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Economic Analysis of Farmers Preference for Mechanization Technology Traits: In Case of Jimma

Mengistu Jifara Medeksa
Oromia Agricultural Research Institute, Jimma Agricultural Engineering Research Center,
PO Box 386, Jimma Ethiopia

Abstract
The aim of this research is to better understand farmers' perception of the relevance of different technology intervention programs. Farmers' subjective ranking of mechanization problems and their preference for development intervention are elicited using a stated preference method. The factors influencing these preferences are determined using a random utility model. Study is based on a survey conducted around jimma area of the southwestern Ethiopia. Individual interviews were conducted with 145 randomly selected farm households using semi-structured questionnaires. The study suggests that quality of technology, income of farmers and access of technology are high priority preference problems for farmers.Local market prices for mechanization technology and high prices for purchased it also came out as major problems for the majority of farmers. Farmers' preferences for mechanization technology traits fall into two major categories: pre-harvest post-harvest technologies. Multinomial logit analysis of the factors influencing these preferences revealed that farmer's specific socioeconomic circumstances and subjective ranking of agricultural problems play a major role. It is also shown that preferences for some interventions are complementary and need to be addressed simultaneously. Recognition and understanding of these factors, affecting the acceptability of development policies for micro level implementation, will have a significant contribution to improve macro level policy formulation.Technology preference information is essential to targeting research. This manuscript presents the findings of a study that evaluated farmers' preferences on mechanization technology traits, including the economic perspective; as a basis for enhancing adoption of the technologies in the central southwestern Ethiopia. Also reports an effort on different technology to measure the market value of technology characteristics/attributes. Five technologies were selected from jimma agricultural mechanization. In the market, price and easy to use characteristics were noted. In the quality of technology, price, easy to use, availability and damage levels were considered
Keywords: preference, traits, technology and farmers

1. INTRODUCTION

Agriculture is the most dominant and important sector in the Ethiopian economy. The economic importance of agriculture stems primarily from the fact that it contributes about 45 per cent of the Gross Domestic Product, 94 per cent of merchandise exports, provides employment for 85 per cent of the population, and supplies about 70 per cent of the country's raw material requirement for large and medium sized industries that are predominantly agro-based (NBE, 2011).

The average size of their land holdings is small, just 0.11 hectares per person and production is subsistence, rather than market, oriented (DFID 2006). The sector can be characterized as low input and low value since it is heavily dependent upon rain-fed agriculture; seldom uses improved agricultural inputs and methods; and suffers from declining land productivity owing to land degradation and soil erosion. Ethiopian agriculture is very vulnerable to climatic shocks, especially drought, which often lead to harvest failure and food insecurity (Ayenew Alem 2008).

Like elsewhere in African countries, in Ethiopia the role of improved agricultural mechanization technologies and equipments to small and medium-scale farmers in increasing agricultural production and productivity has created so much controversy (Mrema, 1991). It is perhaps the indivisible nature of agricultural mechanization technologies, as compared to biochemical ones (improved seed varieties, fertilizers, crop protection chemicals and better crop and livestock husbandry techniques), which has made this technological input so controversial.

Societies depend on agricultural innovation processes for food security on local, regional and global scales. Agricultural technology embodied in the agricultural production practice by farmers, are important component of these process. Sustainable management agricultural productivity means assuring their optimum utilization both in trust collections and on farms. In agricultural systems technology preference depend on their contribution in productivity, combat the risks farmers face from different shocks.

Technological changes in agricultural production over the past century, spurred by technology improvement combined with the use of other farm inputs, have transformed rural societies in many parts of the world (Smale, 2006). Not all of these changes have been positive. The common challenge now is to develop strategies that enable agricultural technology to be managed in ways that satisfy the needs of farmers at present and in the future. Some countries with different agricultural technologies belong to the group of poorest countries in the world (Von Braun and Virchow, 1996). Ethiopia is among those countries that are economically poor but still have different pre and post-harvest technologies.

The benefits that Ethiopia may derive from its agricultural technology on her hands depend on their priority on productivity, adoptability, risk minimization and other attribute to prefer/chose one technology to the other.

The purpose of this study is to contribute to a better understanding of the challenges by obtaining an insight into Ethiopian farmers' agricultural technology attribute preferences and identify the most important farm household contextual factors that condition their agricultural technology attribute preferences. Its use for undertaking to increasing agricultural productivity for successful rural interventions like contextual agricultural technology development and dissemination, policy has to be informed on among other things 'who prefers what kind of technology attributes most?' and 'how much are farmers willing to trade-off one technology attribute for another?' In this study, we try to give answer to these and related questions by analyzing farmers' agricultural technology adoption behaviors towards the selected technology in the country.

Why and how are farmers' preferences for agricultural technology traits relevant for modern technology adoption? According to the characteristic model developed by Lancaster (1966), consumers derive utility not from goods themselves but from the attributes they provide. Accordingly, this implies that farmers are maximizing their household utility by consuming their preferred technology attributes not by directly utilize any technology embedding those preferred attributes. Hence, what farmers are looking for at the end of the day is technology attribute, and the demand for technology can be considered as a derived demand revealed from farmers' preferences for technology attributes. Therefore, understanding farmers' technology attribute preferences will be useful to predict the likelihood of survival of technology embedding those attributes. This enables policy makers to identify technology for which policy incentives are required and those that can be maintained de facto (It is the decision of farmers to continue utilize local technology or It is not deliberate result of farmers' derived demand for different agricultural technology while trying to achieve their livelihood). In JAMRC priority setting too, understanding farmers' technology attribute preferences will serve as an input for developing different technologies with more chance to be adopted and be successful.

2. Methodology

2.1. Sampling Procedure and Sample Size

For the purpose of this research, multistage stratified sampling technique was applied to select representative sample unit farmers from a domain of mechanization technology users. Primarily, districts are purposefully selected from three districts of Jimma zone. These were Gomma,Limu kossa and Omo nada districts. In each district three PAs were selected for the study. These are Chedaro suse,Bulbulo,Kotta,Kecho Tirtira,Mixo Gundub and Chime respectively, since they are among technology users. Then, farmers in each woredas are stratified to two strata using their capital holding as performance indicator to form more homogeneous household to randomly select farmers from each stratum pursuing for representativeness of generated data.

2.2. Methods of Data Collection and Data Sources

The data used for this analysis was obtained from secondary and primary sources.

2.2.1. Household survey

The fulfill data needed for accomplishment of this research, primary data was collected by house hold survey in two phases. The first phase involved a reconnaissance survey using semi-structured and open ended questioner, focus group discussion, experts and elders consultation. It was conduct mainly to generate information used to develop structured questionnaire for formal household survey. Then, the developed structured household questionnaire was pretested for its understandability, answer and completeness. Improvements will make by test results and the final structured questionnaire for household survey will develop. Then, formal household survey was administered using the finally edited structured questionnaire.

2.3. Survey Design and Study Sites

The study was employee a choice experiment approach to evaluate farmers' preferences for the various attributes of technologies. In a choice experiment, individuals are given a hypothetical setting, and then ask to choose their preferred alternative (usually repeatedly) from several alternatives in a choice set. Each alternative is described by a number of attributes that take on different levels. In our case, the farm households are given choice sets with different alternative technology type. The most important technology attributes and their levels will identified in consultation with experts (technology users and researchers with hands-on experience and practical knowledge of the relevant technology attributes), by reviewing previous studies and historical data, and by identifying the most important technology selection criteria put forward by a focus group of will survey households.

The technology traits will be identified based on historical facts and with carefully crafted focus group discussions that have involved field extension workers, experienced farmers, village leaders, agricultural researchers working in the areas (mainly for post/pre-harvest technologies), district agricultural officers etc. The expert consultations and intensive discussions made with farmers reveal that technology levels, technology stability, environmental adaptability, and buying unit price are the most important technology attributes for their productivity. Based on this, the experiment will conducted using these technology attributes and for the major technology available in Jimma and Ilubabor zone.

2.4. Methods of Data Analysis

2.4.1. Descriptive Statistics

By employing descriptive statistics, it is possible to describe sample desired characteristics. The aim of using descriptive analysis in this research is to give an overall picture of technology users of household socio-demographic and geographic characteristics. Descriptive statistics such as mean, standard deviation, percentage and frequency of occurrence will used with econometric models to illustrate and offer the picture of collected data.

2.4.2. Econometric models

Depending on the objectives of this research, different econometric models will employ. However, all models employed can be categorized under Random utility modeling and simultaneous linear regression modeling frameworks.

2.4.3. Random utility modeling theoretical framework

Utility theory plays significant role to model economic agent's choice decision. It is useful to analyze individual's laws of choices while welfare theory is prime tool to discuss the scientific conclusion of the relationship between the choice individuals made and its possible consequence on social interest (Rothbard, 1997). Small scale farmers are expected to decide on using technology. The heart of rational economic theory is the thought that a rational decision makers seek to maximize the utility of innate and stable preferences over the quantities and attributes of their decision. As a result, any farmers' decisions have an implication on utility maximization of the household.

According to the consumption technology theory (Lancaster, 1966), the utility derived from a decision not comes from the decision itself that one made, rather from the attributes of the decision. It asserted that the value of a good is then given by the sum total of the value of its attributes. Further, under random utility theory first developed by (Thurstone 1927) and later empirically applied by (McFadden, 1974ab, 1978), a decision maker visages a choice among alternatives with a utility decomposable in to two components. According to this theory, the total utility that a decision maker obtains among alternatives is known to the decision maker. Following, some attributes of the choice alternatives and characteristics of a decision maker are observable for the analyst and the function that relates these observed factors to the decision makers' utility can be specified. However, the other component of the utility that an individual knows is not observable. Individuals face a choice among alternatives and choose the alternative that provides greatest sum of both utility components. It chooses one alternative if and only if its utility is greater than other alternatives.

3. RESULTS AND DISCUSSION

3.1. Preferences for mechanization technology traits

Preferred mechanization technology traits suggested by farmers are classified into two major categories for analysis, pre-harvest and post-harvest mechanization technologies (Table 3). These stated preferences correspond to past and current OARI pursued by the regional government and jimma agricultural research center, indicating farmers' awareness about possible intervention areas. The focus of this study is analysis of the differences in farmers' technology preference as a function of their specific circumstances.

The results show that about 32 percent of the respondents would prefer intervention in the area of improving pre-harvest technology and its quality. This reflects the problems farmers face due to inability to pay for technology and improved technology credits that sometimes cost them their important technology asset.

Table 3: Sample farmers preferred agricultural mechanization technology in Jimma area

Type of assistance preferred	Responses	
	Number	Percent
No opinion	19	13.1
Pre-harvest	46	31.7
Post-harvest	33	22.8
Pre-harvest and its quality	25	17.2
Others	22	15.2

This is an indication of the absence or low level of using mechanization technologies. Farmers do not have access to credit from formal governmental or private financial institutions because of lack of capital assets to be used as collateral especially on mechanization technologies/selected from JAMRC.

3.2.Determinants farmers' preference

Agricultural mechanization technology traits in Ethiopia are often planned without sufficient knowledge of farmers' resource endowment, priority problems and felt needs. Moreover, the same type of technology is designed and implemented to work for all regions and farmers across the country. The cultural background of different peoples, ecological conditions, available technologies and manpower, and many other factors constitute a context within which rural development programs attempt to bring changes.

Table 4: Summary statistics and definition of explanatory variables for farmers' technology preference in Jimma area

Variable	Definition	Value	Mean values
Prefer	Preferred mech. technology (Dependent variable)	No opinion = 0 Pre-harvest = 1 Post-harvest = 2 Pre-harvest& it qlity = 3 others = 4	
Age	Age group interval of the household (HH) head *	1 … 5	2.53
Education	Years of formal education.	1, 2, 3…	2.32
Ethnic	Ethnic group of the HH head	1/0=majority/ minority	0.70
Family	Family size	-Number. 1, 2, 3…	6.43
Dependent	Economical dependent HH member	Number, 1, 2 3…	3.19
Food	Often produce enough food	1/0 = yes/ no	0.37
Total Land	Cultivable land holding in hectares	-0.1, 0.2, 0.3, …	0.73
Livestock	Livestock in tropical livestock unit	-0, 0.1, 0.2, 0.3, …	1.41
Per-Crop	Grow permanent crops	1/0 = yes/ no	0.67
Fertilizer	Used chemical fertilizer	1 /0 = yes/no	0.41
Output P.	Consider output price to be	1/0= High/reasonable	0.32
Input P.	Consider input price as	1/0= high/reasonable	0.84
Erosion	Priority rank of erosion problem	Same	0.61
Small Land	Priority rank of farmland shortage	Same	
Disease	Priority rank of disease & pest problem	Same	0.23

*1 = < 30, 2 = ≥ 30 & <40, 3 =≥ 40 & <50, 4 = ≥ 50 & < 60, 5 = > 60 years old

**1 = 1st, 0.8 = 2nd, 0.6 = 3^{ed}, 0.4 = 4th, 0.2 = 5th, 0 = not in 5 major priority problems

The preference determinant function, used in this study, incorporates a list of variables (Table 4) that reflects the socio-economic circumstances of farm households, institutional aspects, and farmers' perceived priority technology. These variables are assumed to potentially affect farmers' preferences for mechanization technology intervention. However, no *a priori* assumption is made about the direction or magnitude of the influence of the variables due to lack of a theoretical or empirical background relating personal and farm characteristics to preferences for different development intervention programs in jimma zone.

The multinomial logit analysis results (Table 5) suggest that educational status and priority rank of mechanization technology positively and significantly (<0.1) influence preference for pre-harvest technology. Total land holding and the number of economically dependent household members have a significant (<0.05) negative influence on this preference. The influence of mechanization technology and total land holding is straightforward and can be explained by simple logic. Those who have more land do not have any motivation to be displaced and face an uncertain new technology; they rather prefer interventions that help them improve productivity on their land.

Farmers who do not have enough land holding to feed their family have a weak motivation to take the risk of displacement with the hope of getting enough land resources to solve their family problems. The positive correlation of educational status with pre-harvest mechanization technology can be explained by the higher-level awareness of educated farmers about the problems and opportunities provided by such an involvement.

The influence of economically dependent household members provides an interesting insight into the issues to be considered. It appears that families with a higher number of economically dependent members are less willing to use mechanization technologies. This shows the concern that the economically dependent household members, children (≤14 years old) and elderly people (>65 years old), may face hardships to mechanization technologies. Families with fewer dependent members are showing willingness to take the risks and find productive lands on which they can use their labor force more productively.

Table 5: Marginal log probabilities of determinants of farmers preferences for mechanization technology traits in jimma area

	Pre-harvest/mech				Post-harvest/mech			
Variable	Coeff.	Std. Err.	T-ratio	P-value	Coeff.	Std. Err	T- ratio	P-Value
Age	-0.070	0.056	-1.249	0.212	-0.017	0.055	-0.304	0.761
Education	-0.020	0.023	-0.874	0.382	0.000	0.022	0.042	0.966
Ethnic	-0.157	0.123	-1.283	0.200	0.992	0.116	0.858	0.391
Family	0.134	0.040	0.336	0.737	0.007	0.041	0.163	0.871
Dependent	-0.041	0.048	-0.856	0.392	0.022	0.047	0.471	0.637
Food	0.328	0.139	2.351	0.019**	-0.230	0.134	-1.711	0.087*
Total Land	-0.037	0.199	-0.188	0.851	0.351	0.180	1.958	0.050** -0.024
Livestock	0.013	0.062	0.211	0.833	0.056	-0.418	0.676	
Per-Crop	0.007	0.115	0.061	0.952	0.047	0.113	0.414	0.679
Fertilizer	-0.109	0.129	-0.844	0.399	-0.778	0.116	-0.672	0.502
Output P.	0.004	0.117	0.035	0.972	-0.091	0.120	-0.757	0.449
Input P.	0.833	0.220	3.782	0.000***	-0.509	0.163	-3.115	0.002***
Drought	0.226	0.171	1.322	0.186	-0.108	0.150	-0.716	0.474
Erosion	-0.241	0.186	-1.294	0.196	0.327	0.185	1.764	0.078*
Small Land	-0.186	0.159	-1.170	0.242	0.111	0.144	0.773	0.440
Disease	0.394	0.200	1.972	0.049**	0.177	0.193	0.918	0.359
	Pre-harvest & quality/mech				Others/mix			
Variable	Coeff.	Std. Err.	T-ratio	P-value	Coeff.	Std. Err	T- ratio	P-Value
Age	0.019	0.038	0.495	0.621	0.011	0.026	0.406	0.685
Education	0.007	0.128	0.512	0.609	0.021	0.011	1.932	0.053*
Ethnic	0.093	0.083	1.123	0.261	-0.015	0.056	-0.267	0.789
Family	-0.014	0.028	-0.515	0.607	0.026	0.018	1.423	0.155
Dependent	0.025	0.032	0.787	0.431	-0.049	0.025	-1.959	0.050**
Food	0.106	0.083	1.271	0.204	0.015	0.068	0.212	0.832
Total Land	-0.085	0.109	-0.783	0.434	-0.305	0.127	-2.407	0.016**
Livestock	-0.026	0.346	-0.743	0.458	0.040	0.030	1.330	0.183
Per-Crop	0.060	0.076	0.793	0.428	-0.045	0.054	-0.831	0.406
Fertilizer	0.027	0.077	3.474	0.001*** 0.054	-0.084	0.068	-1.233	0.218
Output P.	0.072	0.750	0.453		-0.019	0.053	-0.351	0.726
Input P.	-0.179	0.095	-1.880	0.060*	-0.054	0.077	-0.703	0.482
Drought	0.016	0.108	0.148	0.881	-0.068	0.068	-1.009	0.313
Erosion	-0.103	0.099	-1.040	0.298	0.060	0.089	0.666	0.505
Small Land	-0.145	0.096	-1.514	0.130	0.145	0.845	1.717	0.086*
Disease	-0.059	0.113	-0.523	0.601	0.129	0.093	1.390	0.165
Dependent variable					Preference			
Number of observations					145			
Log likelihood function					-163.263			
Restricted log likelihood function				-225.7050				
Chi-squared					124.883			
Significance level				0.00000				

*Significant at < 0.10, **Significant at < 0.05, ***Significant at < 0.01.

Farmers' experiences in chemical fertilizer use positively and very significantly (< 0.01) influence preference for mechanization technologies. This could be explained by the fact that availability post-harvest technology is crucial to get higher yields from the use of all technologies. In order to be able to pay for the purchase of mechanization technology maximizes the returns from its use. Perception about input prices has shown significant (< 0.1) negative correlation with preference for pre-harvest and its quality. This is an indication of the complementarily between chemical input use and pre-harvest and its quality. Investment in chemical fertilizer gives higher benefits when pre-harvest and its quality/mechanization availability is ensured; and returns from investment in mechanization technology could be .

The correlation is significant (<0.05) for food production status and very significant (<0.01) for farmers' perception of input prices. Rank of crop disease and pest problems has also shown significant (<0.05) positive correlation with preference for mechanization technology traits in the area of pre-harvest technology. These results are straightforward because those farmers who consider input prices to be high and those farmers who give a high ranking to disease and pest problems would prefer pre-harvest technology in the area of an input supply system. The positive correlation between food production status and preference for intervention in the sphere of pre-harvest could be explained by the desire of farmers to have good prices for any amount of surplus they would be able to sell in order to procure themselves with consumer goods and farm inputs at reasonable prices.

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The author, Mengistu Jifara Medeksa, was born on 24 September 1984 at a small village called Chobi in Jeldu district, West Shoa zone. He attended has elementary education at Chobi Primary School from 1994-2000 and secondary education at Jeldu Junior Secondary High School from 2002-2003 and at Ginchi Comprehensive Senior Secondary School from 2001-2004. After he successfully passed the Ethiopian General Secondary Education Certificate Examination (E.G.S.C.E.), he joined Hawassa University in 2005 and graduated with the degree of Bachelor of Science in Agricultural Resource Economics and Management in July 2007. Then he was employed by Oromia Agricultural Research Institute (OARI) and was assigned to work at Jimma Agricultural Mechanization Research Centre (JAMRC) as a Junior Researcher in December 2008. He worked in socio-economic Team as junior researcher until he joined Haramaya University in September 2010 to pursue Master degree of Science in agricultural economics. Mengistu holds Bsc degree in Agricultural Resource economics and management from the University of Hawassa and Msc in Agricultural Economics from Haramaya University. Mengistu has nine Years of Experience in Research, program management, monitoring and evaluation in the area of research and development issues in mandate of his jobs. He also certified by design & analysis of experimental data using 'SAS' and 'research proposal writing from EIAR and Jimma university college of agriculture and veterinary medicine with collaboration of Ministry of Science and Technology respectively.