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Determinants of Arable Land Management Technologies in Damot Gale, Wolaita, Southern Ethiopia

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Abstract The need to tackle problem of food insecurity and soil erosion as well as growing land scarcity has forced Ethiopian government to launch program on sustainable soil and water conservation these days. Besides, different agricultural technologies have been diffused throughout the country though they are adopted by farmers at different scale. This study investigates determinants of adoption of preparation and use of compost among the farmers in Damot Gale district using standard multiple regression. The data for this analysis were collected through questionnaire survey, observation and structured interview. The results of this study indicated that preparation and use of compost by the farmers of the district is determined by number of socio-economic, individual as well as institutional factors. Results from the standard multiple regression shows that farmers preparation of compost is strongly determined by frequency of extension contact, farmers training, availability of TV or radio, and sex of households. Institutional factors like extension service and farmers training were found to be the major determinants affecting preparation and use of compost. Therefore, provision of extension service and farmers training has to be expanded to whole farmers in the district.

Keywords Adoption of best technologies, Farm communities, Compost, Questionnaire, Damot Gale

1. Introduction

Ethiopia is a country where the majority of citizens are directly or indirectly dependent on the productions gained from agriculture. As cited in[1], it has been shown that agriculture is the country's major means of foreign exchange and accounts for 45% to 50% of GDP. Though it accounts for approximately half of foreign exchange, it is still characterized by small scale and low standard technology. Besides, the size of arable land owned by the farmers is too small in many parts of the country though the total share of agricultural land out of the total land mass is about 13.9 %[2]. The average size of land owned by the farmers in the country was 0.17ha[2]. The farming system is traditional and subsistent. Consequently, rural poverty as well as other socio-economic problems have been shown for many years. The current global concern, environmental issues, particularly land degradation and sustainable soil and water conservation have got great attention in different nations due to its great importance. Hence, the use of agricultural technologies and management practices have been applied recently to feed population grown out of the holding capacity of the scarce arable land[3]. Like many other nations, Ethiopia has started implementation of programs on sustainable soil and water conservation. Besides, best agricultural practices from both indigenous as well as modern agricultural technologies are being distributed to farmers at different scale by the leading government to attain the goal planned in the growth and transformation plan of FDRE [1]. However, the adoption of technologies widely diffused to farmers by government or non-governmental agricultural organizations are determined by a number of socio-economic, farm, and institutional factors[3],[4]. For instance, some studies show that larger areas tend to increase the overall benefits of adoption of beneficial innovations and so increase the likelihood of adoption of best technologies [5],[6]. On the other hand institutional factors like farmers training, extension service, and information from researchers have shown varying correlation status in many researches. Study of[3], found negative correlation between information from researcher and adoption of fertilizer in Uganda. On the other hand, extension service and farmers adoption of conservation practice has shown significant positive relationship[4]. Similarly, positive correlation between adoption of cereal production and extension service were found in study conducted in Ethiopia[7]. Some studies found farmers training through workshop and seminars as the major approach to enhance the adoption of best technologies [8].

1.1. Theoretical Approach

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[1] FDRE: Federal Democratic Republic of Ethiopia

There are a number of factors determining the use of agricultural technologies among the farm communities. The factors range from individual to institutional as well as climactic factors. Many studies have found different determinants regarding adoption of agricultural technologies. Therefore it is important to set theoretical base for further researches that will be conducted in the study area. The common factors indicated in literatures regarding adoption of agricultural technologies fall in to three major categories. These are socio-economic and personal, farm, and institutional factors.

Socio-Economic and Personal Characteristics of Farmers

The theoretical expectation of this study was set that, sex of household head will have significant effect on the use of soil management technologies particularly use and preparation of compost. A recent study[9] has shown that ownership of agricultural land by the woman increases efficient production of food and enhances sound management of arable land. Likewise,[10] suggest women's land access right for better adoption of arable land management strategies and eradication of food security. On the other hand, age is one of significant determinants of arable land management. However, there appear no clear correlation between age of farmers and adoption[11]. Some other authors found positive correlation[12]. Number of labor in the households was also expected to have significant impact on the use and preparation of compost as well as other technologies. However, there is mixed evidence in associating number of labor and arable land management technologies. According to[13], sufficient availability of labor enhances intensification process. Therefore, availability of much labor helps to carry heavy works like preparation and transportation of compost. However, study of[14], has indicated that available household labor is insignificant factor in adoption of soil and water conservation technologies. Socio-economic factors like availability of credit and income of household were said to have varying effect in adoption of varying soil and water conservation technologies. Income of farm households determines use of some soil management technologies like use of inorganic fertilizer. Study of[15], indicates that lack of money was given by 60.4% of no inorganic fertilizer users as the main reason for not using inorganic fertilizer. Therefore, studies suggest that use of organic technologies like use of compost is sound in many aspects for poorer small scale farmers since it can easily be made from decomposable materials available around their home. Availability of credit is also another factor determining adoption of agricultural intensification technologies. Some other work[13] shows that there is significant positive association between adoption of agricultural intensification and availability of credit.

Farm characteristics

Farm characteristics or farm structure factors reported in many papers include size of farm, ownership of land, distance of farm, and farm profitability. Therefore, the effect of farm characteristics on adoption of arable land management technologies has got different result in many researches. Theoretical expectation of this study set that as a distance of farmland gets far from the farmer's resident, the adoption of preparation and use of compost will decrease significantly. The study of[13] showed that farmers are expected to adopt agricultural intensification when the farm plot is closer and the yield is higher. In contrary to this, some other authors[16] found negative correlation between distance of farmland from homestead and use of soil and water conservation technologies.

Institutional factors

Institutional involvement in agriculture has great role in enhancing both the productivity and adoption of agricultural technology in the small scale farm communities. Institutions may involve in agriculture through providing extension services, provision of short trainings, introducing research results and etc. Studies showed the impact of institutional factors in adoption of agricultural technologies among small scale farmers. According to[4] and[17] extension services are a major source of technical information for farmers therefore contact with extension agent's increases adoption of technologies. Likewise, according to[18] lack of extension service is the major constraint in adoption of productivity enhancing technologies. Both formal and informal institution can forward extension services to farmers and are crucial in making farmers aware and diffusing technologies to farmers [4],[19], and[17]. Besides, an access to information through different media (TV or Radio) is very important in adoption of agricultural technologies. It makes the adoption of technologies very easy[16],[18]. On the other hand, studies show that farmer training has great association with adoption of technologies[16]. On the other hand, in other paper it has been found a negative association between use of soil and water conservation technologies and farmers training[20].

2. Materials and Methods

2.1. Study Area

This study was conducted in Damot Gale District in Southern Ethiopia. It is located between coordinates of 6º 32′ 24′′N and 7º 7′ 30′′N latitude and 37º 44′ 53′′E and 37º 56′ 24′′ E longitude (Figure 1). Relatively it is located to Southern direction from Addis Ababa at distance of 372kms. The district has a total areal size of 255.54 km^2 which is about 6.07% of the total areal size of Wolayita zone. It has total population of 177,570 inhabitants according to CSA[2] estimate of 2012. The crude population density of the district exceeds 694 persons/km^2[2]. The mean annual rainfall of the district based on the computation of 10 year record was 1140.064 millimeters, while the mean minimum and mean maximum temperature is 14.5 C^0 and 27 C^0 respectively

[2] CSA = Central Statistical Authority

[24].The dominant soil types according to the survey made by the regional government in the period (2008-2010) in the district are: Eutric Nitosols, pellic vertisols, Orthic Acrisols, Dystric Nitosols, and Eutric Fluvisols. The major land uses are annual crops (65.7%), perennial crops (13.3%), forest (6.5%), social service (1.3%), and eroded land (3.02%)[25].

2.2. Data Collection Methods

To collect data, questionnaire was administered based on literature reviews and objectives of the study. Before the actual distribution of the questionnaire, validity of questionnaire was conducted by the panel of academicians and agricultural experts and thus questions recording coefficient of relevance < 0.7% were eliminated. Pilot survey was conducted to pre-test questionnaire on randomly selected 30 household heads. Systematic random sampling was applied to select 304 sample farm household heads from the total of 2894 household heads of three kebeles [3]. Therefore, only 10.8% of the household heads were selected due to farmer's homogeneity in socio-economic and farm structure characteristics. The samples were again proportionally divided to three kebeles based on proportional allocation formula[21]. Accordingly 81 from Akabilo, 112 from Obe Jage, and 111 from Wandara Boloso kebeles were selected. The actual questionnaire survey was conducted between February and April 2013 by six trained enumerators. Almost all the response of interviewees were included for analysis except response of one landless household head.

Further discussions were conducted through field observation and key informant interview. Both field observation and key informant interviews were conducted to collect qualitative data which were very difficult to collect using questionnaire. Therefore, key informant interview was conducted by purposively selected twelve household heads by trained enumerators. Principal investigator interviewed two purposively selected elders using unstructured interview.

In order to measure the adoption level of preparation of compost, the amount of compost prepared in quintal was taken from the farm households. Therefore, since the analytical method used to measure the predictive power of predicting variables was standard multiple regressions, the amount of compost were taken without any categorization. On the other hand, the independent variables which were theoretically hypothesized to have positive or negative effect on preparation of compost were used in the questionnaire in both dummy variables (sex (M=0, F=1) availability of credit (not available=0, available=1), farmers training (not trained=0, trained=1) availability of TV or radio (No=0, Yes=1) and continuous variables (age, number of livestock, number of labor) question forms.

2.3. Models Specification

Standard multiple regression

The standard multiple regression model was considered to be an appropriate analytical tool for this analysis. The model has a high ability in examining the effects of independent variables on the dependent variable. Therefore, the extent of preparation of compost measured as the amount of compost prepared by the individual farm household is influenced by a set of independent variables specified in the following model:

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots + b_nX_n$$

Where Y, the dependent variable, is the amount of compost prepared by farm households, b_0 is the intercept, and b_1, b_2… b_n are the coefficients of the independent variables X_1-X_n.

The SPSS[4] software was used to estimate the model. The model was carried out to identify and assess the ability of predicting variables (Age (X_1), Sex (X_2), distance of land from residence (X_3), availability of credit (X_4), farmers training (X_5), availability of TV or Radio (X_6), number of livestock (X_7), number of labor demand (X_8), and frequency of extension contact (X_9)) in affecting preparation and use of compost among the investigated households.

Primarily before undertaking actual regression, preliminary test of multicollinearity and normality was conducted. Multicollinearity test was done to test presence of very strong interrelationship among the predicting variable. This was done because presence of such correlation may have unsound effect on the determination power of independent over dependent variable. Therefore, it was expected that predicting variables having correlation of 0.7 and above should have to be eliminated. Fortunately, there was no variable having such correlation so that no variable was omitted or formed composite variable[22]. Also to test out normality, Normality P-P plot was drawn using the SPSS. The result of the Normality P-P plot shows the point lying on straight diagonal point from bottom left to top right of the plot. This suggests that there is no major deviation from the normality[22].

3. Result and Discussion

The majority of investigated household heads were males and accounts for about 81.6% of the total respondents. The remaining 19.4% of household heads were females. Each household has got an average family size of 6.16. The majority of the respondents were those who can read and write. Therefore, 69.7% of the investigated household heads were those who can both read and write. This was due to majority of household heads i.e. 58.5% of the total investigated household heads are within age limit ranging between 24 and 40. Therefore, majority of household heads has a chance to get free government educational service. Almost all the households have their own farming land though some landless household heads exist. The average farm size of investigated farmers was 0.132 hectares having

[3] Kebele is the sub division of district in Ethiopian administrative system

[4] SPSS = Statistical Package for Social Science

extreme land scarcity which is below the national average land size i.e. 0.17 hectares. Besides, due to its smallness of land, the majority of the farmers are near their farm. The average distance of farm from farmer's residence was 21.67 m. More than half of the farmers received training on soil and water conservation practices. Also 45% of the investigated farmers have usual contact to extension service providers. Therefore, both the farmers training and extension service are not widely reaching the farmers though the government is working to provide the service in door to door base. More than half of the farmers have either TV or radio so that chance of access to information from mass media is relatively high.

Correlation Analysis

The correlation between selected variables and the amount of compost prepared by the household has been found to have varying values. Table 1 shows that there is significant positive correlation ($P<0.01$) between farmers training and amount of compost prepared by the households. This result is in agreement with finding of many studies that concluding availability of farmers training enhances use of soil and water conservation strategies[4],[16]. This positive correlation assumes that as access to training regarding soil and water conservation increases farmer's preparation and use of compost increases significantly. Also frequency of extension contact has shown positive and significant correlation ($P<0.01$) which implies that as frequency of extension contact increases the amount and use of compost by farmers increases significantly. Similarly many studies have found importance of extension contact in enhancing use of soil management technologies[17],[18]. On the other hand, number of livestock has also shown significant positive correlation ($P<0.05$) implying as the number of livestock owned by the farmers increases, the amount of compost prepared increases accordingly. Other investigations show that livestock holdings may have an ambivalent effect on farmers' adoption decisions of technologies that protect environmental integrity of the soil[26] Number of labor has also shown significant positive correlation ($P<0.01$) with the amount of prepared compost. This result implies that as the number of labor force increases amount of prepared compost increases significantly which is in agreement with[4]. Preparation, processing, and transportation of compost needs much labor force; therefore the correlation in most studies is certainly positive. Similarly, according to[23] many of the organic methods for improving soil fertility, such as application of manure and compost, are very labor-intensive.

Regression analysis explaining variation in adoption of preparation and use of compost:

Standard multiple regression was used to explain the effect of independent variables over the preparation and use of compost among the farmers in the district. The general model of standard regression result shows, how much of the variance in the dependent variable is explained by the model which includes predicting variables (X_1-X_9). In this case, the value is 0.629 (Table 2) expressed as a percentage, which means the model which includes variables (X_1-X_9) explains 62.9% of the variance in preparation of compost in quintals. Out of the nine studied variables two were found insignificant. The remaining seven variables have been found to have effect on the dependent variable (Table 3). More specifically:

***Age (x_1)*:** young aged farmer household heads prepare 0.029 times more compost than old aged household heads. Age of household head uniquely explains 0.03% of variance in the total preparation of compost in quintals.

***Sex (x_2)*:** female headed households prepare compost two times greater than male headed households. Sex of household heads explains uniquely 3.1% of variance in the total preparation of compost in quintals.

***Distance of farmland (x_3)*:** the distant families prepare less compost than those having their land around their residence. Distance of farmland determines 0.057% of the total R^2 in the model.

***Availability of credit(x_4)*:** farmers having access to credit prepares 0.193 more compost than farmers having no access to credit. Availability of credit determines 0.023% of variance in the total preparation of compost in quintals.

***Farmers Training (x_5)*:** is also found as the determining variable in our study. The regression result reveals that, farmers who received training prepare compost three times greater than those who received no training. In some other studies it has been shown that training of farmers regarding soil and water conservation technologies enhances use of agricultural technologies[16]. In contrary, the work of[20] has found negative relationship between adoption of agricultural technologies and farmers training. In our study farmers training explains 9.42% of the total R^2.

***Availability of TV, Radio and other mass media tools (x_6)*:** farmers that have TV, radio and other mass media tools have prepared compost double greater than those who lack these tools. Access to media makes adoption of technologies very easy[16],[18]. This variable explains 1.53% of the total R^2 in the model.

***Size of livestock(x_7)*:** famers that have higher livestock produces higher amount of compost than those who have small number of livestock. The size of livestock explains about 9.54% of the total R^2 in the model.

***Number of labor demand(X_8)*:** implies that farmers having high labor force produce more amount of compost than those families which have small labor force engaging in agricultural activities. According to[23], many of the organic methods for improving soil fertility, such as application of manure and compost, are very labor-intensive. The labor force participation rate explains 0.88% of the total R^2 change.

***Frequency of extension contact (x_9)*:** the interpretation of coefficient of frequency of extension contact is that, household heads having a usual contact with extension service providers prepares compost two times more than those having no such contact. Many studies on soil and water conservation explain significance of extension service[4], [17]. Extension contact explains uniquely 4.33% of the

variance in preparation of compost in quintals in the present paper.

Model Presentation

Based on the results of the standard multiple regression analysis, our model has been drawn to show the relationship between the dependent and predicting variables. This model incorporated the effects of each independent variable on the dependent variable. It illustrates the socio-economic, institutional and spatial factors influencing preparation of compost in quintals. Therefore, the extent of preparation of compost measured as the amount of compost prepared by the individual farm household is influenced by a set of independent variables specified in the following model:

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots + b_nX_n \quad (1)$$

Where Y, the dependent variable, is the amount of compost prepared by farm households, b_0 is the intercept, and b_1, b_2… b_n are the coefficients of the independent variables X_1-X_n[13].

Therefore, the model developed through the above method is presented as follows:

$$Y = -0.5+2.6X_2 - 0.003X_3 + 3.74\ X_5 + 1.45\ X_6 + 0.7\ X_7 + 0.35\ X_8 + 2.3\ X_9$$

Table 1. Correlation analysis between compost prepared in quintals and the predictors

Variables	Amount of compost prepared in quintals Correlation coefficient
Age	- 0.039
Sex of Household Head	0.232**
Distance of farmland	0.018
Availability of Credit	0.169**
Farmers training	0.201**
Availability of TV or Radio	0.2
The size of livestock	0.114*
Number of labor demand	0.252**
Frequency of extension contact	0.168**

*P<0.05 and ** P<0.01
Source: computed from survey data, 2013

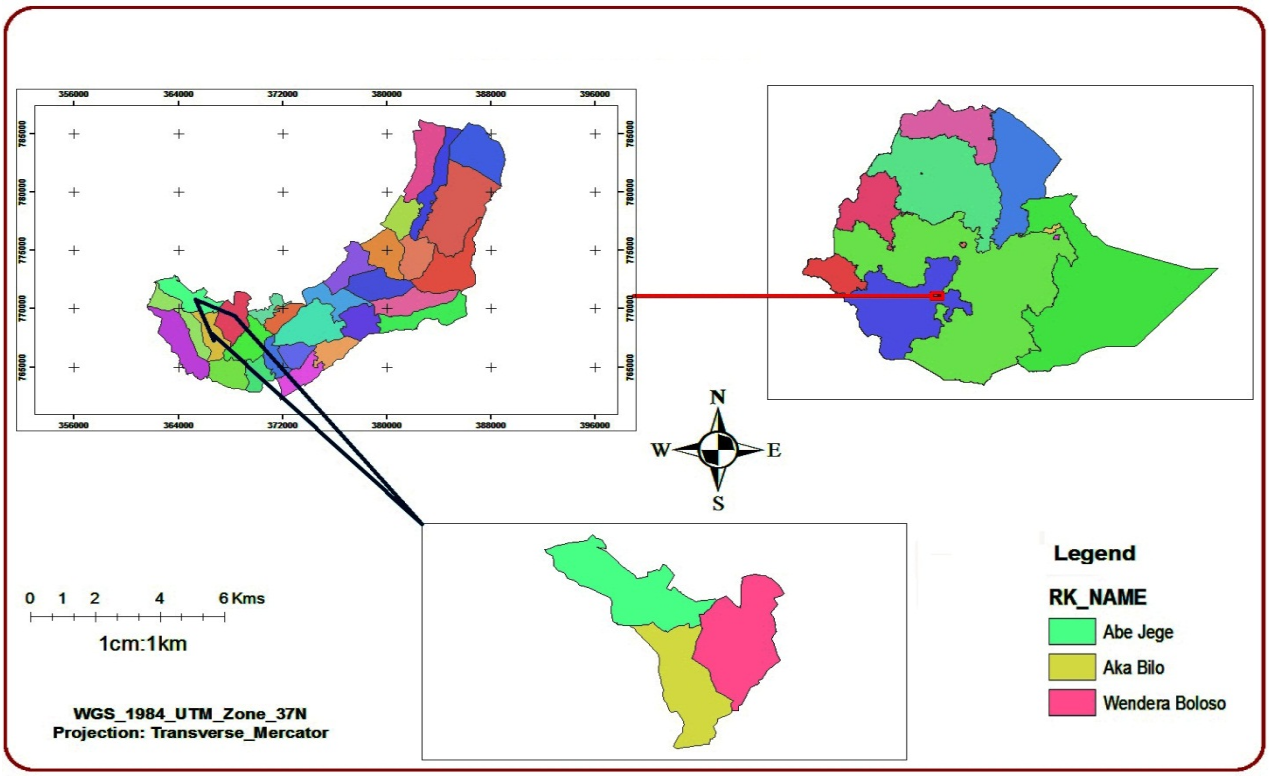

Figure 1. Map of Study Area

Table 2. Model Summary[b]

Model	R	R Square	Adjusted R Square	S.E of the Estimate
1	.793[a]	.629	.617	3.35887

a. Predictors: (Constant) x_1-x_9. b. Dependent Variable: Compost in quintals

Source: computed from survey data, 2013

Table 3. Standard regression predicting the amount of preparation of compost

Model	USC		SC	T	Sig.	Correlations		
	B	S.E	Beta			Zero-order	Partial	Part
(Constant)	-.497	.885		-.561	.575			
X_1	.029	.019	.056	1.536	.126	.126	.089	.030
X_2	2.551	.516	.183	4.944	.000	.293	.278	3.1
X_3	-.003	.001	-.077	-2.146	.033	-.039	-.124	.057
X_4	.193	.399	.018	.484	.628	.035	.028	.023
X_5	3.737	.433	.343	8.633	.000	.582	.450	9.42
X_6	1.448	.417	.133	3.471	.001	.378	.199	1.53
X_7	.710	.082	.346	8.688	.000	.576	.453	9.54
X_8	.340	.129	.098	2.639	.009	.224	.152	0.88
X_9	2.392	.410	.219	5.834	.000	.425	.323	4.33

Dependent Variable: Compost USC (unstandardized coefficient), SC (standardized coefficient)
Source: computed from survey data, 2013

4. Conclusions

The existence of dense farm population settlement resulted in intensive use of arable land. This in return accelerated soil erosion and fertility decline in Damot Gale District. However, use of appropriate soil management technology to minimize the problem is still minimal or has not been applied properly in many regions of Damot Gale District. Compost is one of the technologies used by the farmers to enhance soil fertility.

The intention to identify the factors which are responsible for preparation of compost in quintals has been fulfilled in the present paper using standard multiple regression. Accordingly to our result sex, distance of farmland, farmers training, availability of TV, radio and other mass media tools, size of livestock, frequency of extension contact, and number of labor demand were found to be the major determinates of the preparation and use of compost in the district. Besides, the result of correlation between dependent and independent variables shows significant positive correlation between predictors (farmers training, frequency of extension contact, size of livestock, and number of labor demand) and dependent variable (preparation and use of compost) by farmers. Therefore, based on the findings of this study the following recommendations were made:

The female farmers hold the high class in the preparation and use of compost. Therefore, there has to be enhancement of female farmer's capacity in use of application of the technology through training and education. Likewise, farmers training and frequency of extension contact were found very important in the preparation and use of compost in Damot Gale District. Therefore, provision of training and extension service has to expand to whole farmers in the district. Also farmer's use of information through mass media tools has been found to have great role in adoption of agricultural technologies. Thus, increasing the availability of media tools through both community as well as individual based provision is very important.

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