Factors Affecting Farmers' Hiring Decision on Agricultural Mechanization Services: A Case Study of *Debre Elias Woreda*, East *Gojam* Zone, Ethiopia

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Abstract

The main objective of this research was to analyze the factors influencing farmers' decision on hiring tractor and/or combine harvester mechanization services. The study was carried out in 2020/21 at Debre Elias Woreda in East Gojam zone of the Amhara National Regional State, Ethiopia. A formal survey which involved a two-stage sampling procedure was used to select farmers from three Kebeles. Using random sampling techniques, the study selected a total of 133 household farmers. Of which, 52 hired tractor ploughing service and 78 hired combine harvester service. Descriptive statistical tools were employed to analyze the level of usage of mechanization services. In addition, Binary Logistic Regression Analysis was applied to identify factors affecting the hiring decision of farmers for agricultural mechanization services. Results showed that the number of economically active labor force, number of oxen, land size, goal of farming, off-farm income, and institutional factors significantly affected farmers' tractor hiring decisions. The result also showed that factors like labor cost and weather uncertainty were statistically significant to influence the hiring decision of farmers' for combine harvesters. In the study area, mechanization services were mainly provided by private contractors. Based on the findings, government has a big role in influencing the hiring decision through its extension system. Financial credit must be made available for hiring mechanization services. To increase accessibility of mechanization technologies, government should provide incentives and subsidize the cost of acquiring machineries and equipment. In addition, training for service providers, field demonstrations and community-based discussions involving church leaders as well as applying ICT to minimize the searching and timely availability of services are recommended.

Key words: Hiring tractor services, Hiring combine harvester, Farm machinery services

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Introduction

According to UN, the population of Ethiopia is estimated at 117 million growing at 2.6 percent annually (UN, 2019). Producing adequate food for a rapidly growing population is a prime challenge. Rapid urbanization leads to increased market demand for agricultural products such as cereals, which require more labor than other crops (IFPRI, 2017). Due to increase in urbanization, agriculture is likely to continue be affected by labor shortage unless supported by mechanization technologies. Traditionally, Ethiopian agriculture is low-input and low-output, induced low crop productivity levels that are significantly below regional and international standards (ENAMS, 2014).

While agricultural mechanization has shown to be an effective way of increasing production, it, so far, has not experienced significant application or use in the Ethiopian smallholders' context (ENAMS, 2014). Mechanization and good management can result in better timeliness in field operations and on good soils this can result in improved yields (Landers, 2000). To exploit economics of scale in the use of agricultural machinery and limitations in the financial capacity of farmers to own farm machinery, it is necessary to improve hiring arrangements to provide mechanization services to small scale farmers. Custom hiring services for agricultural machinery enable farmers to utilize the appropriate machinery and equipment for a defined period, only paying for the services (UNESCAP, 2017). However, hiring decisions are based on several factors whose relative importance varies among farmers.

Early research focused heavily on adoption of mechanization technologies, not specific to tractor and combine harvester hiring (Takele and Gebre

Selassie, 2018; Challa, 2016, Berhane *et al*., 2016; Hassena *et al*., 2000). While these studies have attempted to address the the main factors, some of the results reveal similar conclusions. Common to all is that land holding and education status seemed to have a positive effect in technology adoption while age and distance have negative influence. Although Challa (2016) found that family size and age have determinatal effect in technology adoption, Berhane *et al* (2016) in their study found that they are not important. This variablility in the effect of factors in making significant contribuition and the conflictng results suggest for further study to examine population more closely in a speciallized survey.

The making of hiring decision depends on the type of technology offered to the farmer. Most of the researches were broad on mechanization technology adoption, not on a specific technology. The research of Takel and Gebre.Selassie (2018) was based on willingness of farmers' to use a one axle tractor that limits its validity to only a small group and for a specific tractor. Past studies were done in different regions with different socio economic characterstics. The type and degree of influence of each identified variable could vary among differnt cultures and from area to area. Hence, to compare the results of past studies and exploring additional variables, it is suggested to study and examine the factors influencing the hiring decision of farmers' on such specific mechanization technology.

Thus, this research was mainly conducted to fill the gap i.e., further investigation to determine factors affecting the hiring decision of farmers for mechanization services in the study area. The information generated from this research would be useful and essential for stakeholders working in mechanization area by understanding various factors influencing the

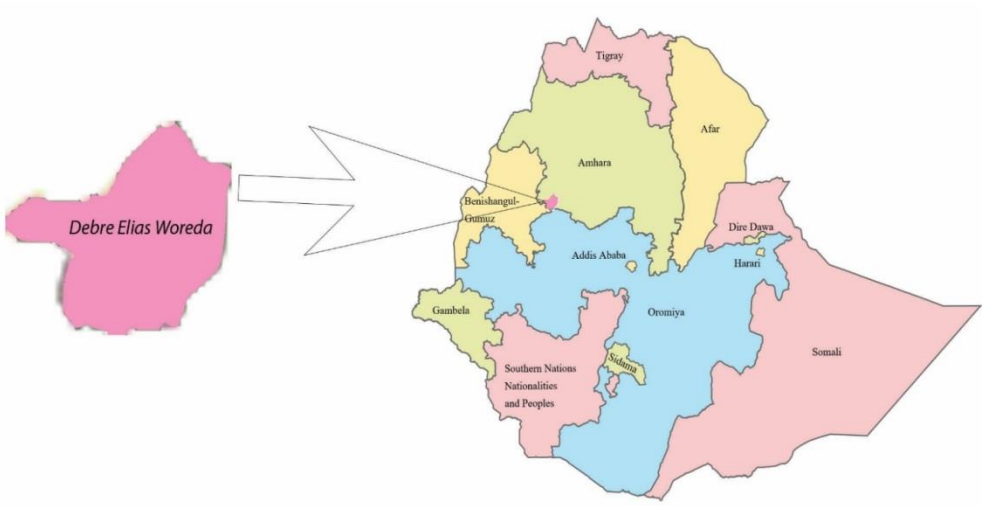
sustainable operation of farm mechanization service provision to smallholder farmers.

Research Methodology

A cross-sectional survey design was employed to collect both quantitative and qualitative data from *Debre Elias Woreda* in *Amhara* region, Ethiopia. Primary data was gathered from farmers in the *Woreda* in the month of August 2020. Secondary data were gathered from publications of government, non-governmental sources and websites.

Sampling Design

Multistage sampling technique using both purposive and random sampling were employed for selection of sample farmers from the *Woreda*. Debre Elias *Woreda* was purposely selected. From the *Woreda*, three *Kebeles* were also selected purposely as they represent the major mechanization service use kebeles of the *Woreda*. These *Kebeles* were *Yekegat*, *Guay* and *Tija Gote*r. The total number of households in the *Woreda* estimated at 22,117. Of which, the three selected *Kebeles* in total have about 3,083 households. According to the report from *Debre Elias Woreda* Office of Agriculture, about 250 households have used tractor hiring service and about 8,000 households used combine harvesting service in the year 2018/19. A total sample size of 148 household farmers was selected to collect data. After data entry and cleaning, fifteen observations were found to have insufficient information. Hence, the final data analysis and reporting was based on a total of 133 households randomly selected from the three *Kebeles*.



Methods of Data Collection

Data was gathered through interviews, focus group discussions, and document review. A structured questionnaire which consisted of various questions in order to obtain the relevant information from interviewed households was used. The questionnaire was pre-tested for its validity before conducting the actual survey. A total of five people were interviewed during pre-test. Following the feedback from pretest and prior discussion with local experts, the final version of the questionnaire was modified accordingly. A focus group discussion (FGD) with eight participants were also conducted to generate qualitative information.

Specification of the Econometric Model

A binary logistic model was used to estimate the relationship between factors and farmers' decision towards hiring of agricultural mechanization services. The logistic regression model is one of the most common approaches used to study the decision between two alternatives (Field, 2005). This model predicts the probability that an individual with certain

socio-economic characteristics and other determinants chooses one of the alternatives (Gujarati, 2003; Field, 2005).

Following Gujarati (2003), the logistic regression model form for binary choice problem could be introduced as:

$$\ln \frac{Pi}{1-P_i} = \beta_0 + \sum_{j=1}^{k} \beta_j \chi_{ij} \qquad \text{(Eq. 2)}$$

The model specification for the analysis is given as: $Y=f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \ldots X_n)$

Where Yi denotes the dependent variable, representing a hiring decision for the i^{th} household. Farmers decision towards hiring a mechanization service (those who decide: 1 and those that do not:0), X_{ij} constitute the independent variables in the study, β_0 = constant term and β_j=coefficient.

Pi is assumed to be the probability that decision is made to hire mechanization services and, therefore, $1-P_i$ represents the probability of not hiring mechanization services.

$P[Y=1] = P_i$

$P[Y=0] = 1-P_i$

The ratio $P_i/1-P_i$ is known as the odds ratio in favor of hiring a mechanization service.

The logistic model applies the maximum likelihood estimation after transforming the dependent into a logit variable. The empirical mathematical model for estimations is formulated as follows:

$$P_i = prob(Y_i=1) = \frac{1}{1+e^{-(\beta_o+\beta_1 X_{1i}+\ldots\beta_k X_{ki})}} = \frac{e^{(\beta_o+\beta_1 X_{1i}+\ldots\beta_k X_{ki})}}{1+e^{(\beta_o+\beta_1 X_{1i}+\ldots\beta_k X_{ki})}} \quad \text{(Eq. 3)}$$

Based on the empirical model presented in Equation (2), the effect of explanatory variables on farmer's decision to hire mechanization services could be expressed through the following linear relationship:

The regression probability is:

$$\text{Ln } P_i/1\text{-}P_i = L = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n$$

Therefore, for estimation purpose, variable Y is defined in this study as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots. + \beta_{24} X_{24} + \varepsilon$$

Where:

Y=Hiring of mechanization services (0 = no decision, 1= hiring decision)

X_1 = Farmer's gender (0 = female, 1=male)

X_2 = Household head age (number)

X_3 = Farmer's education (0=illiterate, 1=literate, read and write)

X_4 = Farming experience (years)

X_5 = Household size (number)

X_6 = Farmer's economically active labor household size (number)

X_7 = Farm size (in hectares)

X_8= Size of rented-in land (in hectare)

X_9 = Wheat land (in hectares)

X_{10} = Off-farm income (No=0, Yes=1)

X_{11} = Number of oxen (in number)

X_{12} = Goal of farming (1= Seed production, 0= otherwise)

X_{13} = Did you hire tractor because of labor shortage (Yes=1, No=0)

X_{14} = Hire tractor because of better land preparation and faster operation? (Yes 1, No=0)

X_{15} = Farmers hire services with neighbor's influence (Yes =1, No=0)

X_{16} = Farmers hire services with institutional influence (Yes=1, No = 0)

X_{17} = Farmers hire services with broker's influence (Yes=1, No=0)

X_{18} = Did you hire combine harvester because of high labor cost (Yes=1, No=0)

X_{19} = Farmers hire due to uncertainty (Yes=1, No=0)

Methods of Data Analysis

Data analysis employed both descriptive and econometric methods. The descriptive analysis was used to summarize some important socio-economic characteristics of the interviewed households. This method included the application of means, percentages and standard deviations. The econometric model was used to measure the significant level of the mentioned factors and its impact on hiring decision of farmers for mechanization services. The

collected data from the survey were coded, summarized and processed for analysis. The quantitative data were analyzed using Statistical Package for Social Sciences (SPSS).

Definition of Variables and Hypothesis

Variables	Description	Min	Max	Mean	St.deviation	Percentage frequency with Dummy=1	Percentage freqency with Dummy=0	Assumption
Dependent Variable								
HIRETRAC (Hire=1)	Farmer's who hired tractor ploughing services.					39.10	60.90	N/A
HIRECOMB(Hire=1)	Farmer's who hired combine harvester.					58.60	41.40	N/A
Independent variables								
GENDER (male=1, female=0)	Gender of the houshold head.					81.20	18.80	_
EDU (Literate=1)	Level of education of the household head.					66.20	33.80	+
AGE (years)	Age of the household head.	25	70.00	42.950	9.714			_
FARMEXP (years)	Years of farming experience of the respondent.	5	50.00	23.440	10.180			+
LABOURACTV (number)	Number of people with age range of 15-60 years living in one household.	0	6.00	2.590	1.181			_
LANDSIZE (ha)	Total cultivated land (ha).	1	5.25	1.964	1.037			+
RENTINLAND (ha)	Size of additional land rented in by household.	0	4.00	0.628	0.836			+
OXEN(number)	Number of oxen owned by househo	0	8.00	2.950	1.878			_
WHEATLAND (ha)	Size of land dedicated for wheat by individual household farmer.							+
OFFINCOME (1=Yes, 0=No)	Income generated outside the farm.					25.60	74.40	+
FARMGOAL (1=Yes, seed producer)	Respondent farmer, a seed producer or not?					24.10	75.90	+
NEBRINFLU (1=Yes)	Hire mechanization service because of other farmer influence.					21.80	78.20	+
INSTITINFLU (1=Yes)	Hire mechanization service because of extension worker influence.					33.80	66.20	+
BROKRINFLU(1=Yes)	Hire mechanization service because of brokers influence.					14.30	85.70	+
LABORSHRT(1=Yes)	Hire tractor because of labor shortage.					24.10	75.90	+
FASTOPR(1=Yes)	Hire tractor because of time constraint and faster operation					10.50	89.50	+
LABORCOST (1=Yes)	Hire combine harvester because of high labour cost.					39.800	60.20	+
UNCERTAINITY(1=Ye	Hire mechanization not to lose yield from unexpected weather					47.400	52.60	+

Results and Discussion

Descriptive statistics of sample households

Table 3.1 shows the hiring status of respondents. From all *Kebeles*, 52 (39.1%) respondents have hired tractor ploughing services and 78 (58.6%) respondents have hired combine harvesting operation. As can be seen from the table, 22.6% of respondents hired none of the services. Other tractor mechanization services such as discing and planting are not available in the *Woreda*. There were large number of farmers who hired combine harvester than tractor services. It showed that the uptake of combine harvesting is much more accepted and developed than tractor mechanization.

Table 3.1. Hire Mechanization Services

Characteristics	Percentage
Hire mechanization services	
Only tractor ploughing	18.8
Only combine harvesting	38.3
Both tractor and Combine harvester	20.3
No hire	22.6

Social and Demographic Characteristics of Sample Households

Sex, Family Size and Age Structure

Data values of the social and demographic characteristics such as gender, age, and number of economically active household member were analyzed using descriptive analysis. By using descriptive analysis, the frequency distribution table shows clearly how the data values affect the variables in this research. Table 3.2 Shows the result of analysis.

From respondents who hired mechanization services 86.4% (tractor) and 83.3% (combine harvester) were male. The average age of the interviewed households was 43 years old. 55.8 percent of households who hired tractor service were in the age group between 15 and 40 years while for combine harvester, 51.3% were in the age group from 41 to 75 years. Implying that age has insignificant effect to hiring decision of combine harvester. Regarding family size, about 59.4% have at least four family members. The maximum household size is 11. Out of households who hired mechanization services, families with large number (72.2% for combine harvester) and families with a smaller number of households (85% for tractor) were dominant. Concerning economically active family size, nearly half (50.4 percent) of the interviewed households said that they do have up to two family members within economically active age category. From households who hired mechanization services in the past, family size with minimum number of economically active labor was majority (75% for tractor and 50% for combine harvester). Of respondents within the economically active age category of up to two family members, majority (58%) hired tractor mechanization services. The finding of this research supports the initial hypothesis that those households with a greater number of economically active labor force are likely not to hire mechanization services since the excess labor is used in land preparation activities.

Table 3.2 Social and Demographic Characterstics

Characteristics	Total	Hire only tractor	Hire only combine harvester	Hire both tractor and combine harvester	No hire
	Percentage	Percentage*	Percentage*	Percentage*	Percentage*
Gender:					
Male	81.20	16.70	36.10	24.1	23.1
Female	18.80	28.00	48.00	4	20
Age					
15-40 (Young)	47.40	28.60	42.90	17.5	11.1
41-75 (Old)	52.60	10.00	34.30	22.9	32.9
Household size:					
Up to 2	9.80	76.90	7.70	7.7	7.7
3-4	30.80	31.70	29.30	17.1	22
5 and above	59.40	2.50	48.10	24.1	25.3
Economically active family labor involved in farming activities					
Up to 2	50.40	35.80	35.80	22.4	6
3-4	42.10	1.80	42.90	17.9	37.5
5 and above	7.50	0.00	30.00	20	50

*Row percentage

Education Status

Out of the interviewed households (Table 3.3), 33.8% were illiterate and 66.2% were categorized as literate who can read and write. Among households who hired mechanization services, majority (78%) are literate who can read and write. Within the category of illiterate, 46.7% did not make any hiring decision in the last cropping season. Similarly, from those who are literate only 10.2 percent did not hire any mechanization service. The finding matches with earlier researches who also discovered that educated farmers are more likely to make technology adoption decisions.

Table 3.3. Education Status of Sampled Household Heads

Characteristics	Total	Hire only tractor	Hire only combine harvester	Hire both tractor and combine harvester	No hire
	Percentage	Percentage*	Percentage*	Percentage*	Percentage*
Education level:					
Illiterate	33.8	15.6	28.9	8.9	46.7
Literate, Read & Write	66.2	20.5	43.2	26.1	10.2

*Row percentage

General Resource Characteristics

There was wide range of farming experience in the study area, varying from 5 to 50 years. In this study, faming experience was classified into three categories, according to the length of time with agricultural work. The average farming experience of interviewed households was 23 years. In this research, 10.5% of farmers had a farming experience of 1 to 10 years while majority (50.4%) of respondents had farming experience from 11 to 25 years and 39.1% had more than 25 years of experience in farming. Of respondents within farming experience category of 1 to 10 years; majority hired combine harvester while only 7.1% hired none of the services. Similarly, within farming experience between 11 and 25 years (13.4%) and above 25 years (38.5%) hired none of the services during the last cropping season.

Table 3.4 Resource Characterstics of Sampled Household

Characteristics	Total	Hire only tractor	Hire only combine harvester	Hire both tractor and combine harvester	No hire
	Percentage	Percentage*	Percentage*	Percentage*	Percentage*
Farming experience					
1-10 years	10.50	21.4	64.3	7.1	7.1
11-25 years	50.40	25.4	43.3	17.9	13.4
> 25 years	39.10	9.6	25	26.9	38.5
Land size					
Small<=1ha	18.80	16	8	0	76
Big >1ha	81.20	19.4	45.4	25	10.2
Land ownership					
Partially or fully owned	89.50	21	32.8	21.8	24.4
Rented land	10.50	0	85.7	7.1	7.1
Rented in additional land	54.10	12.5	54.2	29.2	4.2
Oxen owned					
None	12.80	64.7	11.8	0	23.5
1-2	32.30	27.9	32.6	25.6	14
3-4	37.60	4	46	16	34
5 and above	17.30	0	52.2	34.8	13
Off-farm income	25.60	41.2	20.6	32.4	5.9

*Row percentage

The smallest and biggest land size cultivated by households range from 0.5 to 5.25 ha, with the mean of 2 ha. Nearly 18% of respondents cultivate less or equal to 1ha and 82% cultivate more than 1ha (Table 3.4). Land size indicated in this study includes all land managed by the farmer. Majority of households with previous experience with hiring of mechanization services had more than 1 ha of land. Among respondents who were operating more than 1 ha of land; 19.4% hired only tractor ploughing service, majority (45.4%) hired only combine harvester, 25% hired both tractor and combine

harvester and 10.2% hired no mechanization service at all. Regarding to the farm ownership structure, the percentage of respondents who own their farm was 89.5% followed by 10.5% who depend on rented land. Of respondents who relied on rented land, 85.7% hired only combine harvester, 7.1% hired both tractor and combine harvester. More than half of respondents who rented in additional land also hired mechanization services. From those who rented in additional land, 54.2% hired only combine harvester and 29.2% hired both mechanization services during the last cropping season. The average number of plots of the sampled households during the survey period was greater than three in number. This indicates that there is land fragmentation in the area, with the number of plots varying from one to twelve.

Regarding oxen ownership, most of the households' own oxen as it is a major input in crop production process serving as a source of draft power, only 12.8% of respondents did not have oxen. There was variability in oxen ownership among farmers in the study area, ranging from one to more than five. From the interviewed respondents 43 (32.3%) own one to two oxen, 50 (37.6%) own three to four oxen and 23 (17.3%) own more than four. Among interviewed farmers who had three to four oxen, only 20% hired tractor ploughing mechanization services. From the interviewed households with no ownership of oxen; 64.7% hired tractor mechanization service. Within oxen ownership category of more than 5, a large (52.2%) number of respondents hired only combine harvester however none hired tractor mechanization services, implying that farmers with no or less number of oxen are likely to hire tractor ploughing services.

Income sources were categorized into two groups; off-farm income and farm income. From the interviewed households, 25.6% had additional off-

farm income. Of households who had used tractor mechanization services, nearly half had additional off-farm income. From respondents who had an off-farm income; 41.2% hired only tractor service, 20.6% hired only combine harvester and 32.4% hired both. The average farm income of the sampled households was 53,538 Birr per year. Mean annual farm incomes of households who hired services for tractor and combine harvester are 72,154 Birr and 63,485 Birr respectively. This means that farmers with better income are likely to hire mechanization services.

Table 3.5. Total Farm Income in Birr

Characteristics	**Frequency**	**Mean**	**Std. Deviation**
Sampled households	133	53,538	31265.16
Hire Tractor	52	72,154	36,279.08
Hire Combine Harvester	78	63,485.00	34984.65

Perception and Social Factors

The relationship between farmers' perceptions about different attributes and their decision towards hiring agricultural mechanization services was considered by asking different questions about farmers perception and opinion which includes, goal of farming, neighbor's influence, institutional influence, broker's influence, hiring fee opinion and norm limitations. The results as can be seen in Table 3.6 from the surveyed household, 24.1% were seed producers while the rest are producing for local market and consumption. And near half (48.1%) who used tractor services were seed producers while among those who hired combine harvester, 29.5% were seed producers. Among respondents who were seed producers, 53.1% used both tractor and combine harvester services and only 3.1% did not hire any

mechanization service in the last cropping season. The focus group interview indicated also that mechanized services have especially been taken up by wheat producer farmers.

Of all respondents, 21.8% of households made hiring decision influenced by other farmers. The result showed that about 33.8% of respondents made hiring decision influenced by institutions (extension worker and experts from office of Agriculture) and few (14.3%) were convinced by brokers to hire mechanization services, indicating the significant role of extension in bringing positive effect on the adoption of agricultural technologies. Of households who used mechanization services, 53.8% (tractor service) and 39.7 percent (harvesting service) said that they first hired the services convinced by government extension workers.

Table 3.6 Perception and Social Factors

Characteristics	**Total**	**Hire only tractor**	**Hire only combine harvester**	**Hire both tractor and combine harvester**	**No hire**
	Percentage	**Percentage***	**Percentage***	**Percentage***	**Percentage***
Goal of farming					
Seed supply	24.10	25	18.8	53.1	3.1
Other	75.90	16.8	44.6	9.9	28.7
Influence for making hiring decision					
Farmer	21.80	3.4	75.9	17.2	3.4
Institutions	33.80	28.9	35.6	33.3	2.2
Brokers	14.30	36.8	42.1	21.1	0
Fee opinion for hiring tractor ploughing service					
Fair	2.30	33.3	33.3	33.3	0
Costly	97.70	18.5	38.5	20	23
Fee opinion for hiring combine harvesting service					
Fair	8.30	0	63.6	36.4	0
Costly	91.70	20.5	36.1	18.9	24.6

*Row percentage

The hiring cost associated with a particular technology is also seen as a factor that influences the decision to hire. Almost all (97.7%) of respondents thought that the hiring rate for tractor operation was too expensive and very few (2.3%) thought that the hiring rate is fair. Similarly, 91.7% thought that hiring rate of combine harvester was too expensive and only 8.3% believed that it is a fair rate. From respondents who said the hiring rate was costly, about 24% did not hire the service. The focus group discussion indicated that service rate in the area was relatively higher. Average service rate for tractor ploughing and combine harvesting were 3,200 to 3,500 Birr per hectare and 100 to 150 Birr per quintal respectively.

Due to religious reasons, majority (75.2%) of the respondents did not allow mechanization services to be operated in their farm every day. There are days where no work is allowed in the farm. Of the interviewed households, 6.8% said that they do not allow any machinery operations on Sunday's, 29.3% don't permit on Saturday's and Sunday's, 40.6% don't permit for five to eight days in a month, 18% said no operation for nine to twelve days per month and 5.3% allowed field operations for only fifteen to eighteen days in a month. In focus groups, respondents indicated that too much no work day in a month is a serious problem. Mobilizing combine harvesters from *Arsi* and *Bale* areas to the area was tried in the past. Participants of the FGD said that service providers were unable to work day by day as a result of that they returned back with a loss.

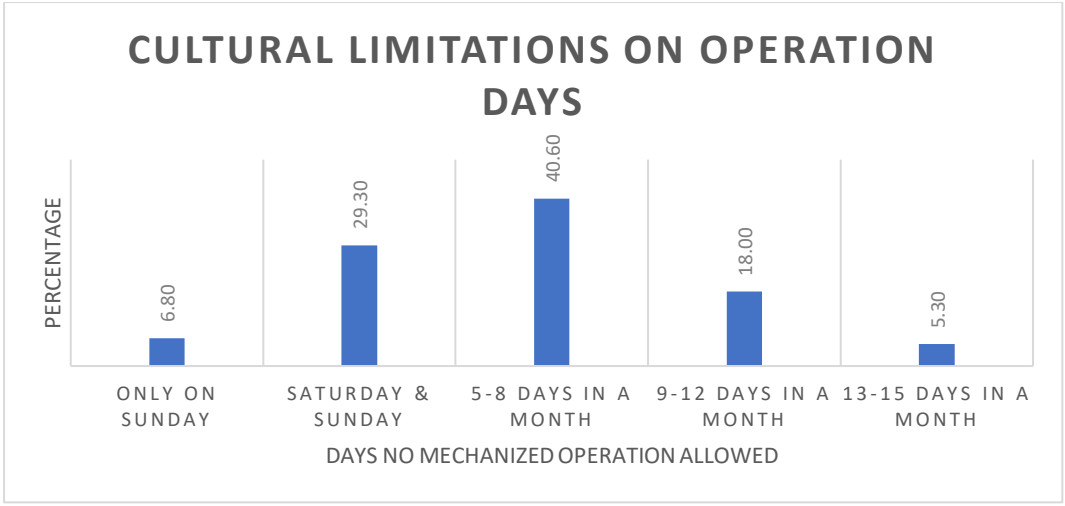


Figure 3.1 Effect of Cultural Norm in Technology Access

Supply Characteristics and Uncertainties

Of interviewed households, majority (85%) of the respondents got mechanization services from private service providers while 15% got from farmers unions and cooperatives. It means that cooperatives provide mechanization services primarily to some of their group members. On average, most of the interviewed households farm is located 1.5 km away from road with a minimum of 1km and maximum of 10 km.

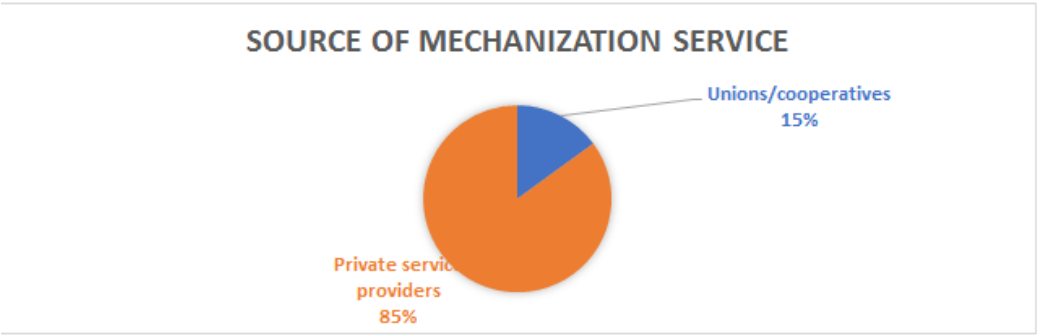


Figure 3.2 Source of Mechanization Service

Availability of service providers in the area plays significant role in the hiring decision and among the surveyed households. Among respondents, 42.1% confirmed the existence of few tractor service providers in their area while 57.9% said there are quite very few of them giving service in their localities and a very large group of respondents agreed that they don't get the service fast if needed. The focus group discussion also pointed out accessibility of tractor mechanization services as key factor to make hiring decision. Similarly, respondents said that there are very few (48.1%) and few (51.9%) combine harvester service providers operating in their area and only quite very few of respondents thought that they can get the service fast when the need comes.

Brokers are situated between farmers and service providers. 69.9% of respondents reported that there are mechanization brokers in their locality. With regard to role of brokers, 50.4% of respondents believed that brokers are not important in the hiring process while 39.8% thought that brokers are responsible in making the hiring rate expensive and few respondents (9.8%) were in favor of brokers role which they believed that brokers make the hiring process easy and fast. Among respondents who hired mechanization services, 15.4% of those who used tractor services and 11.5% of those who used combine harvester services thought that they are important in facilitating the hiring process. Of respondents who believed that brokers are important in making the hiring process fast and easy, 23.1% hired tractor only service, 30.8% hired combine harvester only service, and 38.5% hired both services.

Table 3.7 Role of Brokers

Characteristics	Total	Hire only tractor	Hire only combine harvester	Hire both tractor and combine harvester	No hire
	Percentage	Percentage*	Percentage*	Percentage*	Percentage*
Brokers exist	69.90	23.7	33.3	20.4	22.6
Opinion: Role of brokers in mechanization service hiring					
Not important	50.40	13.4	40.3	17.9	28.4
Make hiring process easy and fast	9.80	23.1	30.8	38.5	7.7
Make service hiring rate expensive	39.80	24.5	37.7	18.9	18.9

*Row percentage

Results of the Logit model

The econometric model results for farmer's decision to hire mechanization services are reported in Table 3.8. Model one is for tractor ploughing hiring decisions and model two is for combine harvester hiring decisions.

Tractor services Hiring Decision

Table 3.8 Results of Logistic Regression Model Analysis

Variables	Coefficient	S.E.	Wald	Sig.	Exp(B)
Gender of household head	2.587	1.73	2.240	0.135	13.288
Age of the household head	0.17	0.16	1.164	0.281	1.185
Education level of household head	-0.333	1.60	0.043	0.835	0.717
Years of farming experience	0.034	0.12	0.075	0.785	1.034
Economically active labor size	-3.76	1.28	8.583	0.003*	0.023
Total farm land size	1.527	0.80	3.668	0.055	4.603
Size of land rented-in	-1.575	1.01	2.459	0.117	0.207
Number of oxen	-1.509	0.62	6.021	0.014*	0.221
Off-farm income	5.091	2.08	5.967	0.015*	162.546

Variables	Coefficient	S.E.	Wald	Sig.	Exp(B)
Goal of farming	3.734	1.80	4.288	0.038*	41.837
Shortage of labor	1.97	2.11	0.875	0.350	7.173
Time constraint and faster operation	2.842	1.78	2.561	0.110	17.143
Broker's influence	1.714	2.19	0.613	0.434	5.551
Institutional influence	2.421	1.19	4.113	0.043*	11.262
Intercept	-2.436	4.59	0.282	0.596	0.087

*Significant at 5% level. -2 Log likelihood=33.461, omnibus tests of Model coefficients (chi-square, df, sig) =144.541,14,0.000)
Hosmer and Lemeshow Test=0.999 sig. 0.998 Nagelkerke R square=0.898, percentage of correct predictions=95.5%

Combine Harvesting Services Hiring Decision

Variables	Coefficient	S.E.	Wald	Sig.	Exp(B)
Gender of household head	-1.504	3.22	0.218	0.641	0.222
Age of the household head	-0.178	0.28	0.421	0.517	0.837
Education level of household head	-0.213	1.91	0.012	0.911	0.808
Years of farming experience	-0.169	0.27	0.394	0.530	0.845
Household size	1.879	1.07	3.063	0.080	6.545
Total farm land size	1.113	1.34	0.694	0.405	3.042
Rent in additional land	1.119	1.83	0.375	0.540	3.061
Total area planted with wheat	3.681	1.98	3.472	0.062	39.683
Off-farm income	0.754	4.26	0.031	0.860	2.125
Goal of farming	2.496	4.08	0.374	0.541	12.131
Harvesting labor cost	4.978	2.32	4.595	0.032 *	145.231
Neighbor's influence	0.925	1.84	0.254	0.615	2.523
Institutional influence	2.766	2.04	1.832	0.176	15.889
Uncertainty-weather	4.912	2.46	3.995	0.046 *	135.957
Intercept	-9.404	7.42	1.606	0.205	0.000

*Significant at 5% level. -2 Log likelihood=16.880, omnibus tests of Model coefficients (chi-square, df, sig) =163.499,14,0.000)
Hosmer and Lemeshow Test=0.687 sig. 1.000 Nagelkerke R square=0.953, percentage of correct predictions=97.7%

The results in the Table 3.8 found that out of the fourteen selected variables, five variables were statistically significant at 5% level with respect to hiring tractor mechanization services. Among the selected factors, economically active family labor, off-farm income, number of oxen, goal of farming and institutional influence were found to be important in determining tractor hiring decisions. Similarly, to make hiring decision for combine harvester, out of the fourteen selected variables two were statistically significant. These are, higher harvesting labor cost and uncertainty due to weather factors.

Among the personal factors shown above (Table 3.8), the number of economically active labor force in the household was found to have a negative relationship with tractor hiring decisions. It was found that to be significant at the 5% level. The finding indicated that households with bigger number of economically active labor force are less likely to hire tractor mechanization services as the excess labor is used for carrying out field operations. This can be interpreted as when other independent variables remain constant, for every unit increase in number of economically active labour in the household, the odds of hiring tractor mechanization services decreases by 97.7%.

The existent of off-farm income of the household exhibits statistical significance ($p<0.05$) to make tractor hiring decisions and is consistent with the hypothesis. Farm households who have additional income from other activities tend to spend much of their time on trading activity or engage in employment opportunities and would prefer to hire tractor services for their land. In line with this, the result indicates that the odds that households decide to hire tractor ploughing services is 163 times more for farmers who

had off-farm income. However, the result showed that this variable is statistically insignificant for making combine harvesting hiring decision.

Number of oxen owned was found to be significant ($P<0.05$) at 0.014, but negatively related to tractor hiring decision. This means that the odds of hiring tractor ploughing services decreases by 78 percent for every unit increase in the number of oxen owned. The result of the logistic regression is in line with the hypothesized assumption that farmers who owned a greater number of oxen tend to use the available animal draft power instead of hired tractor.

Farming goal was measured using a dummy variable; represented by value of 1 for farmers who used their land to produce wheat seed and 0 other wise. The model result for tractor hiring decision showed positive and significant ($p<0.05$) impact and it confirms to the hypothesis that those farmers who are seed producers tend to hire tractor mechanization services. Farmers who are seed producers believed that tractor ploughed fields are better to get a better yield. However, though it has got a positive influence, it is statistically insignificant to make combine harvesting hiring decision.

Institutional influence through government extension system was statistically significant to make tractor hiring decision positively which is in line with the hypothesized assumption. However, this variable was found to be statistically insignificant to make hiring decision for combine harvester. The reason may be that little or no effort is required by extension workers to convince farmers since combine harvesters are well accepted and have higher demand. However, for tractor service, there is low uptake and an institutional influence through government extension service have a role in affecting the hiring decision of farmers. As predicted in the model, the odds

of making tractor hiring decision is 11 times more for farmers who said that an extension worker convinced them to hire tractor services.

Higher harvesting labor cost was found to be statistically significant, hence, it influences the hiring decision of combine harvester positively. It was hypothesized that if there are relatively less agricultural laborers, shortage will be created and labour cost would become high then farmers' demands for agricultural machinery operations will be relatively strong. Thus, the result of this study confirmed the hypothesis. The result showed that the odds in favor of hiring combine harvester are 145 times more for farmers who reasoned out a high harvesting labour cost as a cause. However, the model for tractor hiring decision showed that shortage of labour has no significant role to make tractor hiring decision.

The effect of weather factors to make hiring decision of combine harvester was found to be significant. It was hypothesised that uncertaininty from weather is a push factor to make hiring decision of combine harvester. The results of the model confirmed that farmers in general will make hiring decision in order to avoid crop loss due to unexpected rain. The odds of success in hiring of combine harvester due to unexpected weather factors is 136 times higher for farmers who used the service.

At 10 percent significant level, only total farm land size was found to be positively associated with the decision to hire tractor mechanization services. The model predicted that for every unit increase in the total farm land size of the household, the odds of hiring tractor ploughing service increases by five unit. Farm size was hypothesized to have a positive influence to make hiring decision, but it was found to be significant ($P<0.1$) only for making hiring decision of tractors. Though not significant for

making hiring decision of combine harvester, respondents who had larger land size tend to hire combine harvesting mechanization services.

At 10 percent significant level, size of household and area of land dedicated for wheat production have significant contribution to make combine harvesting decision. In line with the hypothesis, the model predicted that the odds of making hiring decision for combine harvester service is 40 times more for households who allocates larger area for wheat production.

Similarly, the odds ratio from Table 3.8 explains that for every additional number of household member, the likelihood to hire combine harvester service increases by approximately 7 times. The reason for this may be that most farmers with large families are those with higher income level who can afford to hire combine harvester. However, the result suggests further study.

Even if statistically insignificant and has no correlation to combine harvesting decisions, the result suggested that women households are likely to hire the service. Moreover, the model predicted that households headed by men are dominant to make tractor hiring decision. In both model's, level of education has got a negative sign and insignificant to make hiring decision. Although higher education level was postulated to have a positive influence on hiring decision, the findings of this paper indicated a negative relationship - contrary to the hypothesis of the study, suggesting further investigation.

Conclusions and Recommendations

Conclusions

The study analyzed the factors affecting farmers' decision in hiring tractor ploughing and/or combine harvesting mechanization services in three kebeles of *Debre Elias Woreda*, Amhara region. Overall, the survey findings suggest that personal factors such as economically active labor force, resource factors, perception and social factors as well as time factors had explained the circumstances in which farmer decide to hire mechanization service. The decision of hiring for such service is due to the fact that farmers have obtained higher benefits of using the services, which eventually contributed for the livelihood improvement of their families.

The results from the regression model showed that many of the independent variables were significantly associated with hiring decision. In other words, they confirmed the original expectations. The explanatory variables considered had specific role in making hiring decisions. The existent of greater number of economically active labor force within the household has a negative influence in making tractor hiring decision. While other factors such as off-farm income, farm size, the number of oxen owned, the influence by extension personnel/system and goal of farming showed a positive influence on the decision of farmers in hiring mechanization services. The findings of the regression analysis also identified some factors that have significant contribution for farmers to make hiring decision for combine harvester. Shortage of labor resulted in high labor cost, and it influences farmers' decision positively to hire combine harvesters. Push factor from weather uncertainty was identified as one of the significant factors which influenced farmers to make a hiring decision. It was also

identified, following the response of interviewed farmers, using combine harvester significantly decreases harvesting costs and improve quality of the product harvested.

Majority of the respondents did not hire tractor mechanization services, there are many who are not convinced of the benefits. Apart from ploughing and some discing operation other tractor mechanization services are non-existent. Majority of the farmers got machinery service from private custom hire operators. Unions and or cooperatives have few machineries and only serve a small portion, mainly to their members. Thus, there is lack of access specially for tractor hiring services. The number of service providers operating in the study area were few and the service hiring rate for both technologies was relatively higher when compared to other places.

The study has also shown that service providers are not able to fully utilize their machinery in the working days due to cultural limitations. Due to cultural factor, machineries can be under farming operation only for a few days of a month i.e., days agreed/permitted for farming activities in the study area. It is suggested that such practice affects the profitability of service providers by restricting the generation of more sales. Thus, the relatively higher service charge requested in the area might be to compensate and increase service provider's return on investment. Moreover, it may discourage service providers from investing in additional equipment and expanding the service in the area.

An important conclusion coming from the analysis of the surveyed data is the role of extension in influencing the hiring decision of farmers. Most of the farmers who hired mechanization services made decisions following the information they received from extension workers through the existing

extension system. In addition, farmers also trust information coming from other farmers. Even though brokers exist in most parts of the research area, most farmers are not convinced of their role. Most of them don't consider them as important actor in promoting the service and to extent farmers also blamed brokers for making the hiring rate expensive. Thus, the findings suggest that demonstration and awareness creation is important for better understanding of the mechanization technologies in order to improve the hiring decision of farmers.

The factors that affect the hiring decision of mechanization services are identified to help various stakeholders to enhance the current level of utilizing mechanization technology by smallholder farmers. This paper can be used to inform the government to develop interventions that would increase the accessibility of mechanization services by smallholder farmers. Interventions regarding institutional support such as availing financial credit for mechanization services, incorporating mechanization support to farmers through extension system and encourage the establishment of support services (small workshops, spare parts shop, fuel stations etc.) are required for the smooth functioning of machinery service providers in the locality.

Recommendations

Based on the results of the study, the following recommendations are formulated.

- Agricultural extension plays a central role in assisting farmers utilize technologies. It is important that farmers are well informed about the multi-functional use of tractors. New approaches to extension services are recommended through interactive training and demonstrations. Increasing training and demonstration on farm

mechanization technologies will increase farmers knowledge on the economic and social benefits and may have a positive effect to decide to hire the services.

- Shortage of economically active family labor was identified as significant to make hiring decision for tractor mechanization services. Due to rapid urbanization, this will continue, and the increase in mechanization use will grow. Hence the custom hire model should be supported to become efficient and accessible.

- Farmers with better off-farm income and total income were relatively better to make hiring decision for mechanization services. Hence, it is recommended to introduce activities that would enhance the income generating capacity of household. In addition, credit and finance should be made available to hire the services with a special arrangement with the service provider to ensure credits are used for the intended purpose.

- Facilitating information and communication technology (ICT) solutions using mobile phones can be used as a means of making accessible mechanization service to farmers. It can facilitate the timely availability of mechanization services. Rural educated unemployed youth who have high aspirations for ICT should be encouraged to engage. Brokers service might also help. Building trust and maintaining satisfaction of farmers is important for brokers to influence the hiring decision of farmers. They need to be supported in facilitating and in making the hiring process short and

easy. Training for brokers to make them efficient and more professional is recommended.

- Trust needs to be built between service providers and farmers. Availing machinery when it is required and offering quality services to the satisfaction of the farmer are important. Due to the critics of quality of service offered by machinery contractors, it is recommended to strengthen the skill and knowledge of operators as well as the managers through training.

- Most interviewed farmers responded that apart from ploughing service, no other tractor mechanization service is available. Hence it is recommended to make demonstration and promotion on different tractor mechanization operations such as discing, harrowing, row planting and spraying.

- Improving rural road network is highly recommended for farmers to gain better access to mechanization services. In addition, government should encourage and support the establishment of rural maintenance workshops, fuel stations, spare parts and supplies shops.

- High cost of machinery is one cause for insufficient accessibility. Government policy should support the expansion of agricultural machinery supply through long term loan with low interest rate, subsidy, lease, tax and duty exemption and establishing agricultural mechanization fund. In addition, subsidizing fuel cost used in

agriculture would help to minimize the hiring rate of mechanization services.

- Promote cluster-based farming operation for effective use of farm machineries. Accessibility will be enhanced as clusters will give a chance for the service provider to work on a greater number of plots in one locality. Clustering farmers will also make convenient to organize mechanization services given to a group of smallholder farmers such as tractor spraying operation.

- As uncertainty due to weather is important to make hiring decision for combine harvesters, provision of timely local weather forecasts would help farmers plan and book for hiring services.

- Cultural factors limit the increased use and accessibility of agricultural machinery service to few days in a month. Since society guides the behavior and thoughts of their members, it is not that easy to bring fast change. However, these cultural beliefs may weaken over time. Hence, government-initiated discussions among community leaders, church leaders and other important actors are suggested.

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