Adoption and Impact of Improved Wheat Technology: The case of Hula Woreda, Ethiopia.

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Abstract

This study provides information on the factors affecting adoption and the impact of wheat technologies. It also identifies the adoption rates and patterns of adoption of wheat technologies in the study area.

The study was based on the data collected using from 124 randomly selected households. The survey was conducted structured questionnaire. In addition, secondary data collected from relevant sources were used to substantiate the primary data.

Tobit model was used to identify factors affecting adoption and intensity of use of improved wheat varieties. Fourteen explanatory variables were included in the model. Among these fertilizer use, income and access to credit were important factors influencing adoption and intensity of use of improved wheat varieties. The impacts of improved wheat varieties also portray the increase of the farmers' production of wheat varieties and improve their incomes as farmers adopted wheat technologies. The financial analysis using the partial budgeting method and price sensitivity analysis substantially ascertain the profitability of the adopted improved wheat technologies.

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Introduction

Agriculture in the Ethiopian economy contributes 50% of GDP, employs 80% of the population and generating income for the majority of the rural population. Cereals, pulses and oil seeds are the major crops grown in Ethiopia accounting for about 42.5% of the total agricultural GDP.

Wheat (*Triticum aestivum*) is grown in the highlands at altitudes ranging from 1500 to 3000 masl. However, the most suitable agro-ecological zones for wheat production fall between 1900 and 2700 masl (Hailu, 1991). In sub-Saharan Africa, Ethiopia ranks second to South Africa in terms of total wheat area and production.

At present in the South Nations, Nationalities and Peoples Region State (SNNPRS), maize, teff, barley, wheat and sorghum account for 78% of the crop production (BOPED, 1998) and wheat accounts for 13% of cereal production. In Hula Woreda of SNNPRS, new wheat technologies were promoted. The technologies promoted include improved varieties, fertilizer rates, methods and types, improved agronomic and weed control practices. These technologies were promoted by governmental and non-governmental organizations.

Farmers learnt about new technologies from various organizations, programs and projects dedicated to research, extension and rural development. The level of adoption of these improved agricultural technologies in respect to the use of improved practices and improved agricultural inputs by the farm households is still low. Although the yield potential of improved wheat varieties range from 30-70 qt/ha, farmers' yields are substantially lower at around 18 qt/ha. The severity of smut infestation and weeds competition, use of traditional farming practices contributed to low level of yield.

The adoption decision of farmers is usually determined by various factors. Factors affecting the adoption of improved wheat technologies are documented by Chilot et al (1996), Mulegetta (1994) and Tesfaye et al, (2001). The rate and intensity of adoption, as well as the impact of the new technologies on yield of wheat and farmers income are not known in the

study area. Accordingly, this study was conducted in Hula woreda of Sidama Zone with the Objective of:

(i) Examine the rate and intensity of improved wheat varieties by smallholders;

(ii) Identify socio-economic and other factors that influence the adoption of improved wheat varieties;

(iii) Assess the impacts of the technologies on yields and farmers' incomes.

Literature Review

Definition of Adoption

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

The history of adoption and diffusion research can be dated back to the early 1940s beginning with the study of Hybrid maize diffusion in Iowa, USA, by the rural sociologists Ryan and Gross (1943). Although the period indicated was taken as an important period with respect to a modern type of adoption and diffusion studies, there are evidences showing that studies were undertaken on the subject prior to that period.

A review of the literature on the adoption of high-yielding seed varieties (Ruttan and Binswanger 1978) suggested that neither farm sizes nor farms tenure has been a serious constraint to adoption. Although different rates of adoption by farm size and tenure have been observed, the available data showed that within a few years of introduction, the lags in adoption due to size or tenure have usually disappeared. Of course, the non-adopters will have foregone the potential gains of early adoption and may already have suffered as a consequence. However, these conclusions have not been altered by more recent research.

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

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

An adoption study by Chilot et al. (1996) applied probit and tobit regression models to assess factors affecting adoption of new wheat technologies in Wolmera and Addis Alem districts. They found that perceived profitability of the new wheat technologies and the timely availability of fertilizer and herbicide had significant effect on farmers' decisions to adopt. Distance of respondents' homes from extension centers also influenced the probability of adopting improved wheat variety, as well as the intensity of fertilizer and herbicide use. They found that characteristics of the household and household heads had little influence on the adoption decisions of farmers.

A study done by Mulugetta (1994) showed that wheat production technologies are profitable but inputs are used sub-optimally. Mulugetta also pointed out that institutional variables (input availability, access to credit and extension contact) significantly affected the incidence of adoption while economic factors (farm size, oxen ownership, labor availability) influenced the intensity of use.

Furthermore, an adoption study by Tesfaye et al. (2001), shows that farm size influenced the adoption of improved wheat varieties positively and significantly. Participation of farmers' in on-farm demonstration also positively and significantly affected the adoption pattern of farmers. Interaction with extension agents, service cooperative (SC) representatives, or leadership position contributed significantly and positively to adoption. Other variables such as radio ownership contributed very little suggesting that information about improved wheat production technologies is more effectively diffused among farmers through extension contact and demonstration of an improved wheat variety. Livestock ownership, distance to a development center, and years of farming experience did not contribute to the adoption of improved wheat varieties.

From the review of empirical studies, it could be inferred that agricultural technology adoption and diffusion patterns are often different from area to area or location to location. Such differences were attributed to variations in agro-climatic, information, resource endowment and the type of technologies adopted in the respective study. Hence, carrying out adoption studies to identify adoption determinants for different areas can help in developing suitable technologies and in effectively promoting them.

Methodology

The study area

This study was conducted in Hula Woreda located in Sidama zone of SNNPRS. The woredá is 97 kms away from the regional capital, Awassa. Wheat is one of the major crops in Hula woreda. The study area has better access to improved agricultural technologies: improved seed, fertilizer, and herbicide. Improved wheat varieties introduced in the area include HAR-604, HAR- 710, HAR -1685, and HAR-1709. The main rainy season starts in June and continues to the end of September. The major crops produced in the worada include wheat, barley and enset. Farmers have an integrated crop and a livestock production system and hoe cultivation practice is predominant.

Sampling Procedure

For this study four kebeles were selected based on their wheat production potential and accessibility. Random sampling technique was applied to select the sample households. From selected kebeles a total of 124 household-heads were randomly selected.

The survey was conducted in October 2001. Enumerators who have local knowledge and fluent in local language were recruited and trained. A questionnaire was developed and pre-tested and modified. Enumerators administered the questionnaire under the supervision of the researcher.

Analytical Model

The econometrics models commonly used in adoption studies are qualitative choice models including the linear probability function, logistic distribution function (logit), and normal distribution function (probit) and the tobit model. Factors influencing the adoption and intensity of use of new wheat production technologies were analyzed using tobit model. A tobit model is superior to probit and logit (Tobin, 1958; Goldberger, 1964) when the dependent variable is truncated and continuous between a certain lower and upper limit.. The advantage of tobit compared to probit and logit models is that it reveals the probability of adoption and the intensity of adoption.

The impacts of wheat technologies were analyzed using the partial budget method and sensitivity analysis. In addition to the econometric model, descriptive statistics such as mean, percentage and standard deviation were used. Descriptive statistics help to assess and analyze farmers' responses and draw implications for adoption of improved wheat varieties.

Following Maddala (1992) and Johnston and Dinardo (1997) the tobit model can be specified as:

$Y_i = \{Y_i^* = \beta X_i + U_i\}$ if $Y_i^* > 0$ ---------- (1)

$Y_i^* = 0$----------if $Y_i^* \leq 0$

Where Yi = the observed dependent variable.

Y_i^* = latent variable (which is not observable).

X_i = vector of explanatory variable;

β = Vector of parameters to be estimated;

U_i = An independently normally distributed error term with zero mean and constant variance.

McDonald and Moffitt (1980), Maddala, (1983), and Johnston and Dandiro (1997) proposed alternative techniques how to decompose the effects of explanatory variables into adoption and intensity effects. Thus, a change in X_i has two effects. It affects the conditional mean of Y_i^* in the positive part of the distribution, and the probability that the observation will fall in that part of the distribution. This procedure was used in this study.

The change in the probability of adopting improved wheat variety as X_i changes was estimated by:

$$\frac{\partial F(z)}{\partial X_i} = f(z)\frac{\beta_i}{\sigma} \quad \text{---------- (2)}$$

Where, z = Xß/σ, F (z) is the cumulative distribution function, f (z) is the value of derivative of the normal curve at a given point, z is the Z-score for the area under normal curve, ß is a vector of estimated parameter and σ is the standard error.

Similarly, the change in intensity of adoption with respect to change in an explanatory variable among adopters was estimated by:

$$\frac{\partial E(Y|Y_i^* > 0)}{\partial X_i} = \beta\left[1 - z\frac{f(z)}{F(z)} - \left(\frac{f(z)}{F(z)}\right)^2\right] \text{ ----- --------- (3)}$$

The variables hypothesized to influence improved wheat varieties have been analyzed using the Tobit model. The definition of the variables and their unit of measurement was summarized and presented in Annex 1.

Dependent variable

The dependent variable is area planted to improved bread wheat variety as proportion of total wheat area cultivated.

Independent variables

Education level

Education could increase the farmers' ability to grasp, process and use of information relevant to the adoption of improved bread wheat varieties and fertilizer. Education was, therefore, expected to increase the probability of adoption of improved bread wheat varieties and fertilizer.

Age of the Household Head

Age of household head in years. The Farmers' age on adoption and intensity of use of improved wheat varieties can either develop or erode confidence in new technology. In other words, with more experience, a farmer can become more or less risk-averse in evaluating adopting new technology.

This variable could thus have a positive or negative effect on a farmer's decision to adopt improved wheat varieties and fertilizer.

Farm Size

Total land owned by the household. Population pressure in the study area is causing a land shortage, and the scope for increasing land productivity will rely on increased cropping intensity. This in turn will require farmers to allocate their limited land to high yielding wheat varieties. Hence, cultivated land per household is hypothesized to increase a farmer's adoption of new wheat varieties and fertilizer.

Labour in

This refers to the total number of members in a family. Larger households will be able to provide the labor that required for improved wheat technologies. Thus, a larger family size would be expected to increase the probability of adopting new wheat technologies.

Livestock owned

The number of livestock owned by a farmer was hypothesized to be positively related to the adoption of an improved wheat varieties and use of fertilizer. Livestock is the farmers' important source of income, food and draft power in Ethiopian agriculture. Hence, a household with large livestock holding can have access for more draft power. It is also one of the main cash sources to purchase inputs.

Extension contact

Agricultural extension services provided by the Agriculture and Rural Development Bureau at all levels of SNNPRS represent the major source of information for farmers. Contact with extension agents was hypothesized to increase a farmer's likelihood of adopting improved bread wheat varieties and fertilizer.

Exposure to improved technology

Participation on on-farm trials, pre extension and extension demonstration, attending field days gives the farmer's access to information which increases the likelihood that the farmer will adopt new wheat varieties.

Contact farmer

The farmer served as contact farmers has better access and awareness' regarding the available technologies through the extension agents. Thus, contact farmers are expected to adopt improved wheat technologies and positive relation exits between contact farmers and technology adoption behavior.

Use of fertilizer

Fertilizer is a complementary in put in using improved wheat varieties. Use of fertilizer considerably increases yield. Thus it was hypothesized to be positively related to the probability of adoption of an improved wheat variety.

Access to credit

Farmers who have access to credit can minimize their financial constraints and buy inputs. Thus, it is expected that access to credit increase the probability of adopting improved wheat technologies

Accesses to information through radio

Radio ownership and listening to agricultural programs was expected to influence a farmer's awareness and, therefore, the adoption of improved bread wheat varieties and fertilizer.

Income

This represents the amount of annual income the farm household earned in the year. Since smallholder farmers have inadequate farm income, they often look for external source of income to purchase food and farm inputs. Therefore, households who managed to earn more cash income including off-farm income are more likely to adopt new wheat varieties.

Hand hoes

The improved wheat varieties do not require cultivation practices other than what farmers predominantly used hoe cultivation. Hence, the numbers of hand hoes used by farmers are expected to positively affect the adoption of improved wheat varieties.

Empirical Results and Discussion

Wheat Varieties Adopted

Table 1 shows wheat varieties adopted in the study area. The proportion of farmers growing improved wheat varieties is increasing while the proportion growing local varieties is declining. About 67% and 33% of sample farmers were found to be adopters and non-adopters of improved wheat varieties respectively,

Table 1. Wheat cultivars grown by farmers

Cultivars	Percent of farmers growing					
	1996	1997	1998	1999	2000	2001
Local verities	86	84.2	70.9	64.6	34.0	33.0
Improved varieties	14	15.8	29.1	35.4	68.0	67.0
HAR-604	2.4	11.7	10.8	34.2	66.0	67.0
HAR-710	2.4	1.7	10.0	2.4	0.0	0. 0
HAR-1685	9.2	2.4	8.3	0.8	0.0	0. 0

Source: Survey data, 2001

Information on wheat yields by patterns of technology adoption and performance of improved agricultural technologies is presented in Table 2. Use of improved varieties substantially increased the farmers' yield. About 58% of farmers adopted both fertilizer and improved variety, 13% of non-adopters of improved wheat variety adopted fertilizer only.

Table 2. Wheat yields by patterns of technology adoption, Hula Woreda

Pattern of adoption	Farmers reported	Yield kg/ha	% of Adopters	% of Non- adopters
F and V	72	1804	58	0
F only	16	1607	0	13
V only	11	1467	9	0
No technology	7	967	0	6

Source: Survey data, Oct., 2001. Note F= fertilizer , V= variety

Econometric Analysis

The Tobit regression model was estimated to assess the effects of the hypothesized explanatory variables expected to influence the adoption of improved varieties of wheat. Results of the Maximum Likelihood estimate for factors influencing the intensity of adoption of improved wheat varieties is shown in Table 3. Among the variables included in the analysis, farm and farmer specific variables such as fertilizer use, income and credit are highly significant in influencing the probability of adoption and intensity of use of improved wheat varieties.

Fertilizer use was found to be positively and significantly affected the probability of adoption and intensity of use of improved wheat varieties at less than 1% level of significance. This reveals that fertilizer is a complementary input enhancing use of improved varieties. On the other hand, the influences of age, labor, livestock owned, education, farm size, extension contact, demonstration, contact farmer, training, oxen plow, hoe and radio ownerships were not significant.

Income from crop, livestock and off-farm was positively related with adoption and intensity of use of improved wheat varieties at 5% significance level. This is in line with the hypothesis that households who managed to earn more cash income including off-farm income are more likely to adopt new wheat varieties.

Access to credit was found to be positively related with the adoption of improved wheat varieties and its coefficient was significant at less than 1% probability level. The results verify the hypothesis that farmers who have access to credit can minimize their financial constraints and buy inputs more readily.

Thus, accesses to credit increase the probability of adopting improved wheat technologies.

Table 3. Maximum-Likelihood estimates of the Tobit model: Improved wheat variety

Variable	Coefficient	Standard err	t-ratio
Constant	-31.37001	14.7657	-2.12451**
Age	-0.0002	0.014691	-0.0134
Labour	0.036571	0.028347	1.29013
Livestock owned	-0.147115	0.279108	-0.527
Fert. Use	0.547477	0.076559	7.15107***
Income	0.01309	0.006028	2.17176**
Education	-2.51677	5.91104	-1.42577
Farm size	-1.69686	3.91802	-0.43309
Ext-contact	0.30298	0.31545	0.960
Exposure to technologies	0.11598	0.19953	0.058
Contact farmer	0.88729	7.5160956	0.118
Training	-0.13492	0.22915	-0.589
Access to credit	23.53857	6.27342	3.752***
Oxen plow	-0.19409	0.13145	-1.476
Hand hoe	0.70150	0.14024	0.500
Radio	0.83968	0.34370	0.244
Sigma	27.16564	2.26246	
Log likelihood function	-406.4673		
F(z)	0.778		
Z	0.76		

***Significant at P<0.01; ** Significant at P<0.05; Source: Model output

Effects of Changes in Explanatory Variables

The estimates of Tobit model can be used to assess the effects of changes in the explanatory variables into adoption and intensity of use of improved wheat varieties using decomposition procedure suggested by McDonald and Moffit(1980). The effects of changes in the explanatory variables on the probability of adoption and intensity of use of improved wheat varieties are depicted in Table 4.

Fertilizer use, income and credit positively influenced the probability of adoption and intensity of use of improved wheat varieties. Thus increasing fertilizer use by one unit will increase adoption and intensity of use of improved wheat varieties by about 0.0045% and 0.36% respectively.

One percent increases in income increases the probability of adoption and intensity of use of improved wheat varieties by about 0.0012% and 0.09% respectively. The estimated increase in the probability of adoption and intensity of use of improved wheat varieties resulting from having access to credit is 0.19% and 15.44%, respectively.

Table-4. Changes in probability of adoption and intensity of use due to changes in explanatory variables

Variable	Change in probability of adoption*	Change in intensity of use*	Total change
Fertilizer use	0.0045	0.3571	0.3616
Income	0.0012	0.0859	0.0871
Accesses to credit	0.1924	15.4355	15.6279

*Computed using mean values

Source: Based on model output

Analysis of the Impacts of wheat varieties

Partial budget analysis

Improved varieties and fertilizer can increase wheat productivity and production there by improve farmers' income. In assessing the impacts of wheat technologies, it is important to estimate the extent new wheat variety adoption and the resulting productivity gains. Farmers are concerned with the benefits and costs of particular technologies.

Table 5 shows the partial budget analysis for adopters and non-adopters of improved wheat varieties. Adopters obtained net benefit of 2999 birr/ha and the non-adopters obtained 2140 birr/ha. The adopters have gained additional net benefit of 859birr/ha with the additional variable cost of 149 birr/ ha.

Table 5. Partial budget for farmers using combination of Wheat technologies, Hula Woreda

Technology	Yield kg/ha	Gross benefit Birr/ha	Cost that vary (birr)			TVC Birr	Net Benefit Birr/ha
			F and its app	Seed	Trans-port		
Fertiiizer+ Variety	1804	3518	139	368	12	519	2999
Fertilizer only	1607	3134	74	293	3	367	2716
Improved Variety	1467	2860	0	368	7	375	2486
Local variety	1287	2510	0	293	3	370	2140
NT	967	1886	0	293	0	293	1593

Note: NT= No technology, TVC : Total Variable cost
Source: Own computation.

Sensitivity Analysis

Future prices and costs may change and this change influences profitability of improved wheat variety and complementary inputs (CIMMYT,1988) . Therefore, sensitivity analysis was conducted to ascertain the stability of the net-benefit with change in output and input prices with 20% decrease and increase on the current price respectively.

Table 6 shows the effect of price changes on net benefits for wheat technology adopters. Decreases output price by 20% reduces the net benefit to 1914 birr/ha. A 20% increase in input price also reduces the net benefit to 2036 birr/ha.

Table 6. Effect of price changes on net benefits for wheat technology adopters, Hula Woreda

Technology	Price		
	Current (Birr)	20% decrease	20% increase
	AD	AD	AD
Variety	2486	1914	2036

Note: AD = Adopters

The effect of price changes on net benefit for (variety and/or fertilizer) adopters of combination of technologies is indicated in Table 7. A 20% decrease in price of output for the adopters of fertilizer and variety has reduced net benefit to 2295 and 2376 birr/ha respectively. Hence, the additional net benefits of adopters compared to farmers who didn't use wheat technologies were 1079 and 1134 birr/ha and these ascertain the stability of the net benefit. Thus, price sensitivity analysis shows that use of improved wheat varieties were more profitable than use of traditional practices.

Table 7. Effect of price changes on net benefit for wheat technology Adopters , Hula Woreda

Technology	Price of inputs and outputs		
	Current (Birr)	20% decrease in output price	20% increase in input price
FV	2999	2295	2376
F	2764	2137	2321
V	2486	1771	2036

FV= Fertilizer and Variety, F= fertilizer, V= Variety

Conclusions and Recommendations

The econometric results show that socio-economic factors in particular use of fertilizer; household income and credit were found to be determinants of the adoption and intensity of use of the new improved wheat technologies. The profitability of the new wheat technologies increases the rate of adoption of improved wheat technologies. The impact analysis of these technologies also demonstrated that the use of improved wheat varieties were more profitable than the use of local cultivars. Hence, adopters have benefited substantially from the use of improved wheat technologies.

The household income on adoption and intensity of adoption was positively significant on the decision to adopt improved wheat varieties. Therefore, the source of income generation to farmers such as crop, livestock and off-farm activities should be encouraged to hasten the adoption of new agricultural technologies.

Making credit available to farmers is an important way of increasing the adoption of improved wheat technologies and hence increasing the level of production. The current requirement that farmers must have 0.5 ha under wheat in order to participate in the credit program is limiting. In an environment where farm sizes are shrinking due to increased population pressure, this requirement should be reviewed in order to allow more farmers to participate in the package program that includes credit for improved seed and fertilizer. The terms of repayment should also consider the farmers ability to pay. Thus similar results also substantiate the credit issue that "to achieve a positive impact on credit on adoption, the role of the agricultural bureaux should be limited to educational activities and a mechanism should be devised in which the creditor banks themselves enforce loan disbursement and overdue loan collection," (Legesse, et al., 2001).

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ANNEX TABLE

Annex 1. Definition of the variables and units of measurement

Variable	Unit/type	Description
Dependent		
$IVAD_W$	Percent	Area of improved bread wheat as percentage of total wheat area.
Explanatory		
Education	Dummy	Education of household head: 1 if literate, 0 otherwise
Age	Years	Age of household head in years
Farm size	ha	Total land owned by the household
Family labor	Adult equivalent	Family labor availability
Tropical Livestock Units	TLU	The number of livestock owned by the household
Extension contact	Dummy	The extension visit of the households: 1 if there is visit, 0 otherwise.
Served as Contact farmer	Dummy	If the household had served as contact farmer: 1 If served as contact farmer, 0 otherwise.
Demonstration	Dummy	Household visits to practical demonstrations : 1 if visited, 0 otherwise;
Farmers Training	Dummy	Household heads participation in training: 1 if trained, 0 otherwise;
Fertilizer	Kg	Amount of chemical fertilizer for improved bread wheat per hectare.
Credit	Dummy	Households access to credit: 1, 0 otherwise.
Own radio	Dummy	Households owning radio: 1 if having radio, 0 Otherwise.
Income	Birr	Households total income from crop, livestock and off-farm.
Hoe	Number	Number of hand hoes owned by the households.

Source: Sample survey, Oct., 2001

Annex 2. Conversion factors used to estimate Adult Equivalent (AE)

Age Group	Male	Female
Children < 7 yrs	0.0	0.0
Children 7-14 yrs	0.4	0.4
Adult 15-64 yrs	1.0	0.8
Adult ≥ 65	0.5	0.5

Source: Storck et al., 1991

Annex 3. Conversion factors that are use to estimate Tropical livestock units (TLU) Equivalents

Livestock Type	Average Biomass(kg)	TLU Equivalent
Camels	250	1
Cattle	175	0.7
Sheep/Goat	25	0.1
Equine*	162.5	0.65

Average of horse/mules and donkeys biomass and TLU taken.

Source: ILCA (1990)

Annex 4. Extension Demonstration of wheat varieties, Hula Woreda from 1996- 1999

Wheat	Average yield qt/ha
Improved varieties	
HAR – 604	37.50
ET 13 A2	32.50
HAR 1685	31.20
HAR 710	35.00
HAR 1709	31.15
Local Variety	
Kululame	22.50

Source: Hula Woreda, Agricultural Office

Annex 5. Extension package participating and non-participating farmers for wheat area and yield in quintal Sidama Zone

Description	Years					
	1999		2000		2001	
	Area	Prod.	Area	Prod.	Area	Prod.
Local seed with fertilizer	1300	27591.5	335	4020	1014	15210
Local seed only	357.25	4967	11669	81683	11088	88704
Extension package participating farmers						
Improved seed with fertilizer	492	6388	1546.3	34018.	107	2140
Local seed with fertilizer	6850.0	40608	625.2	7052.4	1507.5	22612.5
Extension recommendation						
Seed rate 150 kg/ha						
Fert.-DAP 100 kg/ha						
-Urea 100 Kg/ha						

Source: Sidama Zone , Department of Agriculture, 2001.

Annex 6. Average Prices of Agricultural Inputs

Improved variety of wheat seeds per 100 Kg	245 Birr
Local variety of seeds per 100kg	195 Birr
DAP fertilizer per 100 Kg	275 Birr
Urea fertilizer per 100 kg	197 Birr