth, disposable income, living standards, health, life expectancy, political freedom, social status, economic opportunity, or gender equality). From a practical point of view, these indicators are often difficult and/or expensive to measure empirically.

Consequently, the evidence on project impacts is best captured using both quantitative and qualitative assessments. Impact also includes the change in cropping pattern, food and income security as well as labor displacement which are direct or indirect results of loss reduction and time and labor saving. The end result of the benefits from MCTs use is improvement of food security, employment and the rise in income for smallholder farmers and service providers.

4.1.5.1 Major Outcomes and Changes in the Study Areas

Shift in Cropping Patterns

One interesting finding of this study (also in Dejene et al, 2008) was the shift in cropping pattern in the study areas (Table 9). More and more of the total available land in West Arsi area was being covered by

[3] Expert interview, 2013

teff - over 50% of more land in Shashemene Woreda was covered on teff in 2012. Teff has also become one of the major cash crops in Shashemene. For example, in Edola Burka Kebele in Shashemene, farmers who previously had covered their Belg season land with potato shifted more land to teff. The main reason for this was the availability of improved technologies like MCTs. Improved agronomic practice, like line planting was also additional factor. Other factors for shifting production in favor of teff included better market price of teff and suitability of producing teff in low rainfall environment.

Table 10: Cropping pattern Shift towards teff plantation in Some Kebeles of West Arsi

Some Kebeles in West Arsi	Season	2010	2011	2012
Edola Burka Kebele – Shashemene	Belg (in ha)	300	400	500
Edola Burka Kebele – Shashemene	Meher (in ha)	60	70	80
Aliwoyo Kebele - Arsi Negele	Meher (in ha)	261	280	301
Kersa Meja Kebele - Arsi Negele	Meher (in ha)	260	294	300
Siraro Woreda	Meher (in ha)	2900	3839	4005

Source: Recordings from Crop Expert DAs in respective kebeles and Woredas

This study found that dissemination of MCTs in West Arsi Zone influenced teff production in the Woredas. In Siraro Woreda many farmers began producing teff very recently. According to interview with the Woreda agricultural expert, teff production in the Woreda carries a history of approximately five years. The introduction of threshers has helped farmers in the area to produce large quantities of teff.

With the introduction of MCTs in the Shashemene area, teff production has increased from 9,797 hectares in 2003 to 13,416 hectares in 2013. According to a study by Dejene and Wondwossen (2008), the improved production of teff is partly attributed to the good quality of teff threshed with the MCTs which had also resulted in increased price of teff. Production of quality teff increased teff demand. Millers in Addis Ababa pointed out that teff from Shashemene has over the recent years gained great acceptance by Addis Ababa dwellers.

The significant diffusion of teff-threshers in Shashemene Woreda may be explained in terms of the following benefits: a) quality improvement as the mechanical threshing keeps the grain free of sand; b) time and labor saving benefits; c) social benefits as the mechanical threshers have brought about employment opportunities; d) relieving women from the tedious and laborious job of threshing on the ground (awdima) as well as preparing the threshing floor itself; and e) reduction of loss mostly associated with the traditional way of threshing.

MCTs Reduce Crop Loss

Use of the mechanical thresher significantly reduces grain losses as compared to traditional method. The traditional way of teff threshing is associated with high losses which is found to be about 83 kg per 1 ton of cereals threshed. Asfaw et. al., (2010) and Dejene and Wondwossen (2008) estimated the loss in traditional threshing up to about 10% of the produce. The data from the household survey came up with roughly similar percentage of loss during threshing. For teff, the loss is 9.2% while for wheat the loss amounted to 7.5% [4].

[4] This figure is obtained based on farmers' interview/estimation than actual calculation of crop loss, which this study strongly recommends for future study.

The loss in traditional method is quite pronounced as compared to the MCTs which are by far very low. When teff is threshed with MCT, farmers indicated that they lose around 2.5 kg per 100kg.
The traditional method of threshing is prone to significant quantity and quality loss. For threshing purpose, the teff straws and grains are spread over a plastered floor. The significant loss is due to the scattering of crop, un-threshed crop remaining in the straw, mixture with dung and urine and the amount eaten by the livestock when they thresh the crop. In some areas the teff is also threshed by beating with stick which is very tiresome, time consuming and also wasteful as the stick throws away teff sheaves with seed.

Table 11: Average Crop loss during threshing

Crop type	MCT (in kg)	Traditional Method (in kg)		
	Amount threshed	Loss	Amount threshed	Loss
Teff (n=124)	427 (3.97)	11 (0.06)	438 (0.98)	41 (0.55)
Wheat (n=16)	1325 (8.41)	29 (0.44)	244 (5.92)	18 (0.93)

The figures in parenthesis are standard deviations
Source: Survey 2012

The Multi-Crop Threshers Save Labor, Time and Cost

Farmers save considerable time and labor using MCTs. Threshing about one ton of teff usually requires 2-3 hours and 3 man-days by mechanical threshing whereas 10 oxen-days and 4-5 man-days are required if it is done traditionally. Dejene and Wondwossen (2008) estimated net saving of about 20.5 man-hours and 4 oxen-days getting 1 qtl (100 kg) of teff processed mechanically. This is particularly true in areas where farmers produce smaller amounts of teff (like Shashemene) and they do not need to prepare awdema. They use the plastic sheet (tarpaulin) to line the ground for threshing, and 2-3 men are enough to thresh and winnow.

A study by Asfaw et. al., (2010) also indicated that the traditional method of teff threshing is labor and oxen power intensive. At a time, the labor required per teff threshing operation is 4.5 man-days while about 11 oxen-days are required. The field capacity of traditional teff threshing was estimated at 5 quintal/day, the time worked per day being 10 hours. The traditional methods of teff threshing by live animals' foot trampling and hand beating are not only time consuming but also tiresome and arduous operations. Due to this and other arduous farming operations, young people in rural areas have become less enthusiastic about teff farming.

Use of the MCTs saves energy and cost. It on average saves around Birr 73.2 per 100 kg of teff threshed as compared to traditional method of threshing (see table 12). The benefits of threshing by the MCTs is high, particularly for a smaller quantity of teff. This is because the canvas is enough for smaller quantities of teff. There is no need to prepare the plastered floor called "awdema." For larger quantities of teff, the MCTs still save time and labor but not as significant as smaller quantities. In Shashemene and surrounding areas, the production of teff per household is not high. Survey by SG2000 in 2013 indicated that the average teff production per household in Shashemene and Siraro Woreda was 0.47 tons while it was 2.8 tons in Ada'a Woreda. This could be one factor that contributed to higher adoption in Shashemene area while it is slower in Ada'a Woreda.

Below is cost estimation for threshing 1 ton of teff using both the traditional and mechanical methods. It compares the total cost of threshing teff traditionally and using a rented thresher. Data for this estimation was gathered from different sources including field observations and expert interviews.

Table 12 Threshing costs using traditional and multi-crop thresher

Cost Items	Cost of Traditional threshing (in Birr)	Cost of Mechanical threshing (in Birr)	Remarks and explanation
Labor for threshing 1 ton of teff	225	150	4.5 persons for traditional and 3 persons for mechanical*50 birr per day
Oxen rental payment [5]	330	0	For breaking the straw oxen may be needed
Service fee	0	183	70 birr per hour*2.6 hours
Meal for laborers	180	120	40 birr per person per day
Estimated threshing loss [6]	750	300	Threshing loss is estimated to be 5% in traditional and 2% in mechanical
Total cost for 1 ton	1485 Birr	753 Birr	
Cost per quintal (100 kg)	148.5 Birr	75.3 Birr	
Net cost saving per quintal (100 kg)		73.2 Birr	

Note: This estimation assumes no significant difference in price of teff threshed by the two methods.
To calculate the above figure, the following information/assumption were used;

1. The farmer (service receiver) is expected to pay 70 Birr per hour as service fee
2. Labor cost is 50 birr per day for ordinary worker and 70 birr for operators
3. In 1 hour the machine can thresh 3-4 quintals
4. Operators' cost is covered by the owner and other labor is covered by the service receiver
5. It is reported that threshing one ton of teff takes one day for 4-5 men and 10-12 oxen in traditional way and takes 2.6 hours for 2 operators and 3 assistants.

Similarly, a study by Asfaw et. Al., (2010) also indicated that the mechanical threshing resulted in significant cost saving over traditional method of threshing. The net private cost savings in switching from traditional to mechanical teff thresher were 31% per hour, 96% per 100 kg and 96% per hectare of teff threshed. The cost of teff threshing using traditional method of threshing was estimated at 114 Birr/hour, 227 Birr/100 kg, or 4550 Birr/hectare while for the mechanical teff thresher the costs were estimated at 79 Birr/hour, 10 Birr/quintal, or 197 Birr/hectare.

[5] There is no market for threshing oxen, this is based on estimation by farmers and previous studies (Asfaw et. al, 2011)
[6] Estimated postharvest loss is given in Annex B.

MCTs Improve Quality

Use of the MCTs improve quality of produce and thus fetch better price, particularly of teff. Teff threshed by MCT can fetch an average price of over Birr 25 price premium per quintal in comparison to that threshed in the traditional method. In some areas the price difference is over Birr 100 per quintal. The reason for this huge price difference is that MCT threshed teff is clean and is not mixed with dung, animal urine and soil impurities. In addition, it is also free from straw which makes it preferable in the market.

In Shashemene area, the quality of teff before the introduction of MCT was poor because of the impurities. Mechanical threshing (example the use of MCT), unlike traditional threshing, kept the grain free from sand. Consumers had historically considered teff from Shashemene as inferior in quality because of kechkech (sand mixed with teff). After the adoption of MCT, teff from Shashemene had become popular and received premium price in the market. In 2008, farmers received 60 Birr per quintal (100 kg), and this has currently increased to 80 birr per quintal. Similarly, the household survey indicated that around 72% of interviewed households reported teff processed with MCT fetched a premium price in comparison to the traditional method. Moreover, demand for animal trampled teff was very low as buyers preferred quality teff processed by the MCT.

But in the case of wheat, the price was lower for MCT threshed one. Since the machine breaks the wheat kernel while threshing, it reduces the price premium of wheat threshed by MCT. The interviewed farmers in West Arsi indicated that they preferred combine harvester (predominant method for wheat harvesting in the area) for threshing their wheat. However, this result requires further study and analysis as in some areas wheat producers appreciated the machine's performance for wheat as well. The problem could be due to improper operation of the MCTs while adjusting the machine for a particular crop, which suggested need for intensive training to machine operators.

Table 13: Crop price (per 100 kg) differential due to threshing methods

Crop Type	Traditionally threshed	Threshed with MCT
Teff (n=138)	997.6 (817.96)	1025.6 (296.15)
Wheat (n=16)	682.5 (126.62)	642.5 (154.29)

The figures in parenthesis are standard deviations
Source: Survey 2013

Perception and suggestion of farmers on the threshers

Interviewed farmers positively rated the MCTs as compared to traditional threshing methods. The farmers indicated that crop loss is low in MCT in comparison to traditional method. Crop quality (in terms of purity from foreign matters) is good in case of MCT. More labor is demanded in traditional threshing. Time required to thresh is shorter in case of multi-crop thresher. The quality of byproducts as a roughage for animal feed is perceived to be equal. Few farmers indicated that the byproduct of crop from traditional methods is good for cattle feed since mechanical threshing does not finely crush the straw, while others prefer the byproduct from MCT for animal feed as the traditional one is poor quality due to mix with dirt (urine and dung).

Table 14: Rating for different parameters under different threshing methods

Description	MCT	Traditional
Crop Loss	---	+++
Crop Quality	++	--
Labor	-	+
Quality of By Product	=	=
Time consumption	---	+++

Source: Survey 2013

However, as the number of threshers increased during the harvesting season, the demand for maintenance and servicing of the machines also increased. As indicated from key informant interviews, many thresher owners trained their younger household members to do machinery maintenance and repair and now run local garages to provide services for threshers. At the same time, the market for spare parts ordered from Addis Ababa is also on the rise.

Farmers indicated that they want more threshers to operate in their areas. To this end, they suggested the following as solutions:

- Access of threshers via credit as buying them on cash may be difficult. The credit scheme could be with an individual or group.
- Motorized transportation instead of animal hauling: This enables them to get it quicker when they want it.
- Increase the threshing power of the threshers: Some said operators sometimes reduce the power so that they could charge excess hours.
- Farmers requested for fair user price. According to some, the current price is relatively expensive.
- Some farmers also indicated that they want the MCTs to have winnowing service.

4.1.5.2 Private Service Provision Using MCT as a Viable Business Model

The study attempted to demonstrate profitability of private service providers (MCT owners) by looking at cash flow of benefits minus costs. Since both costs and benefits occur over different periods of time, the measurement of all costs and benefits must be carefully and logically worked out. Currently, the two widely employed approaches are through the use of either the present value concept (in which all future streams of net return are discounted) or the internal rate of return concept.

Characteristics of the Thresher Owners

The interviewed owners indicated that they have on average 17 years of farming experience. They indicated that they cultivated an average of 1 hectare of land. Few also cultivated land by renting and were also involved in crop sharing schemes (Table 15).

Table 15: Owners experience and area cultivated (in ha)

Description	Mean
Experience in farming	17.25 (8.41)
Total Cultivated Land	1.03 (0.72)
Owned Land	1.35 (0.82)
Rented in land	0.1 (0.21)
Rented out land	0
Crop Shared in Land	0.2 (0.28)
Crop Shared out land	0

The figures in parenthesis are standard deviations
Source: Survey 2013

The interviewed thresher owners are all capable of reading and writing as 50% attained junior and secondary level education while the remaining 30 percent attended high school and above. This indicated the importance of education in farmers' decision to adopt a technology since literate farmers tend to be more willing to acquire MCTs.

Table 16: Educational background of thresher owners

Description	Percent
Primary Education	20
Junior Secondary Education	50
10th grade	20
University degree	10

Source: Survey 2013

With regard to use of improved technologies, around 85% of the owners indicated that they planted improved crop varieties. This showed that thresher owners are also more likely to adopt other improved agricultural techniques (Figure 9).

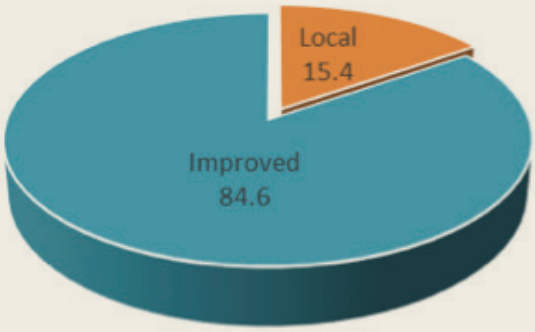

Figure 8. Crop variety planted by Thresher owners

Source: Survey 2013

Profitability of the Threshers (based on survey of MCT owners, in 2013)

A single thresher in Shashemene served about 320 farmers and obtained a total revenue of Birr 86,000 from threshing service in two seasons in 2012. The service fee per farmer was Birr 270 (as most of them use the machine for roughly 3 hours at a price of Birr 90 per hour).

Table 17: Number of farmers a single MCT served in the two seasons in 2012

Number of users in	Mean
Belg	166.5 (151.47)
Meher	153 (75.13)
Total	320

The figures in parenthesis are standard deviations
Source: Survey 2013

Feasibility analysis of investment was divided under four groups which are initial investment, annual fixed cost, annual variable cost and returns. Initial investment is the cost initially incurred for the purchase of multi-crop thresher, oil engine, cart and canvas by the owner. This cost also includes sales tax, accessory and transportation charges. Depreciation charges were calculated using the straight-line method.

Thresher owners (50% of them) reported that they set service fee depending on operation costs. When the fuel price goes up or when the cost of labor in the area changes, they also change their service price. About 30% indicated they incorporate demand and threshing costs while setting threshing fees. While only 20% of the owners indicated that they set the threshing fee depending on the threshing demand in the area. Of the interviewed thresher owners, 90% say the threshing business is successful although there are a number of difficulties associated with skilled labor and spare part availabilities.

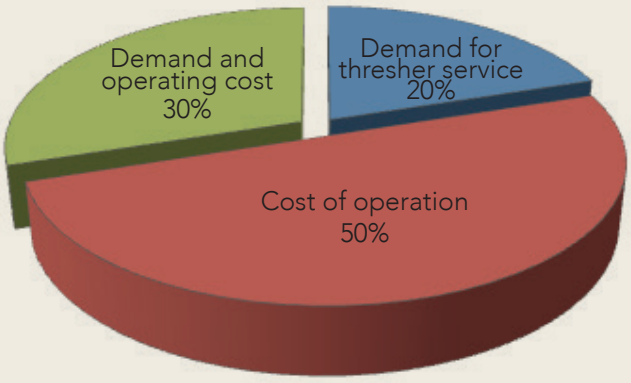

Figure 9. How owners set service fee (for thresher use

Source: Survey 2013

As shown in Table 18, annual operation days of the machine was found to be 93 (3.8 months x 24.4 days/ month). Given that the machines operate on average for 8.9 hours a day, the total working hours of the machine was about 825 hours a year. The average service fee per hour being Birr 103.57, the total gross benefit for owners per year was Birr 85,466.79.

Table 18: Average operating time and hourly renting fee

Activity	Mean
Operation months per year	3.8 (1.23)
Operation days per month	24.4 (8.09)
Operating hours per day	8.9 (1.79)
Average service fee per hour (in Birr)	103.57 (11.07)

Source: Survey 2013

The total acquisition cost that included the purchasing price of MCT, cart, canvas, donkey and other costs related to acquiring MCT were around Birr 54,000. Working 85 days per year, the total operating cost was about Birr 27,998.5 during the two threshing seasons. This made it a total profit of Birr 57,486.29 in subsequent years, assuming fixed renting prices.

Given the income generation indicated above, the payback period analysis showed that investment made on threshers could be recovered within one to one and a half years. The break-even point was observed to be 792.6 operation hours or 250 tons during the acquisition year and only 270 hours or about 90 tons per year in subsequent years (Table 19).

Table 19: Costs and benefits related to the MCT

Costs	Mean	Annual values
Total acquisition cost	53,800	54,000
Operator cost per day	183	183 X 85 = 15,555
Oil cost per year	836	836
Fuel cost per day	125.5	125.5 X 85 = 10,667.5
Maintenance per year	781	781
Other operating cost per year	53	53
Total cost acquisition year *		81,639
Total Benefit per year		85,466.79
Net benefits during the acquisition year		3,827.79

* Total running costs is 27,839.
Source: Survey 2013

The threshers were used below their potential capacity. The machines' utilization per day is 69%. In terms of operation days, they indicated that they utilized about 88% of the potential. In terms of threshing capacity per quintal (100kg) per day, they indicated that they utilized 58% of the potential. The reason for underuse of the MCTs is machine breakage and travel time spent in search of clients (Table 20).

Table 20: Capacity Utilization

Description	Potential	Actual	Capacity utilization (%)
Operating hours per day	10.1 (2.42)	7.05 (2.16)	69.8
Operating days	82 (87.3)	72.5 (75.91)	88.4
Capacity per day	24.7 (9.03)	14.4 (6.02)	58.3

The figures in parenthesis are standard deviations
Source: Survey 2013

Profitability of MCTs (based on in-depth surveys of selected owners, in 2014)

Multi-Crop Thresher (MCT) is a profitable business, although it requires high initial investment. A survey on 10 machine owners in Shashemene (in 2013) indicated that the total average investment for a thresher was about Birr 45,787. In 2014, the total investment required for a thresher business (including cart) increased to Birr 54,000[7]. The total operation cost (fuel, maintenance, depreciation, oil and labor) is estimated to be Birr 36,344 per season.

The MCT is highly profitable and worth investment, particularly in the Shashemene area. This was also confirmed by previous studies by Dejene and Wondwossen, 2010 and 2008, and Asfaw et.al, 2011. Analysis by this study also confirms this fact but with some conditions.

Results of this study showed that investment on the machine is worthwhile assuming efficient capacity utilization. The thresher is profitable provided that there are minimal breakdowns since significant interruptions reduce capacity utilization. In the Shashemene Woreda, the average actual operating hour is 7.1 hours per day and 26.2 days per month which is almost equivalent to its potential capacity. In other Woredas, on the other hand, the actual operation time of the machine is usually far below its potential capacity. Payback period of a thresher is estimated to be less than two years at 75% capacity.

With efficient capacity utilization, investment on the MCT generate good return. The Net Present Value (NPV) is positive (Birr 29,130), assuming that a machine's life is 7 years with a salvage value of 15,000 Birr and constant cash flow and 10 percent discount rate. The Internal Rate of Return (IRR) is 33% which is well above the current market interest rate. In financial analysis, if NPV is greater than zero or IRR is higher than the prevailing market interest rate, the investment is then worthwhile.

Table 21. Profitability analysis for Multi-Crop Thresher, 2014

Year	Estimated operation hours	Service fee	Gross benefits	Total Cost	Net benefits	Discount factor	Present Value (PV)
1	630	70	44,100	85,860	-41,760	0.91	-37963.2
2	630	70	44,100	29,542	14,559	0.83	12031.8
3	630	70	44,100	26,460	17,641	0.75	13253.6
4	630	70	44,100	26,460	17,641	0.68	11995.5
5	630	70	44,100	26,460	17,641	0.62	10937.1
6	630	70	44,100	26,460	17,641	0.56	9878.7
7	630	70	44,100	26,460	17,641	0.51	8996.7
NPV							29,130.2
IRR		33%					

To calculate the above figures the following information/assumptions were used

1. Service fee is 70 birr per hour (from field survey)
2. Fuel consumption per hour 1 liter (field information and machine profile)

[7] Purchase price for one thresher was 45,000 Birr, donkey 2,500 Birr and cart 6,500 Birr (total initial investment 54,000 Birr). Actual operating time of the machine in Shashemene area is about 4.6 months in a year, 26 days per month and 7 hours per day. Conservative estimation of the actual operation is taken as 75% of the above operation time considering unexpected breakdowns, travel time and other interruptions.

3. Labor cost is 50 birr per day for ordinary labor and 70 birr for operators[8]
4. Operators' cost is covered by the owner and other labor cost is covered by the service receiver
5. The discount rate is assumed to be 10% taking in to consideration inflation rate and interest rate

However, feasibility of the machine is low when actual operation time is below 75% of its capacity. In Dejen and Awabel areas, for instance, working days in a month can get less than 14 days because of frequent machine breakdowns. With about a 65% capacity, the payback period of the machine is over 3 years with a negative NPV (Birr -108) and less than 10% IRR. Negative NPV and low IRR indicates investment on the machine is now worthwhile in these areas.

High rate of breakdowns and failures of the machine reduces profitability and increases the payback period (over three years). Whereas, in Shashemene the payback period is mostly less than one production season since private owners have ample experience in using and maintaining the machines by themselves. Innovativeness of private owners in utilizing the MCTs with good follow up and maintenance has facilitated the promotion and use of the machines in Shashemene area. Outside Shashemene, there were only five private thresher owners providing threshing service to limited number of farmers. Most of the service providers were in Ada'a Woreda. Four of the private owners have threshed only 168 tons and provided services to 41 farmers. The low use can mainly be attributed to the machines' susceptibility to breakdowns which reduces profitability and increases the payback period.

A thresher owner in Ada'a, for example, reported that he did not rent out his machine for fear of breakdown of the thresher. Other reasons, reported by two private owners, include farmers' low demand as the machine mixes grain and chaff (ibiq) which needs additional labor time. Seasonality of operation can also explain the low use and demand of the machine. In most areas, the machine is utilized for limited months (maximum of 3-4 months) during the year, which implies that the machine remains idle for the rest of the year. On the contrary, successful entrepreneurs in the Shashemene area take their machines to other Woredas to provide services for longer months in a year.

Table 22. Status of multi-crop threshers owned by private owners

Owner – kebele	Year acquired	Quantity threshed (ton)	No. of Farmers used
Alemu Tesemma-Dhankaka	2010	61.5	16
Beyene-Qaxilla	2011	50.0	2
Dejene- Adulala	2011	45.0	8
Leta (Berek Woreda)	2013	11.4	15
Total	-	**167.9**	**41**

Source: Study team field survey, September 2013

4.1.6 Role of Private Entrepreneurs in the Promotion of MCTs

Private entrepreneurs played significant role in the dissemination and promotion of the use of the MCTs. SG2000 - Ethiopia introduced teff threshers in Shashemene Woreda and demonstrated on a field of a farmer. Then, it was a farmer turned businessman, Mr. Ayele Hirpo, who played a significant role in promoting the use of the thresher. He demonstrated his entrepreneurial skill through providing threshing service to his fellow farmers with a good profit. This allowed him to add two more threshers within two years. Following Ayele's footsteps other farmers in Shashemene, including his brother , have bought the thresher and provided service to almost all teff producers in Shashemene Woreda (see box 1).

[8] Labor (operators), oil, depreciation and interest costs are covered by the owner. Depreciation is calculated using Straight Line method (Cost less Salvage value divided by service life of the machine (7 years)).

The role of private entrepreneurs in promoting the use of the threshers was not only limited to providing threshing service to fellow farmers but also through their active engagement to continuously look for innovative ways of maintaining and operating the machine. Their active engagement also facilitated and encouraged active involvement of local private maintenance service providers in Shashemene. Had it not been for the entrepreneurs' creativity and business orientation, the promotion and dissemination of the threshers may not have reached current levels.

Box1. Private entrepreneurs; the case of Ayele and his brother, Furi

In 2003, SG2000 provided a mechanical thresher to a farmer named Ayele Hirpo, (a seventh grade complete), on credit, for 11,000 Birr. Ayele immediately adopted the new technology. He got an incentive from SG2000-Ethiopia in the form of debt cancellation (amounting to 5,000 birr) and a prize (i.e., a free cart). By the following year, Ayele bought another thresher which was followed by a third one. After having received training from SG2000, he managed to transfer skills of operating the equipment to his brother, who worked with him as an apprentice. Inspired by Ayele's success, his brothers and relatives followed Ayele's suit and bought their own threshers.

The postharvest Theme of SG2000 has been promoting the technology by giving training to those farmers who bought threshers from Selam Technical and Vocational College. Within a few years, the technology was adopted by most farmers who grew teff. Access to the technology was possible both through purchase and ownership of the equipment and through renting machines.

Following Ayele's footsteps and other successful entrepreneurs, his brother, Furi Hirpho, became a major player in the popularization of threshers and recently in maize shellers. Currently, Mr. Furi owns seven machines, (five threshers and two shellers). Unlike other owners, he effectively maintains and repairs the machines and uses them efficiently. Because of his experience and effective utilization of the machines, he was able to realize his return on investment in 2-3 months. In off- seasons, he travels to other places like Borena and Bale, over 400 kms, to exploit the market potentials of these machines. In addition to his business acumen, Mr. Furi has become a very important machine operator, maintainer and mechanic

4.2 Lessons from Successful Promotion and Adoption of MCTs

The dissemination and adoption of MCTs in West Arsi Zone, particularly in Shashemene Woreda was rapid and almost all farmers used the technology, while in other Woredas the dissemination and use was limited or was not as expected. The adoption and dissemination of the machines in different SG2000 project Woredas varies significantly. In Shashemene Woreda alone the 144 MCTs provided services to 14,050 households and threshed about 15,564 tons of teff in 2013. However, the number of farmers in 15 other SG2000 project Woredas who used the MCTs was not more than 2,000 and only about 450 tons of cereals were threshed by these machines in 2013.

The presence and active role of private owners and repair and maintenance service providers was one of the main reasons for speedy adoption and use of the MCT in Shashemene and neighboring Woredas. However, there were few private owners of MCTs in the new SG2000 project sites. Although MCTs were introduced and promoted in SG2000 project Woredas in different times/years, adoption rate (use) and dissemination of the MCTs depend on other factors additional to year of introduction. Hence, understanding the factors for low use of the MCTs is imperative for early and appropriate measures to

[9] This happened after about 4 years after SG 2000 introduced the MCTs in Shashemene

improve the promotion and dissemination of the MCTs in different Woredas.

This section of the study, therefore, intended to look into possible explanations of differences in the adoption and dissemination of the MCTs between SG2000 project sites.

4.2.1 Success Factors for the use of MCTs

The adoption of the threshers in West Arsi Zone was very high as almost all teff growers use mechanical threshers. The adoption (use) rate in 2013 was 81% in Shashemene, Siraro and Arsi Negele Woredas and those who did not use the machine reported not to have grown teff in that season. In Shashemene, there were 121 thresher owners who gave services to farmers in Shashemene and nearby Woredas like Arsi Negele, Wendo, Siraro, Shalla and Borena.

The number of threshers in Shashemene were about 126 threshers in 2008 and the thresher owners collected about 778,637 Birr (or USD 80,687) as revenue in aggregate. A study by Dejene and Wondwossen (2010) indicated that the threshers had been rapidly adopted in the Shashemene Woreda. The threshers served more than 23,684 teff producers, and generated 29.5 million Birr additional benefit to the community.

The following factors (some of which described in detail in the above section and summarized here) contributed to the wide adoption of the multi-crop thresher in Shashemene area:

i) Private entrepreneurs: In Shashemene area, active role and motivation of innovative entrepreneurs in introducing and promoting the use of the MCTs was very crucial.

ii) Access to road and plain topography: In Shashemene and its surrounding area, the use of donkey cart for transporting the MCT is common because of the plain topography and accessibility of roads to farm gates.

iii) Benefits of mechanical threshing: Major ones include;

   a. Improved quality of teff: MCT threshed teff received premium price of 60 Birr per quintal (100 kg).

   b. Labor time saved: Use of MCT saves about 20.5 man hours and 4 oxen days.

   c. Loss reduction: Use of MCT in Shashemene reduced grain losses by about 6% as compared to traditional method of threshing.

iv) Better sources of income: Farmers in Shashemene Woreda are relatively better-off mainly due to availability of cash crops and proximity to markets. The Woreda is known for cash crops like potato production and the town is also a hub for different commodities and hence high on trade activities. These enabled farmers to raise enough income (from cash crops and off-farm businesses) to acquire threshing services. Further, presence of a large market/town, Shashemene, they can get spare parts and fuel and maintenance services from private businesses like garages and shops.

v) Lack of labor during peak season: Shashemene Woreda has a bimodal rainfall nature, in Belg and Meher seasons. Farmers cultivate teff mainly during the Belg season (March –June) - a short rainy season. Right after harvest, they immediately begin activities for the coming season (i.e., Meher). As a result, farmers have a smaller slack season, and therefore, face labor shortages

during this time. The early onset of Meher rainfall also places farmers' harvest at risk of damage. These setups encourage farmers to use the thresher that will not only save them time and labor but also save their harvest from damage by rain.

vi) Lack of oxen and labor: In the Shashemene area, trampling by oxen was the main method of threshing teff. However, compared to other project areas, there is relatively less number of oxen in Shashemene. For example, per household oxen ownership in Shashemene Woreda is 1.13, while it is 3.12 and 1.68 in Ada'a and Awabel Woredas, respectively. Therefore, this may have contributed to the quick adoption of MCTs in the Shashemene area. Availability of human labor in Shashemene is also limited because of presence of cash crops and off-farm businesses in the urban center. In other project Woredas, labor is either available or less costly than the Shashemene area. Family labor is also a problem in Shashemene because of employment in the urban center and schooling as most children attend school during the year.

4.2.2 Major Factors Affecting the Adoption of the MCTs

It is obvious that there are push and pull factors for successful adoption and dissemination of technologies. When the technology is particularly new to the farmers, there are multiple interacting factors that affect the use and adoption of technologies. It should be noted that any of the factors identified may not affect (encourage or discourage) adoption of the machine in isolation, but that they reinforce each other. The following are factors that have been identified to have positively or negatively affected the use and adoption of threshers in Ethiopia.

i) Opportunity Cost of Labor

The length of the threshing season is important for farmers to use the mechanical thresher that save time and labor. If the threshing season is long and farmers do not have alternative activities that they can engage in, they become less motivated to use the machines that incur them additional cost. They prefer to use their free labor unremittingly and save money than save their labor and incur the service charge associated with the use of the MCTs. For example, in Leka Dullecha Woreda, December to March is a common threshing period when there is no risk of untimely rainfall. During this time, farmers are not engaged in income generating activities that occupies their time/labor. In the Woreda, rain usually comes in May, which means farmers face little pressure to harvest and store crops, and thus, prefer to thresh traditionally than incur cost to use the MCTs.

Similarly, in Ada'a, Dejen and Awabel Woredas which are known in teff production, and hence, have adequate capacity to acquire threshers, the utilization of the MCTs was low. The reason could be attributed to the low opportunity cost of labor. There is no forgone benefit if they use their labor and oxen time for threshing purposes. In these sites, farmers particularly prefer to use their labor for threshing traditionally in a well done field and with an important social labor sharing arrangement, called Debo or wenfel. The threshing season last for about four months (from November to March) and involves no risk of untimely rainfall in these Woredas. Moreover, farmers hire labor annually at reasonably low cost which is paid in advance.

Though farmers recognized the importance of the machine, they still prefer to use traditional methods rather than paying the additional cost involved in renting the machine. For example, in Ada'a where farmers hire labor on annual basis paying Birr 6,000 per year (or alternatively 400 kg of teff and additional 200 Birr) renting the thresher makes the hired labor idle. In a farmer's word "What did my laborer do when I rented machine for threshing?" indicating that farmers have already established system for threshing and changing that will take time and more convincing technologies.

In areas where there is water for irrigation, the opportunity cost of labor is high and hence farmers tend

to demand the machine. This is observed in some kebeles in Debre Libanos and Awabel Woredas where irrigation activities take much of farmers' time. On the contrary, in Dejen, Ada'a and Leka Dullecha Woredas, the threshing season is long and farmers have no alternative employment at that time. In these Woredas there is no pressure on farmers that force them to thresh quickly and resort to other activities. Therefore, if they encounter challenges such as the breakdown of machines, they automatically revert to the traditional way of threshing rather than trying to repair the machines. This became clear from decision of one owner of a thresher machine in Ada'a who used the machine for the last two years but abruptly resorted to traditional method when the machine failed in the third year.

ii) Social Values

The traditional way of threshing crops promotes social interaction and values. Threshing in most places in Ethiopia involves community labor called "Debo" or "wenfel" and requires a farmer to pay little or no cash for threshing. Farmers are only expected to provide food and drinks. Farmers contribute labor and oxen for threshing each other's crop. This practice is part of a farmers' social life and they enjoy working in groups with the interaction which promote and build their social capital. Farmers value this social interaction which gives them time to enjoy the good harvest with local drinks and foods than the mechanical threshing which require them to pay cash for the services. Hence, interventions in postharvest activities should consider these social values as well as reducing total cost (both explicit and implicit) of the activity. It is also very important to sensitize farmers and design interventions that can still maintain the social capital while using improved technologies.

iii) Threshing Season and Rainfall Pattern

In areas with bi-modal rainfall patterns such as Shashemene, there is risk of early onset of Belg rain. This has two implications. Firstly, early rain damages harvested crops and forces farmers to thresh their crops as fast as possible. Secondly, if the rain comes, they have to start farming activities which requires them to use a mechanical thresher which saves labor. The fact that rain comes early implies high demand for labor for land preparation activities which, on the other hand, requires machines for threshing and shelling. The early inception of rain in Lemmo, Debre Libanos, and Shashemene Woredas created demand for the machine.

Thresher owners and farmers in Shashemene also reported that they use threshers during the Belg season than the Meher season because during Belg the soil is wet and it is difficult to prepare the threshing floor 'awdema'. In 2011 and 2012, the number of farmers who used the thresher during the Belg season was higher than those who used it in the Meher season. However, the production of teff in the Belg season was lower than the Meher season. In 2012, 72% of the total teff production in Shashemene was harvested during the Meher season. See table below for details.

Table 25. Number of farmers used thresher in 2011 and 2012 by season reported by 10 owners

Thresher owners	2011		2012	
	Belg	Meher	Belg	Meher
1	0	0	0	100
2	0	150	0	0
3	75	100	100	150
4	400	300	100	0
5	300	200	150	0
6	400	180	200	0
7	200	150	200	0
8	100	150	100	200
9	100	150	150	200
10	90	150	100	100
Total	**1665**	**1530**	**1100**	**750**

Source: Survey 2013

iv) Presence of Better Sources of Income

Use of any new or improved technology is affected by the cost of the technology. In areas where there are limited cash crops and there is low cash flow, farmers do not have alternative sources of income to pay for thresher service. A typical example is in Leka Dullecha Woreda where farmers' demand for MCTs was highly affected by lack of cash to pay for services. The study in 2013 indicated that an average farmer in Leka Dullecha spent about 33.70 Birr for hired labor to produce cereals. As a result, there was limited use of hired labor and a high reliance on family labor.

Farmers' willingness to pay for threshing services is limited by presence of cash crop as farmers in Awabel, Dejen and Leka Dullecha Woredas are found to be sensitive to the cost involved with acquiring threshing services. For example, in 2013, the service fee increased from 40 Birr to 50 Birr (excluding fuel cost) in Awabel Woreda. As a result, the number of farmers automatically reduced to 38 from 172 in 2012.

v) Improved Quality of Teff (premium price and market demand)

Previous studies (Dejene and Wondwossen, 2010) indicated that the primary reason for the high demand of threshers in Shashemene was the improved quality of teff. This is still valid as there is little, if any, demand for oxen trampled teff, because of the dirt and sand mixture. However, in the other project sites, there is no problem with respect to quality, as someone can hardly identify teff threshed by thresher from that of oxen. In Ada'a and Dejen areas there is no problem of impurity for teff and hence premium prices were not charged for machine processed teff. Farmers are already receiving premium prices in Ada'a, Awabel and Dejen areas because these areas are well known for producing quality teff. Therefore, there are no incentives to use threshers in these areas. The only possibility in these areas with the use of threshers is to improve the time and labor saving capacities of the threshers.

vi) Local Topography

Easy transportation of the postharvest machines has helped farmers and thresher owners in Shashemene area. It has also helped in using the machine to its maximum potential. Donkey carts are suitable for transporting machines and using donkey carts in this area is also common. However, the unsuitable topography for transporting threshers has negatively affected their use and in many Woredas in Amhara, Oromia and Tigray Regions. In Leka Dullecha Woreda of Oromia Region, for instance, the rugged topography meant farmers needed to pay extra fees for transport (cart) in addition to fuel and service fees. In Bandira and Horda Qawisa kebeles of the Woreda, for example, a farmer needs to pay extra 100-150 Birr to transport the machine 5 kms. Some need to pay about 300 birr for a round trip fare.

On the other hand, in Dhankaka (Ada'a), Dejen and Awabel Woredas, even though the topography is not difficult, the use of donkey cart is either not known or the donkey carts are not available. For example, the DAs in Dhankaka Kebele reported that they tried and failed to train donkeys to pull the cart and thresher that together weigh up to 300 kgs.

vii) Variety of Crops and Quality of Byproducts

The machine is good at threshing some crops depending on the nature (length of stem, size of kernel, moisture content etc.) of the crop. There are some variety of crops the machine works well. In some Woredas, such as Ada'a, Dejen and Awabel, the nature of the crop grown is not easy to thresh by machine. For example, kuncho variety of teff which has a long and strong stem is not easy to thresh by MCT. The quantity of teff threshed per hour will be less for kuncho variety which reduces the efficiency of the machine. Users of threshers in Ada'a, Dejen and Awabel Woredas commented that the machine lacked adequate power to thresh long stem teff like Kuncho. The labor saving capacity (speed of threshing) of the machine is reduced in this case.

This study indicated that the machine was preferred for some of the crops grown in a particular area and not for all crops at the same time and place. For example, in Debay Tilat Gin Woreda, the machine was demanded for threshing the arduous triticale wheat, whereas in Ada'a, Debre Libanos and Lemmo Woredas, they preferred it for teff. Similarly, FTCs in Guagussa Shikudad Woreda used the machine for wheat (66%) threshing.

Previous studies and various field visits by SG2000 MELS Theme indicated that the machine breaks grain kernels and mixes grain with straw for wheat while it properly threshes teff. Similarly, from eight kebeles visited, five reported that the MCT is better for threshing teff. Yet, two of them reported that it is better for wheat, and particularly for threshing the triticale wheat variety that is grown in Debay Tilat Gin Woreda (Debre Yesus kebele). In the Shashemene area, the machine is well known for threshing teff. In a 2013 survey, it was found that 89% of the crops threshed by thresher was teff while wheat constituted 8.8% and 2.2% of this amount was used for maize (Maize shellers).

Quality of byproducts is another factor affecting the use of the MCT. The machine mixes grain with straw and does not crush the straw very well. DAs and farmers in Dire Jibo Kebele (Debre Libanos Woreda), Borebor and Yetenora (Dejen), E. Chifar (Awabel) and Dhankaka Kebele (Ada'a) reported the mixing of grain and straw and some even said that it breaks grain kernels. Farmers threshed the straw again to grind it properly and recover the remaining grain. Improper crushing of teff byproducts (chid) is a major complaint reported by farmers. In areas such as Ada'a, Dejen and Awabel Woredas, crop residues (straw)

are the single most important animal feed. In these areas farmers highly value chid. Hence, enabling the thresher to properly crush byproducts is an important feature to improve its adoption and use.

viii) The MCTs Require Frequent Maintenance

Improved adoption of MCTs require intensive trainings for machine operators to properly use the MCTs and repair them when necessary. The multi-crop threshers were susceptible to frequent failures and interruptions during operation. All users and owners of the machines reported that the machines needed high precautions while being used otherwise they can easily break. All the MCTs that are stationed at FTCs before 2013 faced mechanical problems at least three times. More than 50% of the machines visited needed maintenance before the following season's operation. In the prior season, about 56% of the machines stopped working before finishing threshing. This problem was aggravated by lack of close follow up for maintenance and absence of an appropriate (professional) maintenance service. Thresher owners, operators, and DAs particularly in Awabel, Ada'a Barga, Leka Dullecha, Shashemene, and Guagussa Shikudad reported that trainings should be intensive to equip them with basic skills required to operate, maintain and troubleshoot as and when the need arises.

ix) Institutional Factors

In some kebeles, there is poor management of machines placed at FTCs. DAs and operators are busy with other activities particularly when the threshing season coincides with the government's natural resource conservation programs and other campaigns. At times, the trained operators were not suitable for the job which was the case in Ada'a Barga and Debre Libanos (Wakene Kebele) Woredas. They are model farmers or businessmen who were busy with their own farms and had little time to give threshing services to others. In Dhankaka, Semen Belessa, Bandira and Horda Qawisa Kebeles, there was an absence of clearly responsible person to run the machines that were given to Kebeles. Therefore, the machines were minimally promoted in these Kebeles and remain idle during the season.

Lack of a comprehensive record and data on the status of PHELPs was also related to mismanagement of the machines. Out of seven kebeles visited, it was only one FTC (Dire Jibbo) that had proper record of information on the utilization of the machine. This allowed Kebele officials and DAs to abuse the revenue generated from threshing service and provided wrong information and data about machine performance. In some cases, they also over-utilized the machines (more than 8 hours per day including night times) which could potentially contribute to damage.

5. CONCLUSION AND RECOMMENDATIONS

Conclusion

Recognizing the need for poverty reduction, the government of Ethiopia launched an agricultural modernization blueprint. The agriculture sector is at the center of the country's strategy to alleviate poverty. It is also an important component of sustainable and rapid economic growth. SG2000 Ethiopia has promoted a number of agricultural technologies to smallholder farmers including multi-crop threshers. Yet, the dissemination and adoption of these technologies is negligible considering the country's massive and urgent need of improved agricultural technologies.

This study showed that the number of households using multi-crop threshers over the intervention areas was fairly high and increasing continually. However, the average usage of Woreda wide multi-crop threshers was very low, suggesting truncated adoption rates. Raising farmers' awareness and enabling new avenues of dissemination may prove to be useful in expediting the use of MCTs. In the study areas, sampled farmers practiced both traditional and mechanical methods for threshing. The total cost of traditional threshing which incorporates implicit costs was by far higher than machine threshing methods. Investment on multi-crop threshers was found to be economically viable and financially feasible. Although the initial investment of MCTs was found to be high, total annual cost of operation were found to be relatively low. Moreover, the annual gross return was significantly high. This revoked initial costs incurred which could be recovered within a short span of time.

Postharvest losses during traditional threshing was quite significant but were considerably reduced when MCTs were employed. Sample respondents emphasized the need for the abundant availability of the machines. There was also a need to resolve the deficiency of skilled personnel. The absence of accessible credit was an extra constraint expressed by respondents. Non-availability of fuel at the nearby villages and problems of transportation to move threshers from one place to another were other major problems faced by sample respondents.

Machine breakdowns and subsequent absence of maintenance and service providers led to low adoption in new project Woredas. The number of private owners in all Woredas, except West Arsi Zone, were few. Ada'a Woreda, where some private service providers started operating, was also struggling to sustain. Serious measures should be taken to alleviate this problem and improve the adoption of the technology. FTCs and machine owners need to be encouraged and supported to continue to use the machines with better maintenance service and access to finance.

Farmers build their social capital using community labor sharing arrangements for threshing and other farming operations. This has limited the use of improved threshers as it involves additional cost of renting a machine, and with its reduced labor requirement limits farmers' social interaction. Therefore, interventions in postharvest activities should consider these social values as well as need to work on sensitizing farmers on the use of improved technologies while maintaining their social capital.

Recommendations

The study assessed the adoption, promotion and impact of MCTs: identified factors responsible for adoption, dissemination of the MCTs and the impact on income and cropping patterns. The study identified the untapped demand for postharvest machines and assessed factors that deterred the actualization of this demand. Time and labor saving benefits of the machines were valued by both farmers and owners. However, several factors stood against effective adoption. Vulnerability of the machine to breakage was a primary reason against effective adoption and use. Poor management of machines and lack of systematic follow up and maintenance services were the main reasons that contributed to the breakdown and failure of machines.

The study recommended mechanisms that enable farmers in other Woredas to utilize MCTs as intensively as the case in Shashemene Woreda. One mechanism towards this is the promotion of private ownerships of MCTs by facilitating access to credit.

Based on the findings of the study, the following points are further suggested to improve the adoption and dissemination of the threshers:

- Efforts should be made by the Ministry of Agriculture and manufacturing companies to popularize good quality threshers among smallholder farmers;
- Technology promoters like SG2000-Ethiopia should follow site specific approaches that suit local contexts and conditions. Successful promotion of the PH machines requires a suitable strategy that is detailed and carefully followed. Providing the machine to private owners on a partial credit basis and closely backstopping them can improve adoption rates.
- Operators of MCTs and farmers should undergo appropriate trainings in order to gain the required skills, techniques and knowledge of proper operation. Training and support should be focused on capacitating the operators and farmers to maintain minor failures by themselves. Development organizations like SG2000 should improve their technical backstopping and training. Trainings should be effective to enable farmers, DAs and operators to become proficient users of machines in most places.
- Manufacturers and government bodies should acknowledge the need for simple, easily transportable and small sized threshers.
- There should be an attempt to improve the overall performance of the machines. (E.g. optimal horse power, grinding the crops well, winnower, easily movable and robust machine). Installing winnower to machines increases its labor saving capacity.
- Clear directions on the management of machines as well as the revenue generated by machines should be provided to kebeles/FTCs through management trainings;
- The FTC Management Committee (FTC-MC) should be strengthened and involved in managing the machines (management of the PHELPs) as well as the revenues generated. There should also be proper official documentation of the status and utilization of machines.
- Success in the promotion of PH machines also requires efforts of other partners. Maintenance problems are likely to persist in the future. This require alternative problem solving methods with local institutions.

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ANNEXES

Annex A: Quality Assurance Measures Before, During and After Data Collection Phases

Due to the complexity of this kind of survey operation, it is inevitable that errors may arise at any stage of the survey. To minimize and control errors, it is a good practice to devote part of the budget to quality assurance and control. Therefore, a number of measures have been taken to ensure data quality both from field team administration and the technical side. From the field administration side, two techniques were employed to ensure data quality. First, each supervisor was given airtimes for their cellular phones to be in constant touch with coordinators and the team leader. Therefore, the survey team was regularly in touch to discuss progress, problems, or any clarifications they might need. Second, we hired experienced supervisors and enumerators with good understanding. At the same time, during the training session and field pre-test some of them were dropped based on their performance.

From the technical side, the data quality assurance procedure starts from designing the questionnaires (such as proper skip rule). The pre-test were conducted in selected areas in consultation with SG2000 MELS theme. The overall objective of the pre-test was to improve the quality of the data to be collected. More specifically, the objectives of the pre-test include: (i) identifying problems from interviewers; (ii) identify the problems from respondents; (iii) ensure accuracy and interpretability of the survey; (iv) estimate the time needed to apply the questionnaires; (v) test for the additional information needed to support the survey instrument(s); and (vi) identify any other problems related with the survey instruments. Finally, the questionnaires were adapted to reflect the field conditions.

The pre-testing was followed by a two day long work to implement the experience and modify the questionnaires accordingly. To conduct the survey a survey team was established composing of 8 individuals. The team was composed of a lead researcher, 2 supervisors, and 5 enumerators. A data entry template was developed that had two advantages: (i) help to detect any inconsistencies while survey teams are in the field and (ii) expedite the data processing; verification, entry and analysis.

Annex B. Estimated teff PH loss by Woredas in 2011 (baseline survey)

Woreda	Total harvest (Qt) in the sample kebeles	Harvesting and Drying loss (Qt)	Threshing & winnowing (Qt)	Storage loss (Qt)	Transport loss (Qt)	Total quantity lost (Qt)	Total Postharvest % lost	Threshing & winnowing % lost
Tole	701.5	29.99	11.46	6.15	2.94	50.54	7.2%	1.6%
Ada'a	1826.45	53.11	36.59	69.07	5.56	164.34	9.0%	2.0%
Berek	279	31.52	9.58	2.04	10.87	54	19.4%	3.4%
Robe	152.5	14.09	7.26	0.99	0.71	23.05	15.1%	4.8%
Dejen	843.95	16.03	22.24	0.86	0.43	39.56	4.7%	2.6%
Awable	487.45	3.34	3.24	0.73	1.03	8.33	1.7%	0.7%
Dangila	329.75	17.17	6.81	1.86	1.13	26.97	8.2%	2.1%
Libo Kemkem	77.75	4.64	3.78	0.88	0.53	9.83	12.6%	4.9%
Dawa Cheffa	82.75	9.9	3.01	0.46	0.14	13.51	16.3%	3.6%
Silti	76.17	2.81	2.34	0.92	0.51	6.58	8.6%	3.1%
Lemmo	78.28	3.03	3.78	0.79	0.2	7.8	10.0%	4.8%
Total	**4935.55**	**185.63**	**110.09**	**84.75**	**24.05**	**404.51**	**8.2%**	**2.2%**

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