Journal of Fisheries & Livestock Production

Dilebo, J Fisheries Livest Prod 2021, 9:4

Research Article Open Access

Determinants of Adoption of Improved Forage Technologies: The Case of Sidama Regional State, Gedeo Zone and Halaba Special District, Ethiopia

Tizazu Toma Dilebo*

Southern Agricultural Research Institute, P. O. Box 06, Hawassa, Ethiopia

Abstract

Various forage technologies have been introduced and disseminated in Sidama regional state, Gedeo zone, and Hallaba special district. However, the level of adoption was not as the effort made by different stakeholders. Therefore, studying on adoption determinants of improved forage technology is found to be significant to understand the gap and put directions to improve adoption. The objectives of this study were identifying determinants of farmers' decision to adopt improved forage technologies; intensity of adoption, and opportunities and constraints related to forage adoption. To achieve these objectives, data were collected from 240 farm households selected by multi stage sampling procedure. Both descriptive and econometric model were employed to analyze the data collected. The result indicated that government support, good weather condition, and experience in improved forage production were identified as opportunities in improved forage technologies adoption. Supply of unneeded forage materials, Low market demand, unfair distribution of planting materials, lack of training, market information and extension contact were found to be constraints in forage technologies adoption. Out of 14 variables hypothesized, only 5, namely total income, total landholding (ln), needed forage material supply, extension contact and distance to FTC were found to be significantly affecting farmer's decision to adopt improved forage technologies. In addition, the level/intensity of adoption, was affected by sixth variable (market demand). The study recommended the supply of suitable forage varieties, awareness creation and training on how to produce forage without competing for scarce land and provide forage seeds with low costs.

Keywords: Decision to adopt; double hurdle; improved forage technologies; Intensity ofadoption

Introduction

It is believed that adoption of agricultural innovations can provide a basis for increased production and income [1]. More precisely, farmers will adopt only those technologies that suit their needs and circumstances [2]. As any rational consumer, farmers try to maximize their utility. I.e. they adopt technology if utility of adopting is greater than not adopting [3]. As part of the effort to increase agricultural productivity, researchers and extension staff in Ethiopia have typically promoted a technological package consisting of a number of components. However, because of capital scarcity and risk considerations, farmers are rarely adopting complete packages. There is now an agreement in the literature that agricultural development implies the shift from traditional methods of production to new, science-based methods of production that include new technological components and/or even new farming systems [4].

Various forage technologies have been introduced and disseminated in almost all districts of Sidama regional state, Gedeo zone, and Hallabaspecila district by wereda and zonal agriculture offices, Hawassa agricultural research center, other GOs and NGOs. Some of these technologies include desho grass, elephant grass, Rhodes grass, Susbania, cow pea, pigeon pea, lablab, oat, vetch, trilucern and others. The most disseminated technologies were Desho and elephant grasses. However, experts in district agricultural offices and researchers in Hawassa agricultural Research center complain that the level of adoption was not as the effort made by different stakeholders. In addition to that the level of improved forage technology adoption in the study area was not studied and documented yet. Therefore, studying determinants of improved forage technology adoption is found to be significant to understand the gap and put directions to improve adoption.

Methodology

Both primary and secondary data were used to conduct this study. Primary data were collected from both adopter and non-adopter farmers, agricultural experts working in the district. Secondary data were collected from different organizational reports and documents, and from different published and unpublished sources. The data from primary data sources were collected using data collection instruments such as observation, pre-tested semi structured questionnaire and check lists. During observation, different types of available forage technologies and size of farm land allocated for improved forage production, were observed. Check lists were used to collect data from agriculture experts working in the study *district* to have the overall outlook on the available forage technologies, the needs of farmers, challenges related to forage technology adoption and the likes. Interview method was employed to collect data from farmers using pre-tested semi-structured separate questionnaires.

Regarding sample size, the sample size of farmers was determined using the formula of Yamane (1968) cited in Israel, (2012). This is because almost all farmers were homogeneous in the type of forage technology they adopted, the agro-ecology they live, crop and livestock enterprises they were engaged in, the landholding size they have, economic status and social setup. The computational process was as follows.

***Corresponding author:** Tizazu Toma Dilebo, Southern Agricultural Research Institute, P. O. Box 06, Hawassa, Ethiopia, E-mail: tomatizazu@yahoo.com

Received April 20, 2021; **Accepted** May 18, 2021; **Published** May 30, 2021

Citation: Dilebo TT (2021) Determinants of Adoption of Improved Forage Technologies: The Case of Sidama Regional State, Gedeo Zone and Halaba Special District, Ethiopia. J Fisheries Livest Prod 9: 299.

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Where n = the sample size

N= the sum of total number of households in sample kebeles of the study Districts. Which is 12520 households

e= the error term and 10% (0.1) was taken.

Based on the above formula, the total sample size will be 2001 households. However, a total of 240 farm households were interviewed to make the study more accurate.

Multi stage sampling procedure was employed to select sample farm households. First, districts in the zone were categorized as adopter and non-adopter *districts* with the help of zonal agriculture bureau. Out of adopter districts of Sidama and Gedeo Zones, 2 districts from each were randomly selected as samples to conduct this study. In the second stage, kebeles in sample districts were categorized as adopter and non-adopter kebeles, and 2 kebeles out of the adopter ones were randomly selected from each district. In the third stage, using list of farmers in the sample *Kebele*s, the pre-determined size of representative households were randomly selected using systematic random sampling technique. In the 4rd stage, the required sample size in each *Kebele* were determined proportionally to amount of households in each Kebele.

Both descriptive statistics and econometric model were used for analysis at the end of collection of all necessary data. Descriptive statistics such as mean, standard deviations, percentages and frequency tables were used to summarize the socio-economic and demographic characteristics related to sample respondents. The types of improved forage technologies adopted, and opportunities and challenges in improved forage technologies adoption were also summarized using descriptive statistics. Triangulation method was employed to cross-check the data collected from different types of respondents to have the whole picture of available forage technologies, farmers demand, the supply side constraints, adoption challenges and the likes.

The econometric model, Double-Hurdle (DH) mode developed by Cragg (1971) cited in Nigusie (2019), which is a combination of probit and truncated regression models, was employed to analyze determinants of farmers' decision to adopt improved forage technologies and the degree/intensity of adoption. This is because both dependents (adoption decision and level of adoption) were independent equations and there were zero observations in the second equation.

The DH model is a parametric generation of the Tobit model, whereby two separate stochastic processes determine the decision to adopt and the level of adoption of technology. In our case, the two decisions are the decision to adopt and the decision about the intensity of adoption. The first decision variable (y) takes the value 1 for farmers who have adopted improved forage technologies and 0 otherwise. However, the expected utility of adopting a technology) (y^*) is latent variable. Hence, the first decision (adoption hurdle) of the households is formulated as:

$$y^* = x_i a + \varepsilon_i$$

$$y_i = \begin{cases} 1 \text{ if } y^* > 0 \\ 0 \text{ if otherwise} \end{cases}$$

where y* is latent adoption variable that takes the value of 1 if a household grew improved forage and 0 otherwise, x_i is a vector of household characteristics and α is a vector of parameters. Not all adopters grow improved forage at the same level of intensity. As stated previously, the intensity of adoption is measured in terms of the proportion of farm area allocated to improved forage. The intensity of adoption (intensity hurdle) of improved forage is given as:

$$t_i^* = z_i \beta + \mu_i$$

$$t_i = \begin{cases} t_i^* = z_i^* \beta + \mu_i \text{ if } t^* > 0 \text{ and } y^* > 0 \\ 0 \text{ otherwise} \end{cases}$$

Where t_i is the observed response on how much land one allocated to improved forage production, z is a vector of the household characteristics and β is a vector of parameters.

Results and Discussion

Socio-Economic and Demographic Characteristics of Respondents

Sex, Marital Status and Adoption Status of Households: The survey result indicated that out of the total sampled 240 farmers, 47.8% were adopters of improved forage technologies and the rest 52.2% were no-adopters (Table 1). Of the total sampled farmers 17.2% were female headed households and the rest 82.8% were male headed. 92% were married, 5% were widowed and the rest 3% were divorced (Table 1).

Age, Total Land Holding and Land Allocated to Forage Production: The mean age of respondents was around 38 years with minimum and maximum age of 20 years and 75 years respectively. The mean landholding was 0.89 hectares with minimum and maximum landholding of 0.12ha and 6ha respectively. The minimum amount of land allocated for forage production in the study areas was 0.01ha and the maximum amount was 1ha with mean value of around 0.21ha (Table 2).

Types of Forage Technologies Available: Of the total producer farmers, 47.8% were found producing desho grass, 23.7% were producing elephant grass and 6.45% were found producing Guatemala (Table 3). The rest 28.6% were producing various types of improved forage such as vetch, lablab, rodus grass, susbania, cow pea, and pigeon pea.

Table 1: Distribution of respondents by adoption status of improved forage technologies, sex, and marital status (n=240).

Variables		Frequency	Percent
Adoption status	Adopter	115	47.8
	Non-adopter	125	52.2
Sex of household head	Female	41	17.2
	Male	199	82.8
Marital status of household head	Single	-	-
	Married	221	92
	Divorced	7	3
	Widowed	12	5

Source: - own survey, 2020

Table 2: Distribution of households by age, total landholding and amount of land allocated for forage production

Variables	Minimum	Maximum	Mean	Std. Deviation
Age of household head	20.00	75.00	38.5538	10.77785
Total landholding in hectare	.12	6.00	.8921	.84282
Amount of land allocated for forage production in hectare	.01	1.00	.2079	.19930

Source: - own survey, 2020

Table 3: Distribution of respondents by type of forage they producing

Types of forage seed produced	Frequency	Percent
Desho grass	115	47.8
Elephant grass	57	23.7
Guatemala	15	6.45
Others	15	6.45
Mixed	37	15.6
Total	240	100.0

Source: - own survey, 2020

Table 4: Distribution of respondents by source of improved forage technologies

Variables		Frequency	Percent
Source of improved forage technologies	FTCs	82	71
	District agriculture -bureaus	22	19
	Other farmers	11	10
Total (adopters)		115	100

Source: - own survey, 2020

Opportunities and Constraints in Improved Forage Adoption

Opportunities in Improved Forage Adoption

Government support: One of the good opportunities to adopt improved forage is government support in bringing improved forages up to the farmers training centers and distributing them for free without any cost. Of the total adopter farmers 71% responded that they are getting improved forages from farmers training centers in their kebeles; 19% responded that they were getting improved forages from district agriculture bureau and the rest 10% responded that they got improved forages from other farmers (Table 4).

Good weather condition: Of the total farmers, 88.6% responded that the weather condition in their kebele is good and convenient for forage production (Table 5). The rest 11.4% responded that it is bad for forage production. Therefore the argument of most farmers (88.6%) saying that the weather condition is convenient for forage production is taken as one of good opportunities.

Experience in improved forage production: The mean experience of adopters in forage production is around 4 years. There were farmers who produced forage for about 10 years though some of them were those who have no experience in forage production. The more experience in forage production the more will be the tendency of farmers to adopt it. Therefore experience in forage production of farmers can be regarded as an opportunity for adoption (Table 6).

Constraints in Forge Technologies Adoption

Types of forage technologies supplied regularly: Of the total farmers 62.9% responded that the types of improved forage technologies being supplied were limited in type and are not needed types by farmers (Table 7). Most of them responded that the types of forage seeds supplied regularly were Desho and Elephant grass. They responded that experts supply forage materials without asking the types of forage materials needed by farmers.

Low market demand, unfair distribution of planting materials and training attendance: Of the total farmers, around 83% responded that market demand for improved forages was low compared to other agricultural products (Table 8). Most of them (54.8%) also responded that there is unfair distribution of planting materials within the kebele in that some of the farmers were receiving large amount and some others were receiving low. 80.6% responded that they were not given any type of training regarding improved forage production.

Table 5: Distribution of respondents by Weather condition for forage production.

Variables		Frequency	Percent
Weather condition for forage production	Good	213	88.6
	Bad	27	11.4

Source: - own survey, 2020

Table 6: Distribution of respondents by experience in forage production

Variables	Minimum	Maximum	Mean	Std. Deviation
for how long the respondent has produced forage seed/cutting	1	10.00	4.12	2.13

Source: - own survey, 2020

Table 7: Distribution of respondents by type of improved forage technologies supplied

Variables		Frequency	Percent
Improved forage technologies supplied	Not based on needs of farmers	151	62.9
	Based on demand	89	37.1
	Total	240	100.0

Source: - own survey, 2020

Table 8: Distribution of respondents by market demand, planting materials distribution and training attendance

Variables		Frequency	Percent
Market demand	Good	40	16.7
	Low	200	83.3
Distribution of planting materials	Fair	108	45.2
	Unfair	132	54.8
Training on improved forage production	Attended	47	19.4
	Not attended	93	80.6

Source: - own survey, 2020

Table 9: Distribution of respondents by market information and extension contact

Variables		Frequency	Percent
Extension contact	Low	177	73.7
	Good	63	22.3
Market information	Did not get	212	88.2
	Got	28	11.8

Source: - own survey, 2020

Market information and extension contact: Of the total farmers, 73.7% responded that extension contact was low regarding forage production. Most of them (88.2%) responded that market information was not being delivered regarding forages (Table 9). Due to that they do not know where to sale and what to do the bulk product of forages. Most of them are giving the surplus forage they produced to non-producers for free after feeding their cattle.

Determinants of adoption of Improved Forage Technologies in the Study Areas.

Determinants of Decision to Adopt: Fourteen variables were hypothesized to determine farmers' decision to adopt improved forage technologies in Sidama regional state, Gedeo zone and Halaba Special District. Out of these 14 variables hypothesized, only 5 were found to be significantly affecting farmer's decision to adopt improved forage technologies (Table 10).

Table 10: Determinants of decision to adopt improved forage technologies at households' level.

Variables	Coefficients	Std. Err.	z-value
Sex of household head	-.0422096	.15687 -0.27	0.788
Education level of household head	.0279648	.01756	1.59
Total family size (EM/LU)	-.0001523	.03434	-0.00
Tropical livestock unit (ln)	.0735359	.07354	1.00
Total income (ln)	.1701901***	.06395	2.66
Total landholding (ln)	.511274***	.08288	6.17
Age of the household head	-.0030522	.00602	-0.51
Needed forage materials supply	.4381715***	.12157	3.60
Market demand	.1463989	.14894	0.98
Unfair distribution of forage materials	-.1472496	.12793	-1.15
Training attended in forage production	-.0477997	.14221	-0.34
Extension contact	.4422602***	.11868	3.73
Distance to FTC	-.2408794***	.09755	-2.47
Market information	.0155693	.16828	0.09

Dependent variable = adoption of improved forage technologies N=240, PR2 = 0.52, the ***, ** and * show statistically significant variables at 1%, 5% and 10% respectively.

Total income

Total income had been one the five variables determining the decision of farmers to adopt improved forage technologies. It is in logarithm form and statistically significantat 1% significance level. The mean annual total income of farmers was birr 13562 (Table--). The probit model in table 10 above predicted that 1% increase in total annual income increases the probability of adoption by 17.02%. The justification is that farmers with better income are more prone to finance and adopt improved forage materials.

Total landholding (ln)

Total land holding was also one those variables affecting farmers decision to adopt improved forage materials positively and significantly. The mean land holding of households in the study areas was 0.89ha (Table 2). It is in logarithmic form to normalize its distribution and was significant at 1% significance level. The model output in table 10 above predicted that 1% increase in total landholding increases the probability of decision to adopt by 51.13%. The justification is that farmers who have large farmland are expected to be more willing to adopt improved forage technologies that those farmers who have low farm size.

Supply of needed forage materials

Out of the total farmers, 62.5% responded that the types of forage materials being supplied were not materials needed by them. They are being supplied by the choice of experts of agriculture office in the districts. Most of the materials being supplied were Ddesho and elephant grasses. This determined adoption of improved forage materials significantly at 1% significance level (Table 10). The probit model result shown in table 10 above predicted that compared to those farmers who were not getting forage materials of their needs, the probability of adopting for those farmers who get forage materials of their need increases by 43.82%. This is because farmers will be more motivated to adopt as far as they get the type of forage material they want.

Extension contact

Extension contact was also one of those variables affecting farmers' decision to adopt improved forage technologies. 63.7% of the total farmers responded that they are not getting extension service regarding forage production. It was a dummy variable and affected adoption decision of farmers positively and significantly at 1% significance level. The model output in table 10 predicted that the probability of adopting forage technologies increases by 44.23% for those who get extension services compared to those who do not.

Distance to FTC

This was also another variable affected farmers' decision to adopt forage materials negatively and significantly at 1% significance level. The mean distance to travel up to FTC was 1.3hrs. i.e., around 3km. The probit model shown on table 10 predicted that the probability of adopting increases by 24.1% if travel distance reduces by 1 hour.

Intensity of adoption: Intensity/degree of adoption was measured by the amount of land allocated to produce improved forage materials for this particular study. 14 variables were hypothesized to determine level/intensity of adoption of improved forage technologies in Sidama regional state, Gedeo zone and Halaba Special District. These variables were Sex of household head, Education level of household head, Total family size (EM/LU), Total income (ln), Needed forage materials supply, Market demand, unfair distribution of forage materials, training attended in forage production, distance to FTC, market information, tropical livestock unit (ln), age of the household head, extension contact and total landholding (ln)Out of 14 variable hypothesized to affect level of adoption of improved forage technologies, 6variables, namely total income (ln), needed forage materials supply, market demand, distance to FTC, extension contact and total landholding (ln)were found to be significantly affecting level of adoption (Table 11).

Total income

Total income had been one the five variables determining intensity of adoption of improved forage technologies. It is in log form and significant at 10% significance level. The mean annual total income of farmers was birr 13562. The truncated regression model in table 11 above predicted that 1% increase in total annual income increases the probability of level/intensity of adoption by 23.41%. The justification is that farmers with better income are more inclined to finance and

Table 11: Determinants of level/intensity of adoption of improved forage technologies

Variables	Coefficients	Std. Error	Z- value
Sex of household head	.3126598	.2942936	1.06
Education level of household head	-.0232662	.0350023	-0.66
Total family size (EM/LU)	.0532294	.0635736	0.84
Total income (ln)	.2341242*	.1204787	1.94
Needed forage materials supply	.4752189**	.2058845	2.31
Market demand	.9260617***	.2741233	3.38
Unfair distribution of forage materials	.0099999	.2149667	0.05
Training attended in forage production	.0167068	.246354	0.07
Distance to FTC	.4408311***	.1871249	2.36
Market information	.1800068	.2588347	0.70
Tropical livestock unit (ln)	.0435359	0.06354	0.68
Age of the household head	-.004052	0.01602	-0.25
Extension contact	.5422602***	0.21868	2.48
Total landholding (ln)	.321274***	0.06388	5.03
_cons	-5.57266	1.107853	-5.03
/sigma	.9289947	.0700256	13.27

Dependent variable = land allocated to improved forage technologies production (ln) N=115, Walid chi2= 36.22, LR = 118.385, the ***, ** and * show statistically significant variables at 1%, 5% and 10% respectively.
Halaba zones.

increase the degree of adopting improved forage materials.

Total landholding (ln)

Total land holding was also one of those variables affecting farmers' intensity of adoption positively and significantly. The mean land holding of households in the study areas was 0.89ha. It is in logarithmic form and significant at 1% significance level. The model output in table 11 above predicted that 1% increase in total landholding increases the intensity of adoption by 32.13%. The justification is that farmers who have sufficient farmland are supposed to adopt more than those farmers who have low farm size.

Needed forage material supply

Out of the total farmers, 62.5% responded that the types of forage materials being supplied were not requested types. Most of the materials being supplied by district agriculture office were Desho and elephant grasses. This determined adoption of improved forage materials significantly at 5% significance level (Table 11). The truncated regression model in table 11 above estimated that the level of adoption increases by 47.5% for those households who get the type of forage materials they need. This is because farmers will be more motivated to adopt as far as they get the type of forage material they wanted.

Extension contact

Out of the total farmers, 63.7% responded that they were not getting extension service regarding forage production. Extension contact was also one of those variables affecting farmers' intensity of adoption of improved forage technologies. It was a dummy variable affecting intensity of adoption positively and significantly at 1% significance level. The model output in table 11 predicted that the level of adoption increases by 54.23% for those who get extension services compared to those who do not.

Distance to FTC

Distance to FTC was also another variable affected intensity of adoption of forage materials negatively and significantly at 1% significance level. The mean distance to travel up to FTC was 1.3hrs. i.e., around 3km. The truncated model output shown on table 11 predicted that the intensity of adoption increases by 44.1% if travel distance reduces by 1 hour. This is because as farmers get sufficient market for the forage materials they produced, they will be more motivated to produce more.

Market demand

Market demand also affected intensity of adoption positively and significantly at 1% significance level. 92.61% of the total sample farmers reported as low market demand was a problem in the study area. The model output predicted that compared to those households who reported low market demand as a problem, the intensity of adopting forage technology increases by 71.9% for those households who did not.

Conclusion and Recommendation

Conclusion

Lots of forage materials were being disseminated and adopted by farmers in Sidama regional state, Gedeo zones and Halaba special district. Desho grass, and elephant grass were out of improved forage materials adopted by farmers and are also the most adopted ones. Good weather condition, government support and long-lasted experience of farmers in forage production were identified to be opportunities to adopt improved forage technologies whereas supply of unneeded forage materials, unfair distribution and low market demand were identified as constraints in improved forage technologies adoption. The double hurdle model, developed by crags (1971) was employed to analyze determinants of adoption of improved forage materials. The result of probit model component of DH model indicated that total income, total land holding, needed forage material availability, distance to farmers training center and extension contact were factors affecting farmers' decision to adopt improved forage technologies. The truncated regression model component indicated that total income, needed forage material availability, distance to farmers training center, extension contact, total landholding and market demand are found to be affecting level of adoption of improved forage technologies significantly.

Recommendations

1. The DH model result predicted that unneeded forage materials supply was affecting improved forage adoption positively and significantly. Improved forage materials being supplied mostly were Desho and Elephant grasses which are in bulk amount in farmers land. They are not needed anymore. Therefore, district agriculture bureau, Hawassa Agricultural Research Center and other organizations who supply improved forage materials should come up with other types of forage materials based on the needs of producers.

2. Low market demand was also one of the significant factors affecting improved forage materials adoption. Therefore, district trade and industry should try to link forage producer farmers to cooperatives/ unions engaged in forage materials sale, livestock fattening, and private investors with large dairy farms.

3. Extension contact was affecting improved forage materials adoption positively and significantly. Therefore, DAs working in each kebeles should frequently visit, technically advice and follow-up the works of farmers.

4. Distance to FTCs where farmers get improved forage materials was significantly and negatively affecting adoption of improved forage materials. Therefore, district agriculture office should work to supply forage materials up to the farm get of each household. So that the distance travelled will be reduced and adoption will be improved.

5. Unfair distribution of improved forage materials was identified as one of constraints in improved forage materials adoption. Therefore, district agriculture office should take the responsibility and work to insure fair distribution to solve discrimination against farmers in forage materials dissemination.

Acknowledgement

I would like to thank Southern Agricultural Research Institute of Ethiopia for its financial support to conduct this study. I have also great appreciation for those who cooperated during this study especially those experts who work in agriculture bureau of Sidama regional state, Gedeo and Halaba zones.

References

1. Israel GD (1992) Determining Sample Size. University of Florida. Fact Sheet PEOD-6.
2. Muluneh NS (2019). Adoption of bread wheat technology packages: a case of Meket district in north Wollo zone of Amhara region, Ethiopia.
3. Mogues T, Cohen MJ, Birner R, Lemma M, Randriamamonjy J, et al. (2009)

Agricultural Extension in Ethiopia through a Gender and Governance Lens: Development Strategy and Governance Division, International Food Policy Research Institute. Ethiopia Strategy Support Program 2, Ethiopia.

4. Feder G, Just RE, Zilberman D (1985)Adoption of Agricultural Innovations in Developing Countries: A Survey. Economic Development and Cultural Change 33:255-298.