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ABSTRACT

BACKGROUND: Adoption of organic fertilization is low among farmers in rural areas of Ethiopia, affecting yields and general food security in the region. This study aimed to identify the determinants of the utilization of organic fertilizers among smallholder farmers in the South Gondar Zone, Amhara National Regional State (ANRS), Northwest Ethiopia.

METHODS: A community-based cross-sectional study was used among smallholder farmers in the South Gondar Zone, ANRS, Northwest Ethiopia. Primary data were collected from 420 sample respondents using multistage sampling with a combination of both simple random and cluster sampling techniques. The binary logistic regression model was used to assess the use of organic fertilizers among smallholder farmers in the South Gondar Zone. The results are presented as adjusted odds ratios (AOR) together with their corresponding 95% confidence intervals.

RESULTS: head of household age (AOR = 1.099, 95% CI 1.018-1.187), married marital status (AOR = 10.506, 95% CI 1.355-81.427), literate head of household (AOR = 3.323, 95% CI 1.571-7.029), number of laborers (AOR = 1.442, 95% CI 1.060-1.962), farming experience (AOR = 1.132, 95% CI 1.041-1.232), farm size (AOR = 1.063, 95% CI 1.008-1.121), and number of livestock (AOR = 1.368, 95% CI 1.115-1.677) were positively associated with the utilization of organic fertilizer while single marital status (AOR = 0.062, 95% CI 0.004-0.851), cost of laborer (AOR = 0.965, 95% CI 0.951-0.978), household income (AOR = 0.880, 95% CI 0.824-0.939), medium soil fertility (AOR = 0.039, 95% CI 0.007-0.229), fertile soil (AOR = 0.020, 95% CI 0.003-0.120), and home to farm distance (AOR = 0.219, 95% CI 0.067-0.717) were negatively associated with the utilization of organic fertilizer.

CONCLUSIONS: This finding showed that multiple variables have an effect to determining the use of organic fertilizer by smallholder farmers. Therefore, the finding is important to adopt programs to encourage the use of organic fertilizer, implement policies in an attempt to adapt the use of organic fertilizer among the South Gondar Zone, and critically consider these factors. Furthermore, extension workers should focus on raising awareness about the importance of organic fertilizers to encourage or expand their use among smallholder farmers.

KEYWORDS: Organic fertilizer, logistic regression model, smallholder farmer, multistage sampling

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Background

Agriculture is a basic instrument for sustainable development, poverty reduction, and food security in developing countries. It is a vital development tool to achieve the Millennium Development Goal (MDG).[1] The prevalence of people who suffer from hunger has slowly increased and more than 820 million people in the world were still hungry in 2018, underscoring the immense challenge of achieving the Zero Hunger target by 2030.[2]

The prevalence of malnutrition is the highest in Africa, where agriculture is the dominant sector and there is a huge yield reduction.[3] Sub-Saharan Africa has challenges of food supply due to the increasing human population, limited opportunities to increase arable land, and declining yields associated with the continuous decline in soil fertility.[4] Food security and agricultural trends in the past 40 years in Sub-Saharan Africa show that achieving food security remains a challenging issue and food aid is still indispensable. Furthermore, the rural households in most developing countries remain disproportionately poor. As a result, the primary goal of many developing countries remains to produce sufficient food.[5] Specifically, in sub-Saharan Africa the prevalence of chronic undernutrition appears to have increased from 20.8% to 22.7% between 2015 and 2016.[6] This indicates that food insecurity is positively related to undernutrition.[7]

Agriculture dominates the Ethiopian economy.[8,9] In 2014, according to Food and Agriculture Organization (FAO) estimate, 44% of the population in Ethiopia is underfed and 47% of children suffer from malnutrition.[10] Soil fertility depletion is the most pressing development challenge in Ethiopian agriculture for

sustainable crop, livestock, and forest production. Land degradation and associated soil fertility depletion have been recognized as the main biophysical root cause for the declining per capita food production in Ethiopia.[11] Deterioration in land carrying capacity due to artificial chemical input directly impacts on declining effects of feed and food supply capacity. Land fertility declines with the use of chemical content, further exacerbated by the inability of land management.[12] However, it can be minimized by using organic fertilizers originating from feces and urine.[13]

Organic fertilizer includes plant origin (mulches), urine, feces, manure after the animal has digested, other wastes of plant and utilized all it could from the ration provided to it. Organic fertilizer management and application have been specifically targeted by regulatory agencies in recent years to try to ensure that losses are low and to avoid environmental consequences off-site. It involves the collection of a mixture of farmyard manure, green manure, compost, and household waste and transporting it to the farm. Organic fertilizer represents a deliberate attempt to make the best use of local natural resources, is an environmentally friendly agricultural system,[14] is cheaper,[15,16] and has more efficacy compared to chemical fertilizer.[17]

Farmers in Ethiopia's rural areas have been confronted with the problem of falling agricultural yield. One of the reasons is the decrease in soil fertility. Since the 1970s, the Ethiopian government has intervened in the agricultural sector to overcome this problem through the promotion of various agricultural technologies such as organic fertilizers. However, soil degradation has continued to lead to a decline in agricultural productivity.[18] Improving soil fertility levels has become an important issue in development agendas due to its link with food security and economic well-being of the population.[19] The integrated nutrient management system is an alternative and is characterized by reduced input of inorganic fertilizers and combined use of inorganic fertilizers with organic materials such as animal manures, crop residues, green manure, and composts.[20,21] Combined use of organic and inorganic fertilizers plays a significant role in sustaining soil fertility[14,15,22] and the use of organic fertilizers together with inorganic fertilizers, has a higher positive effect on microbial biomass and enhances soil health.[14] Microbial bio-inoculants are bio-fertilizers (organic fertilizers) are that are used in agriculture. They are formulations of active or latent strains of microorganisms, primarily bacteria, either alone or in combination with algae or fungi components, that stimulate microbial activity and hence improve nutrient mobilization from soil, either directly or indirectly. Furthermore, microbial inoculants have quicker decomposition procedures and are less likely to induce resistance by the pathogens and pests. However, the practical use of biological fertilizers is well below its full potential, mainly due to non-availability of suitable inoculants.[23]

Organic fertilizer has a positive impact on agricultural productivity and is a solution to deal with poor soil conditions in the study area. It is one of the agricultural technologies that has been believed to reduce direct production costs, improve environmental benefits, and increase crop yields.[24] However, smallholder farmers have a low habit of using organic fertilizer in Ethiopia.[25] The farmers faced with a lot of problems to use organic fertilizer. The problem includes the slow effect of organic fertilizer, labor intensive, limited sources of manure, higher cost of organic fertilizer, storage of manures, the emergence of weeds, and unfavorable smell of most of the organic fertilizers.[26] Lack of skills and technical knowhow are also constraints in the use of organic fertilizers.[27] Other major constraints to increased adoption of the organic fertilizer include technological challenges, policies for quality control of organic products, and lack of or inadequate access to extension services that provide technical advice.[28] Therefore, this study aimed to identify factors that affect the use of organic fertilizers among smallholder farmers in the south Gondar Zone, Amhara National Regional State (ANRS), northwest Ethiopia.

Materials and Methods

Description of the study area

The study was carried out in the south Gondar zone, in northwest Ethiopia. The zone is located in the ANRS, 660 km northwest of Addis Ababa, the capital of Ethiopia. The Zone is known for its diverse topography, ranging from flat and low grazing land to high cold mountains. The altitude of the zone ranges from 1500 to 3600 m above sea level. The South Gondar Zone consists of 12 districts and covers a total area of 14 095.19 km^2.[29] According to the Ethiopian Central Statistical Agency, the zone has a total population of 2 051 738 and a population density of 145.56 persons per km^2. The majority of the population (90.47%) of the Zone were rural inhabitants. A total of 468 238 households were counted in this zone, resulting in an average of 4.38 persons per household.[30] In the study area, farming is the major economic engagement crop production such as teff, barley, wheat, maize, sorghum, potato, triticale, fava bean, field pea. The farming system in the zone is characterized by mixed farming. Hence, more than 85% of the farm households engage in mixed farming systems and more than 93% of the farm households plow their land using traditional farming technologies.[29]

Study design and period

A community-based cross-sectional study was used in the South Gondar Zone. The study period was covered from September 2020 to June 2021.

Source of population

Smallholder farmers in the South Gondar zone were the population source for this study. Data were collected from 3 randomly selected districts in the study area. All smallholder farmers (farmers who own less than 5 hectares of land) from 30 selected kebele ((lower level of the local administrative unit in

Table 1. Description of independent variables.

VARIABLES	DESCRIPTIONS
Sex	1 for male, 2 for female household head
Age	Age of the household head in year
Marital status	1 for single, 2 for married, 3 for divorced, 4 for widowed
Educational status	Educational status of the household head: 1 for literate, 2 for illiterate
Laborer	Number of laborers in a household
Experience	Farming experience of household head in year
Cost of laborer	Cost of laborer in birr per day
Group membership	1 for membership to farmers group, 2 for not membership to farmers group
Household income	The household income in birr per year
Access of information media	1 for access of media, 2 for non-access of media
Information about organic fertilizer	1 for Yes, 2 for No
Access of extension service	1 for getting extension service, 2 for not for getting extension service
Farm size	Total land owned by smallholder farmers in hectare
Farm fertility	1 for fertile, 2 for medium, 3 for non-fertile
Distance of farm to home	The distance of farm to home in Km
Household size	Number of family in smallholder farmers in household
Tropical livestock	Number of livestock unit owned in the household
Credit access	1 for getting access to credit, 2 for not getting access to credit

Ethiopia) who lived more than 6 months in a kebele were the study population of this study.

Sampling technique and sample size determination

Multistage sampling (also known as multi-stage cluster sampling) is a more complex form of cluster sampling that contains 2 or more stages in sample selection. In simple terms, in multistage sampling, large clusters of the population are divided into smaller clusters into several stages to make primary data collection more manageable. This sampling technique would be used for geographically dispersed areas, to minimize cost, and to save time. Therefore, in this study multistage sampling techniques were considered. The multistage sampling technique involves a combination of simple random and cluster sampling methods. From 12 districts, 3 districts (Fogera, Simada, and Libokemekem) are randomly selected for this study. In this study, smallholder farmers were randomly selected from 30 kebele (lower level of the local administrative unit in Ethiopia) in 3 randomly selected districts. A single population proportion formula was used by considering 50% prevalence of the use of organic fertilizer, with a 5% margin of error at a 95% confidence level, and adding 9% for nonresponse to get a representative sample size. The total sample size for this study was 420. In this study, 140 samples are selected from each selected district.

Variables in the Study

Dependent variable

The response variable for this study was the use of organic fertilizer, which is a dichotomous variable, with 1 for a smallholder farmer who uses organic fertilizer and or 0 for a smallholder farmer who did not use organic fertilizer.

Independent variables

The independent variables for this study are listed with their description as follows (Table 1).

Data source and data collection method

Primary data on a wide variety of variables were collected to meet the objectives of the study. Primary data were collected through a personal interview by a team of 3 trained enumerators to 420 smallholder farmers.

Quality of data measurement

The data collection tool was pre-tested before the actual data were collected to maintain data quality. The completeness and consistency of the questions were checked and pretested on 70 sample respondents, and corrections were included after getting feedback from the pilot test.

Method of data analysis

To analyze the data, both descriptive statistics and inferential statistics were applied. In descriptive statistics, mean, standard deviation, frequency, and inferential statistics chi-square test and logistic regression model were computed. Logistic regression analysis is one of the most preferred regression methods that can be implemented in modeling binary dependent variables. A binary logistic regression model was used to identify factors associated with the utilization of organic fertilizer. The results are presented as adjusted odds ratios (AOR) together with their corresponding 95% confidence intervals signifying the level of precision. Multicollinearity was tested using the variance-inflation factor (VIF) test, suggesting that there was no multicollinearity since all variables had VIF < 5. To determine the goodness of fit is through the Homer-Lemeshow statistics, which is computed on data after the observations have been segmented into groups based on having similar predicted probabilities. Therefore, in this study, the Homer-Lemeshow test was greater than .05 (*P*-value > .05), indicating that the model was a good fit.[31] Statistical decisions made at 5% of the level of significance and using SAS 9.4 as a tool of analysis.

Results

A total of 420 smallholder farmers were included in the study, of which, 223 (53.10%) of the smallholder farmers used organic fertilizer and 197 (46.90%) of smallholder farmers did not use organic fertilizer. Out of the total smallholder farmers, 320 (76.2%) of the household heads were male and 100 (23.8%) of the household heads were female. More than two-thirds of 278 (66.2%) of the household heads were married, 22 (5.2%) of the household heads were single, 39 (9.3%) of the household heads were divorced, and 81 (19.3%) of the household heads were widowed. Out of the total smallholder farmers, 289 (68.8%) of the household heads were not educated and 131 (31.2%) of the households were educated. About 351 (83.6%) of the head's smallholder households were a member of the farmers union and 69 (16.4%) of the smallholder farmers were not members of the farmers union. Regarding information on organic fertilizer, 271 (64.5%) of smallholder farmers had information on organic fertilizer and 149 (35.5%) of smallholder farmers did not have information on organic fertilizer. Almost two-thirds of smallholder farmers had access to social media and 143 (34.0%) of smallholder farmers did not have access to social media. Of most smallholder farmers, 334 (79.5%) of smallholder farmers' household heads had access to extension services. 164 (39.0%) of smallholder farmers' household heads had credit access and the remaining 256 (61.0%) of smallholder farmers' household heads did not have credit access. Of 420 smallholder farmers, 90 (21.4%) of smallholder farmers had fertile soil fertility, 147 (35.0%) of smallholder farmers had medium soil fertility, and 183 (43.6%) of smallholder farmers had non-fertile soil fertility. The chi-square test showed that marital status, educational status, membership in farmer union, information on organic fertilizer, access to social media, access to extension service, and soil fertility were significantly associated with the use of organic fertilizer among smallholder farmers at 5% of level significance (Table 2). The mean age of household head was 47.47 years with standard deviation was 12.55 years. The number of total family in a household was 5.24 with standard deviation was 1.84 (Table 3).

For a unit increase in the age of a household head, the use of organic fertilizers among smallholder farmers increased by 9.9% (*P*-value = .016). The odds of using organic fertilizer among smallholder farmers whose marital status was single were 0.062 (AOR = 0.062, 95% CI 0.004-0.851) times less likely compared to smallholder farmers whose marital status was widowed. This means the odds of using organic fertilizer among smallholder farmers whose marital status was single were 93.8% decreased compared to smallholder farmers whose marital status was widowed. The odds of using organic fertilizer among smallholder farmers whose marital status married were 10.506 (AOR = 10.506, 95% CI 1.355-81.427) times higher compared to smallholder farmers whose marital status was widowed. The odds of using organic fertilizer among smallholder farmers whose educational status was literate were 3.323 (AOR = 3.323, 95% CI 1.571-7.029) times more likely compared to smallholder farmers whose educational status was illiterate. For a unit increase in the number of workers, the use of organic fertilizer among smallholder farmers increased by 44.2% (*P*-value = .020). For a unit change in laborer cost, the use of organic fertilizer among smallholder farmers decreased by 3.5% (*P*-value < .0001). For a unit increase in the farming experience of smallholder farmers, the use of organic fertilizer among smallholder farmers increased by 13.2% (*P*-value = .004). For a unit increase in the household income of smallholder farmers, the use of organic fertilizer among smallholder farmers decreased by 12% (*P*-value = .0001). For a unit increase in the farm size of smallholder farmers, the use of organic fertilizer among smallholder farmers increased by 6.3% (*P*-value = .024). The odds of using organic fertilizer among smallholders who have medium fertile land were 0.039 (AOR = 0.039, 95% CI 0.007-0.229) times less likely than smallholder farmers who have non-fertile land. The odds of using organic fertilizer among smallholders who have fertile land were 0.020 (AOR = 0.020, 95% CI 0.003-0.120) times less likely than smallholder farmers who have non-fertile land. For a unit increase in the number of cattle in a smallholder farmer, the use of organic fertilizer among smallholder farmers increased by 36.8% (*P*-value = .003). For a unit increase in the farm distance of smallholder farmers, the use of organic fertilizer among smallholder farmers decreased by 78.1% (*P*-value = .012). The odds of using organic fertilizer among smallholders who have information about organic fertilizer were 960.1 (AOR = 960.1, 95% CI 124.30-7415.15) times more likely than smallholder farmers who did not have information on organic fertilizer. The odds of using organic fertilizer among smallholders who had access to the extension service were 4.204 (AOR = 4.204, 95% CI 1.021-17.314) times higher than among smallholder farmers who did not have access to the extension service. The sex of the household head, the access to credit, and the membership of the farmer union do not significantly influence the organic fertilizer used on farmland (Table 4).

Table 2. Characteristics of categorical variables among smallholder farmers.

VARIABLES	CATEGORY	FREQUENCY	%	ORGANIC FERTILIZER USER				CHI-SQUARE	*P*-VALUE
				YES	%	NO	%		
Sex	Male	320	76.2	170	53.1	150	46.9	<0.0001	.983
	Female	100	23.8	53					
Marital status	Single	22	5.2	8	36.4	14	63.6	9.308	.025*
	Married	278	66.2	140	50.4	138	49.6		
	Divorced	39	9.3	21	53.8	18	46.2		
	Widowed	81	19.3	54	66.7	27	33.3		
Educational status	Illiterate	289	68.8	159	55.0	130	45.0	10.374	.024*
	Literate	131	31.2	64	48.9	67	51.1		
Membership in farmer union	Yes	351	83.6	210	59.8	141	40.2	38.901	<.0001*
	No	69	16.4	13	18.8	56	81.2		
Information about organic fertilizer	Yes	271	64.5	185	68.3	86	31.7	70.592	<.0001*
	No	149	35.5	38	25.5	111	74.5		
Access of social media	Yes	277	66.0	125	45.1	152	54.9	20.745	<.0001*
	No	143	34.0	98	68.5	45	31.5		
Access of extension service	Yes	334	79.5	195	58.4	139	41.6	18.315	<.0001*
	No	86	20.5	28	32.6	58	67.4		
Credit access	Yes	164	39.0	80	48.8	84	51.2	2.011	.156
	No	256	61.0	143	55.9	113	44.1		
Soil fertility	Fertile	90	21.4	31	34.4	59	65.6	48.098	<.0001*
	Medium	147	35.0	60	40.8	87	59.2		
	Non-fertile	183	43.6	132	72.1	51	27.9		

*Shows significance at 5% of the level of significance.

Table 3. Descriptive statistics for continuous variables of organic fertilizer user among smallholder farmers for continuous variables of organic fertilizer user.

CONTINUOUS VARIABLES	MEAN	STD. DEVIATION
Age of household head	47.47	12.55
Number of total family in a household	5.24	1.84
Number of laborers in a household	1.80	2.60
Cost of laborer in birr per day	70.79	64.58
Farming experiences of household head in year	22.33	13.02
Household income in birr per year	41 640.71	23 531.10
How many the current size of your plot under crop production in a hectare?	1.31	0.57
How many livestock do you have?	4.51	3.20
How far is your house to farm in km?	0.96	0.89

Table 4. Results of multivariable analysis factors associated with the use of organic fertilizer among smallholder farmers.

VARIABLES	ESTIMATE	SE	WALD	AOR	95% CI FOR AOR		*P*-VALUE
					LOWER	UPPER	
Sex (Ref = Female)							
Male	0.552	1.121	0.243	1.737	0.193	15.639	.622
Age	0.094	0.039	5.789	1.099	1.018	1.187	.016*
Marital status (Ref = Widowed)							
Single	−2.786	1.339	4.330	0.062	0.004	0.851	.037*
Married	2.352	1.045	5.067	10.506	1.355	81.427	.024*
Divorced	−2.191	1.189	3.398	0.112	0.011	1.149	.065
Educational status (Ref = Illiterate)							
Literate	1.201	0.382	9.885	3.323	1.571	7.029	.002*
Number of family	−0.330	0.217	2.303	0.719	0.470	1.101	.129
Number of laborers	0.366	0.157	5.436	1.442	1.060	1.962	.020*
Cost of laborer	−0.036	0.007	24.444	0.965	0.951	0.978	<.0001*
Farming experience	0.124	0.043	8.294	1.132	1.041	1.232	.004*
Household income	−0.128	0.033	15.045	0.880	0.824	0.939	.0001*
Farm size	0.061	0.027	5.104	1.063	1.008	1.121	.024*
Soil fertility (Ref = non-fertile)							
Medium fertile	−3.242	0.902	12.905	0.039	0.007	0.229	<.0001*
Fertile	−3.910	0.913	18.358	0.020	0.003	0.120	<.0001*
Number of livestock	0.313	0.104	9.047	1.368	1.115	1.677	.003*
Farm distance to home	−1.519	0.605	6.304	0.219	0.067	0.717	.012*
Access to information about organic fertilizer (Ref = No)							
Yes	6.867	1.043	43.359	960.1	124.30	7415.15	<.0001*
Credit access (Ref = No)							
Yes	0.777	0.611	1.619	2.175	0.657	7.197	.203
Access to extension service (Ref = No)							
Yes	1.436	0.722	3.956	4.204	1.021	17.314	.047*
Access to social media (Ref = No)							
Yes	0.358	0.667	0.289	1.431	0.387	5.292	.591
Membership in farmer union (Ref = No)							
Yes	−0.618	0.945	0.428	0.539	0.085	3.435	.513

Abbreviation: Ref = reference category.
*Shows significance at 5% of the level of significance.

Discussion

The main objective of this study was to identify the determinant factors that affect the use of organic fertilizers among smallholder farmers in the south Gondar zone, ANRS, North West Ethiopia. The head of a household age of smallholder farmers was an important significant factor. The use of organic fertilizer increased when the household head age increased. The result is in accordance with those of other

studies.[25,32] The possible explanation for this result may be that the farmers of small farms of older age have enough experience to prepare organic fertilizer and knowledge about organic fertilizer.[28]

The study showed that a household head with married marital status was positively associated with the use of organic fertilizer. In the multivariable analysis, the study revealed that married marital status was more likely to use organic fertilizer compared to widowed marital status. This result is supported by previous studies.[18,33] The result showed that the proportion of married household heads was higher among adopters compared to the nonadopters implying that respondents who are the heads as a result of being married are more likely to adopt organic fertilizer. This consistency may be marriage increases farmers' concern for household welfare, thus increasing farmer participation in the preparation of organic fertilizer.

The use of organic fertilizers was found to be strongly linked to educational status. When comparing literate smallholder farmers to illiterate smallholder farmers, the likelihood of adopting organic fertilizer was higher. This study was similar to other studies.[32,34] This might be because educated smallholder farmers are more knowledgeable about organic fertilizer preparation and the benefits of using organic fertilizer to boost land fertility. Furthermore, the lack of knowledge related to the use of organic fertilizers in terms of compost preparation was another constraint to the use of organic fertilizers. This implies that low skills related to the preparation of organic fertilizer could limit the use of organic fertilizer, as farmers may face difficulty preparing this fertilizer.

The number of laborers in a family increased, the use of organic fertilizer increased. This could be because there is enough manpower in a family; they have a great beginning to prepare organic fertilizer. This study was uniform with other studies.[18,32] The high cost of laborer is significantly associated with the use of organic fertilizer. The cost of laborer increased, the use of organic fertilizer by smallholder farmers decreased. This may be because the high costs of laborers coupled with their low capacity to provide finance could limit the use of organic fertilizer. This finding was in line with another study.[35]

This study showed that the amount of organic fertilizer used on a farm increases significantly with increasing farm experience. This suggests that more experienced farmers have gathered more information and knowledge about the usage of organic fertilizer over time. Furthermore, farming experience enhances a farmer's behavior in dealing with soil infertility issues and decreases the likelihood of utilizing chemical fertilizers. This finding was agreed with other studies.[36-38]

The household income was negatively associated with the use of organic fertilizers. This implies that the amount of organic fertilizer used on a farm decrease significantly with increasing household income of smallholder farmers. This study was in line with another study.[39] The probable explanation is that farmers who have a high household income have access to buy inorganic fertilizer or chemical fertilizer (such as DAP and Urea) in the study area. As a result, a household with a higher income may prefer to purchase and use chemical fertilizer on time.

The study showed that the size of the farm has a positive influence on the use of organic fertilizer. This indicates that the amount of organic fertilizer used on a farm increases significantly with increasing farm size. This could be because the cost of chemical fertilizer is higher than the cost of organic fertilizer, and owning farmland ensures future access to investment returns, boosting the likelihood of utilizing organic fertilizers like compost and manure. Furthermore, organic fertilizer preserves soil fertility and produces high-quality products due to those reasons smallholder farmers who have large farm size organic fertilizer used. This finding was similar to another study.[4]

The result shows that soil fertility is negatively associated with the use of organic fertilizers. The odds of using organic fertilizers in fertile soil were less likely compared to non-fertile soil. The probable explanation is that smallholder farmers who have non-fertile soil used high organic fertilizer to improve soil fertility compared to smallholder farmers who have fertile soil. The result shows that the number of livestock is positively associated with the use of organic fertilizer. This implies that the amount of organic fertilizer used increases significantly with increasing numbers of livestock. This finding was similar to another study.[9] This may be a smallholder farmer with large number of livestock that had access to prepare organic fertilizer and the organic fertilizer used. As domestic animals constitute a good source of organic manure serving as a good substitute for chemical fertilizer to sustainable crop cultivation, households that own a large number of livestock are more likely to get more manure, and thus are likely to adopt organic fertilizer. Moreover, composted manure, kitchen scraps, and other organic wastes represented the only means of improving soil fertility.[40]

This study shows that the distance from the farm to the home has a negative effect on the use of organic fertilizers. This implies that the distance from farm to home is increasing, the ability of smallholder farmers to use organic fertilizer has decreased. The explanation for this could be the high cost of transportation and manpower required to transport organic fertilizer from a home to a farm. This study was identical to another study.[28] This finding showed that smallholder farmers who have information about organic fertilizer were more likely to use organic fertilizer compared to those smallholder farmers who did not have information about organic fertilizer. This means that information about organic fertilizers is key to the use of organic fertilizers by smallholder farmers in the study area. Access to the extension service has a positive influence on the use of organic fertilizer. This implies that farmers who have access to the extension service have applied more organic fertilizer compared to those farmers who did not have the access to extension service. This result was in line with the findings of other investigations.[9,25,41,42] This could be the smallholder farmers getting better education on the effects of organic food on human health have so far yielded some observations, including indications of a lower risk of childhood allergies,

adult overweight/obesity, and non-Hodgkin lymphoma in consumers of organic food.[43]

Conclusions

The study showed that the age of the head of the household, the marital status, the educational status, the number of laborers, the farming experience, the farm size, the number of livestock, the access to information on organic fertilizer, access to extension service, cost of a laborer, household income, soil fertility, and farm to home distance were significantly influenced the use of organic fertilizer. Therefore, the finding is important to adopt programs to encourage the use of organic fertilizer; implemented policies in an attempt to increase the use of organic fertilizers in the South Gondar zone should critically consider these factors. Furthermore, extension workers should focus on raising awareness about the importance of organic fertilizers to encourage or expand their use among smallholder farmers.

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Author Contributions

MWM has led the overall activities of the research process such as drafted the proposal, did the analysis, wrote the results, and prepared the manuscript. GAT, KBA, BDT, MAK, and ATM participated on editing, analysis, and critically revised the manuscript for its scientific content. All authors read and approved the final manuscript.

Availability of Data and Materials

Data are available from the corresponding author on reasonable request.

Ethical Approval and Consent to Participate

The authors received an ethical approval certificate from the ethical approval committee of Debre Tabor University, Debre Tabor, Ethiopia. An effort was made to conduct the research ethically. A research site permission letter was obtained from Debre Tabor University and the verbal consent of participants verbal consent was asked before the interviews and discussions.

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