Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.13, No.7, 2023

Assessment of the Status of Improved Forage Technologies and Factors Influencing Technology Adoption: Empirical Evidence from North Shewa, Oromia, Ethiopia

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Abstract

The objective of this study is to assess the status of improved forage technologies and factors influencing technology adoption in the Debrelibanose district, North Shewa, Oromia, Ethiopia. In this study, survey study was used to collect primary data from 319 households, and Data was collected using a structured and semi-structured household survey questionnaire. Simple descriptive statistics were employed to analyze the collected data. As a result, 128 (40%) of the 319 respondents are adopters, while the remaining 191 (60%) are non-adopters of improved forage. Improved forage crops contributed approximately (14.1%) to the study area, with oats and vetch being the main sources of improved feed for animals. These technologies have been adopted and used by smallholder dairy farmers. The adopter households in the study area allocated only 6.4% of their farmland (0.17 ha on average) for the production of forage crops. Oats vetch and elephant grass were the main forage crops grown in study area and the two most important forage crops covers (58.9%) and (7.2%) respectively. Furthermore, the study attempted to assess gender disparities in the adoption of improved forage technology, and the results revealed that 115 (89.8%) of respondents were male-headed households, while 13 (10.2%) were female-headed households. In general, the study revealed that a small proportion of households have already begun using improved forage crops, while a large proportion of smallholder dairy farmers have yet to begin using improved forage technology. It was found that land scarcity (50.8%) and a lack of source technology (seed scarcity (40.7%) were critical constraints for the low adoption of this particular technology in the study area. Based on the findings of this study, it is recommended to emphasize the importance of addressing extension service, training, and access to forage seed and planting materials and others issues in the study area. In addition, the national agricultural research system, in collaboration with agricultural extension, should work rigorously to promote the uptake of the technology and bridge the huge adoption gap between adopters and non-adopters.

Keywords: Assessment; Debrelibanose; District; Improved forage; Status
DOI: 10.7176/JBAH/13-7-03
Publication date: May 31st 2023

Note: This manuscript is extracted from the author’s thesis work part which entitled “Improved forage technologies adoption and its impact on smallholder dairy productivity: the case of Advances in Agriculture 13 Debrelibanose, Wereda, and Oromia region, Ethiopia.

1. Introduction

Ethiopia is a growing country in Sub-Saharan Africa with a huge livestock potential, rated first among African countries and ninth overall. However, milk production is very low Duressa, D., et al (2014). The livestock production sub-sector has a huge contribution to the national economy and generating income for farmers, creating job opportunities, ensuring food security, providing services, contributing to the asset, social, cultural, and environmental values, and maintaining livelihoods Sintayehu, G., et al(2010). The subsector consists largely of smallholder farming systems with multiple uses and contributes around 16.5% of the national GDP, 35.6% of agricultural GDP, 15% of export revenues, and 30% of agricultural employment. CSA (2015).

Despite its large numbers, the country's livestock productivity is low. In addition to animal health problems, lack of adequate quantity and quality of feed is a major factor in poor livestock productivity. In rural Ethiopia, the use of improved feed is limited (0.3%), and native pasture grass (56.23%) is the most important feed resource, followed by crop residue (30.06%) CSA (2015). Hay and crop by-products are also used as animal feeds that comprise about 7.44% and 1.21% of the total feeds, respectively CSA (2015). However, these resources are poor both in quantity and quality so animal feed shortage remains the main constraint to productivity in both the lowlands and highlands.

Dairy production in Ethiopia is constrained by various interrelated factors; inadequate feed and nutrition, the prevalence of different diseases and poor health services, and poor genetic makeup of the indigenous breeds are the major technical constraints affecting dairy production. Among these constraints, shortage of feed supply in terms of both quantity and quality is the most critical constraint owing to both biological and economic reasons. Biologically, about two-thirds of the cost of improvement in dairy production is often attributed to nutrition. In economic terms, feed cost accounts for about 60 to 70% of the total cost of dairy production suggesting that the feasibility of the dairy enterprise is a function of the type of feed and feeding system Adebabay, K. (2009). Poor nutrition resulting from poor quality feeds and fluctuating feed supply are often limiting the productivity of dairy cattle, particularly under resource-poor smallholder systems in the country.

Livestock feeding is mainly based on natural pasture and crop residues and crude estimations of the available feed in different parts of the country depict a deficit of 35 – 57% even for maintenance and It is unlikely to improve livestock productivity via the commercial orientation of the production system without the concomitant intensification in feed production. Forages are effective in increasing milk yields by as much as 50% ILRI (2009). Additionally, the use of improved forages reduces the pressure on natural pastures, improves soil fertility and erosion on marginal lands, improves carbon sequestration to mitigate climate change, supports system sustainability, and enhances natural assets and system resilience ILRI (2009). Hay and crop residues plus natural grass constitute > 90% of the livestock diets in all the regions, whereas the use of improved forages represents < 0.35% of the diet, except in the Harari region where it is 1.68%. Improved forage species and varieties are insignificant in use and importance but will be critical shortly to sustainably intensify animal production FAO (2018).

As a result, to ease such constraints, national, regional, and international research institutions have developed several feed production and utilization technologies. Introduction, promotion, and utilization of improved forage crops (legume and grass), and multipurpose tree (MPT) forages through integration with food crops cultivation in the mixed crop-livestock system in Ethiopia started in the 1970s to supplement the roughage feed resources EARO (2002). Hay produced from natural grasses improved forage legumes and browse legumes are the most appropriate conserved forage for small-scale fattening or dairy production in Ethiopia Alemayehu, M. (2002).

Many improved forage crops have been tested and selected for the highlands. Some of them have been demonstrated to farmers, Oat, vetch, Elephant grass, Sesbania, Rhodes grass, Tree Lucerne, Desho grass, Alfalfa, and Fodder beet were the major improved forage crops used in the study area. Oats are the only crop, which is widely cultivated both for human food and as forage for livestock in the central highlands of Ethiopia, especially around the Selale, Sheno, Debreberhan, and Arsi areas. Oats are becoming very popular in many areas because it performs well in waterlogged and frost-problematic areas and on soils with poor soil fertility which is less suitable for other food crops Daniel, K. (1988) and Gryseels, G. (1988)

It is believed to be that the availability of improved fodder particularly green feed, as one of the major elements affecting dairy output, with the other factors remaining constant, has a good impact on dairy production performance and body condition Atsede, T. (2017). During the dry and wet seasons, non-adopters milk yields were estimated to be 1.3 liters/day/cow and 2.4 liters/day/cow, respectively. In the dry season, forage adopters' milk outputs were predicted to be 3 liters/day/cow, and in the rainy season, 6 liters/day/cow (wet season). This shows that fodder adopters produce higher milk yields than non-adopters with the same cow breed, which could be due to a variety of variables, including the usage of improved fodder. Similarly, according to Mamaru T (2022), empirical findings from PSM revealed that households using improved forage technologies have increased the household milk yield (productivity) by 29.32% and farm income (welfare) by 19.56%. Higher milk yield and annual farm income were compared to those households not using such technologies. The findings highlight the importance of promoting multiple improved forage technologies among rural smallholder dairy producers.

However, despite several efforts continuing to disseminate various improved feed technologies and feeding systems, and evidence of high returns where technologies have been extended by extension and development organizations is recognized, widespread adoption remains very limited and insignificant for a variety of reasons Gebremedhin, B., et al (2003) and Zekarias, B., et al (2015). According to the CSA (2015) report, only 0.3% of livestock holders in the country use improved feed technologies for their livestock.

Though various empirical studies have been conducted in Ethiopia to identify determinants of agricultural technology adoption, to the best of the author's knowledge, no similar studies have been undertaken in the study area. Moreover, the adoption decision of improved forage crops by smallholder farmers is influenced by different demographic, socioeconomic, institutional, and psychological factors differently in different areas. This indicates that to identify the influence of different factors in different areas; location and crop-specific research should be conducted. Therefore, the study was conducted to assess of the status of improved forage technologies and factors influencing technology adoption in the study area.

2. Literature review

2.1. Theoretical review

The term "technology" is defined in a variety of ways by various authors. Rogers (1995) defines technology as the design for instrumental action that reduces the uncertainty within the cause-effect relationship involved in achieving a desired target. A more accurate definition of technology may be a collection of "new ideas." New ideas are associated with a degree of ambiguity and, as a result, a lack of predictability in their conclusion. Blending into the conventional routine of the targeted financial system without disrupting the system's state of affairs is essential for technology to have an impact on the financial system. This necessitates overcoming the apprehensions surrounding new technologies. As a result, it's no surprise that various research has been conducted to establish what these characteristics are and how they may be avoided (if they are restraints) or increased (if they are enhancers) to achieve technological adoption. Enos and Park (1988) define technology as "public knowledge or information that facilitates the accomplishment of certain tasks, the performance of certain services, or the manufacturing of certain items" in their research on imported technology adoption (p.9). (Singh and Abara) (1993) explain that the application of that knowledge is what is referred to as 'technology.' Agricultural technologies are included in this definition, although Enos and Park (1988) concentrated on non-agricultural technology.

Technology adoption is defined by Van den Ban and Hawkins (1996) as the decision to implement an invention and continue to utilize it. The adoption process, according to this definition, refers to the changes that occur in a person's mind concerning an innovation from the moment s/he becomes aware of it to the final decision to continue using it or not. Adoption is the result of a decision to accept a particular invention. While paraphrasing Roger's earlier work from 1962, Feder et al. (1985) describe adoption as "the process a private goes through from first hearing about an innovation to final utilization." Dasgupta (1989) also defines technology adoption as the utilization of technology over time (by individuals or groups) of the recommended innovation or new practices over a fairly long period.

Campbell's primary phase of the adoption model is based on the fact that adopting a new technology isn't always a quick process (1966). Rather, it's a process that unfolds through time and is influenced by a sequence of events. As a result, the fundamental phase of the adoption process consists of the following five stages: (1) acquaintance: the first time you learn about the innovation (2) curiosity: a desire to learn more about the innovation (3) assessment: assessing the advantages and disadvantages of implementing the innovation (4) trial: a small-scale test of the invention, and (5) adoption: a large-scale application of the technology over traditional methods. However, we must always keep in mind that none of these choices are made linearly. In fact, according to recent research, these stages may occur simultaneously, and some may or may not occur during the adoption decision-making process Rogers (1995).

Model of innovation diffusion According to Feder et al., (1985), adoption is the integration of an invention into a farmer's activity over some time; nevertheless, farmers may not be able to continue the adoption process due to many constraints such as institutional, personal, and societal factors. According to Carr (1999), technology adoption is the process of an individual or a group of people choosing a technology. On the other hand, technology adoption theory is essentially a process in which members or groups of a social system communicate an invention through a specific channel.

Adoption is defined differently by different scholars in different eras. Rogers (1983) defined adoption as the use or non-use of new technology by a farmer over a period of time. It's all about employing technology within a certain amount of time. The adoption decision, according to Feeder et al, cited in Hailu (2008), also includes deciding what share of resources to adopt. (In this case, land) The decision process involves area allocations as well as the level of use or rate of application if the technology is not divisible (e.g., mechanization, irrigation); however, if the technology is divisible (e.g., improved seed, fertilizer, and herbicide), the decision process involves area allocations as well as the level of use or rate of application. In this scenario, depending on the technology type, the adoption of technology can be determined by area allocation and level of use. Aggregate adoption, as described by Thirtle and Ruttan (1987), is the diffusion of new technology across a population. Adoption also considers population coverage in a certain place and at a specific period. Farmers choose technology based on several factors during the adoption process. A farmer, according to Hasan (1996), takes a series of interdependent judgments before making adoption decisions. In general, adoption is a decision made by farmers to use or not use technology within a given time frame based on numerous factors and quantified by area allocation or level of use based on technology type.

2.2. Empirical review

Despite many years of effort in forage research and extension activities, the adoption and utilization of improved forages by farmers are very low. Generally, several factors affect the adoption of improved forage technologies. For example, Njarui, D., et al (2017) examined determinants of forage adoption and production niches among smallholder farmers in Kenya using a binary logistic model. Their findings indicated that access to formal education of the household head, experience in livestock farming, and land ownership influenced the adoption of improved forage technologies positively and significantly. Likewise, Beshir, H. (2014) studied determinates of improved forage technologies adoption among smallholder farmers in the northeast highland of Ethiopia using a Double hurdle model. The model result revealed that access to extension services, age of the sample household head, farm size, livestock ownership, and labor available had a positive and significant effect on the adoption of forage technologies, implying that improving the resource endowment of farmers would boost agricultural production.

On the other hand, Zekarias, B. (2016). analyzed determinates of improved forage technologies in the Doyogena district of Kembata tembaro zone, in southern Nations, Nationalities regional state, Ethiopia using the logistic regression model. The model result mentioned that access to formal education, training, and the number of dairy cattle owned affected positively the household choice to take part in the adoption of improved forages in the district; while access to communal land, access to market points and farmers training center negatively affected the probability.

A study carried out by Yadessa et al. (2016) and Shiferaw et al. (2018) revealed that few farmers assign land for forage farming which might be because of a lack of awareness. Access to training had an extremely important and positive effect on forage adoption. It is not amazing that increasing the knowledge of farmers concerning newly released and adapted forage technologies and viewing them in what way to use them, improves the probabilities of forage adoption (Abebe et al, 2018).

To sum up, the previous studies examined mostly focused on identifying the determining factors of the adoption of improved forage technology. But this study has tried to look at both factors that affect the adoption of improved forage technology, to what extent the technology adoption by the household, likewise as its implication on the agricultural household livelihoods and dairy productivity. It's intended to contribute to the knowledge gap regarding dairy productivity, rural household livelihood change, and improved forage technology adoption in the region.

3. Methodology

3.1. Description of the study area

The study was conducted in three selected kebeles of Debrelibanose Wereda, North Shewa Zone of Oromia Region State. Debrelibanose is one of the thirteen weredas of the North Shewa zone of the Oromia Region. Geographically the Wereda is located between latitudes of 090 43' 30" N longitudes and 380 51'0"E latitudes (see Fig.1). It is found about 104 kilometers from Addis Ababa and 14km from Fiche town, the capital of North Shewa zone, in the Oromia Regional State. It is located in the altitude ranges between 1500 to 2635 meters above sea level. The study area is characterized by diverse landscapes, flora, fauna, and habitat types. The area has extremely steep slopes leading up to a strip of a plateau. It has a bi-modal rainfall pattern ranging from 800 mm to 1200 mm with five months of rain (May- September). The dry p is from December to March. The annual average maximum and minimum temperature of the study area is 23^0c and 15^0c, respectively.

The main economic activities of these study areas are mixed crop-livestock farming, which has been practiced by smallholder farmers. Agriculture share is 54.3%, pastoral farming 36%, hand work product 5 %, and other accounts 0.7% respectively. (North Shewa Zone Culture Tourism Office / April 2017). The area is considered as high potential crop-livestock zones where dairy activities play a significant role in the livelihood of farmers in the area. Considering the potential of the area and the economic significance of dairy production to the local community, there have been repeated efforts by governmental and nongovernmental aid organizations to improve dairy productivity. This area has also better access to livestock development services (governmental and non-governmental) and milk markets than other rural areas. Due to the above-mentioned reasons and the economic capacity of the peasant small-holder dairy production with crossbred dairy cattle is a common practice in the area (North Shewa Zone Culture Tourism Office / April 2017).

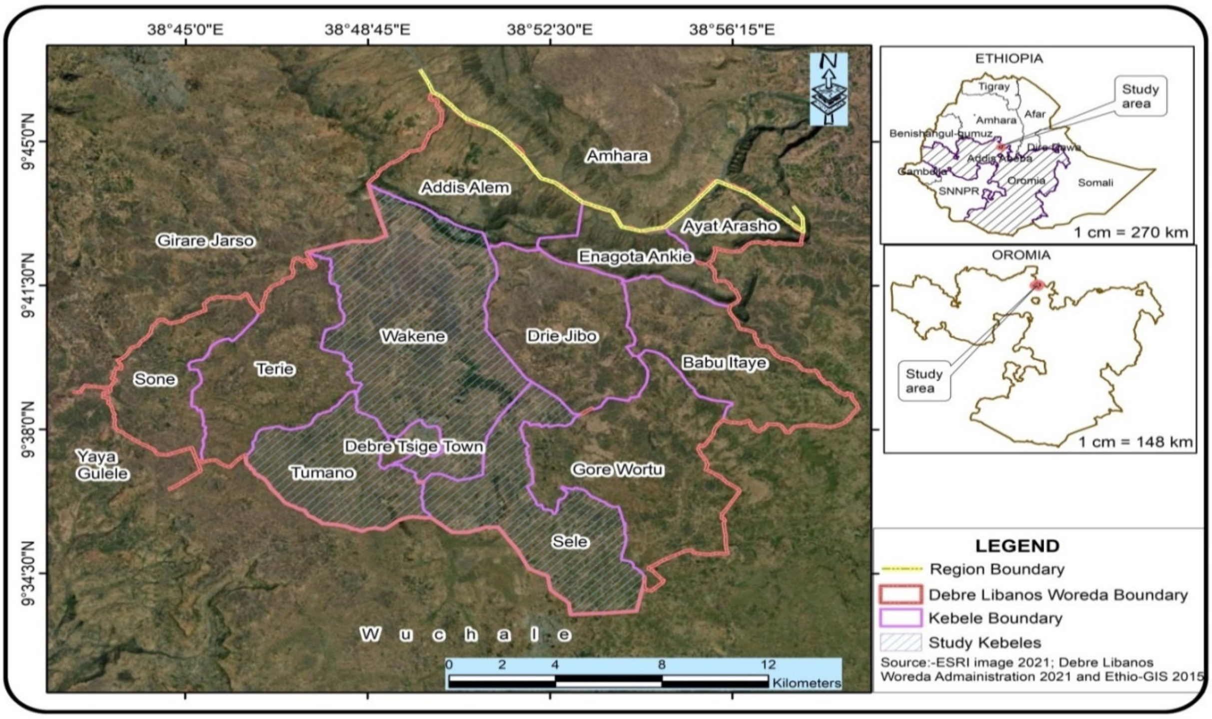

Figure 1: Map of the study area
(Source: ESRI image 2021; Debre Libanos woreda Administration 2021 and Ethio –GIS 2015)

3.2. Sampling method and size

Multi-stage stratified random sampling technique was employed to select the representative sample for this study. In the first stage, the Debrelibanose district of the Oromia region was selected purposively based on its improved forage production potential and the number of dairy technology availability and practiced in the area. In the second stage, three kebeles were randomly selected from the woreda among potentially improved forage producers. These sample kebeles were Sele, Tumano, and Wakene. Thirdly, within the selected kebeles, the respondent households were stratified into two groups: forage technology adopters and non-adopters. Adopters were households who are cultivating and continue using improved forage crops for feeding their livestock. Non-adopters were households that are not engaged in the cultivation of improved forage. The households in each of the two categories were selected at random. In the end, From the total of 1895 households in these three kebeles 319 farm household heads were selected randomly, using probability proportionate to the size and out of which 128 were adopters and the remaining 191 were non-adopters farm households. The total sample size (n=319) was determined by using Kothari's (2004) sample size determination formula. A simplified formula provided by Kothari, C. R. (2004) was employed to determine the required sample size at a 95% confidence level, degree of variability=0.5, and level of precision= 5% (0.05).

$$n = \frac{Z^2 pq}{d^2} \quad , \qquad [1]$$

Where n is the desired sample size, Z is the Standard normal variable at the required level of confidence, p is the proportion in the target population estimated to have characteristics being measured, d is the level of tactical significance set, and q=1-p.

3.3. Methods of Data Collection.

In this study, both qualitative and quantitative data types of primary and secondary sources were utilized. Secondary data was collected by reviewing published and unpublished documents. Primary data was collected using two-survey procedures, formal and informal surveys. In the informal survey: key informants interviews, focus group discussion, and transect walk were done using respondent and development agents. Checklists were prepared to conduct key informant interviews and focus group discussions. A total of five focus group discussions and 15 key informant interviews were made in the formal survey: Data was collected using a structured and semi-structured household survey questionnaire by applying face-to-face interviews with household heads.

3.4. Method of data analysis
The data collected from primary, and secondary source were amazed by employing descriptive statistics; the analyzed data is presented in the form of tables and graphs.

4. Result and Discussion
4.1. Major feed resources in the study area
Farmers depend on various sources of animal feed, most of which are obtained in their locality and from their farms. As shown in (Figure 2) below 87.15 % of the farmers majorly depend on both crop residues and natural pasture as a source of animal feed. The types of residues fed to animals often depend on the types of crops grown in different parts of the country. For instance, straws of teff, wheat, and barley are common in agro-ecology ranging from mid altitudes to highlands while stalks of maize and sorghum are common feed types in the lowlands. Wherever it is, residues of crops are often stored for use in the later season especially when feed scarcity is encountered. Hay (33.54%), crop aftermath (31.33%), and improved forage (14.11%) mainly oats and vetch are also major sources of feed for animals in the study area. Green feed supply commonly oats and elephant grass is usually practiced as cut and carries systems, especially during the rainy season. Concentrate was also reported to be a common source of animal feed by 22.57% of households. These concentrates mostly include noug seed and linseed cake, and by-products of grains and local beverages. Others also contributed to the overall feed resource types in the study area as stated in (figure 2).

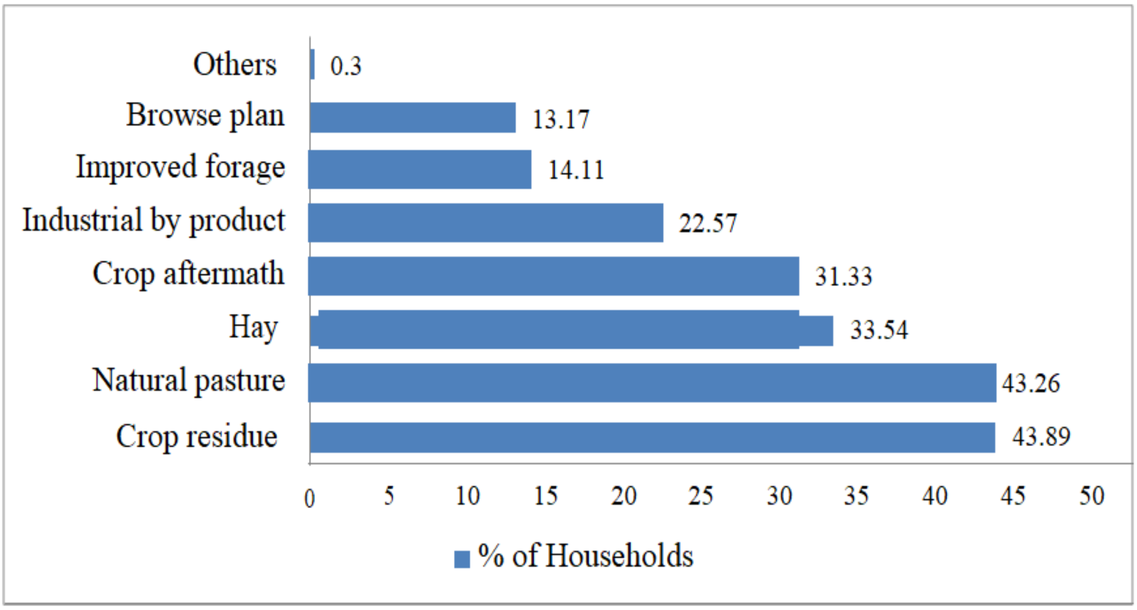

Figure 2: Major feed resources used for feeding animal
Source: Computed from own survey (2021)

4.2.1 Adoption rates
Improved forages of various types have been released for utilization decades ago. The findings, therefore, present how these technologies have been adopted and utilized by dairy farmers in the study areas. In this study, adopters of forage technologies are defined to be farmers who have allocated a plot of land to grow forage crops within the last five years. Accordingly, Out of the total 319 respondents, 128(40 %) of them are adopters and the remaining larger proportion 191 (60%) of them were found to be non-adopters of improved forage in Debre Libanose woreda (Figure 3, below).

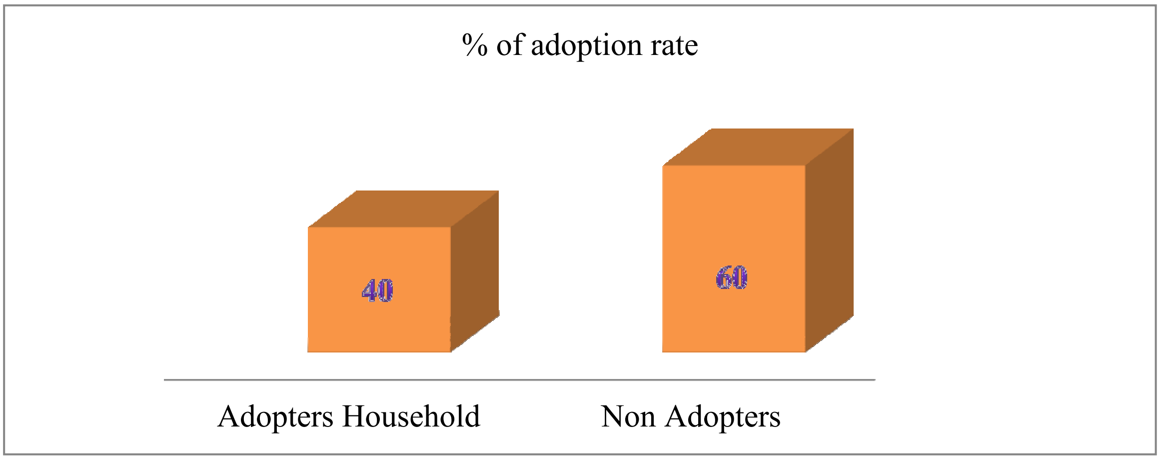

Figure 3: Adoption rates of improved forage technologies
Source: Computed from own survey (2021)

The focus group discussion /FGD/ participants from the three kebeles of the woreda indicated that adoption status/rate/ of improved forage is increasing year to year at a lower rate. They indicated that the low level of land allocation to improved forage is due to the lack of training. The farmers indicated that, if not for the skill and knowledge of the model farmers, the majority would not have conducted it due to a big lack of training on livestock production in general and improved forage in particular. Hence, during the focused group discussion /FGD/ the farmers capitalized on more organized quality training to help them make more use of the improved forage advantage, and to attract more other non-adopters into the improved forage production system.

4.2.2. Adoption intensity of improved forge technologies

Under this particular study, the Extent of adoption of improved forage technology depicts that only 6.4% of the farmland (0.17 ha on average) was allocated for the production of forage crops (Table 1). The actual area allocated for feed could be more than this if we take into consideration the area allocated for grazing and haymaking. There is also a statistically significant difference (P<0.01) among the adopters' households. Households ranging from none (0.0 ha - 1.0 ha) maximum in this specific study area. Conventionally, farmers tend to allocate more area of farmlands for the production of food crops than forage crops. This is partly because of limited land holding or farm size and the perception of the farmers that animals can get feed freely from elsewhere and that it is a waste of land to allocate for forage crops. Limited awareness of the importance of forage crops is also another factor that hindered the wider use of forage technologies.

Table 1: Adoption intensity of improved forage crops in Debre Libanose woreda

Woreda	Total area (ha) of land Cultivated (sample mean)		Total area (ha) of land cultivated (forage growers mean)		
Debre Libanose	**N**	Total sample average (ha)	**N**	Area allocated for forage(ha)	% area allocated for forage
	319	2.63	128	0.17	6.4
	Statistical test P<0.01				

Source: Computed from own survey (2021)

4.2.3. Varietal level adoption rates of improved forage crops

Various stakeholders were engaged in the promotion of these forage crops, such as the Office of Agriculture, Agricultural Research Institutions, Higher Learning Institutes, special purpose projects (such as the 4th Livestock Project, ILRI (the then ILCA) projects, Smallholder Dairy Development Projects, and others). According to the findings of this study, the different varieties of forage crops have varying levels of adoption rates. As presented in Table 2, the two major forage crops that have relatively been expanded and grown in the study areas included oat-vetch (58.9%), elephant grass (7.2%), and sesbania (4.7%), Rhodes grass (4.1%) and tree lucerne (2.2%). On the other hand, Desho grass (0.94%), alfalfa (0.30), and fodder beet (0.30%) were the least adopted forage crops in this particular study area. The major reasons behind the low adoption rates of forage crops are associated with, limited access to improved forage seeds, shortage of farmlands, and the consequent interest of the farmers to give priority to food over forage crops.

Table 2: Varietal level adoption rates of improved forage crops in the study area, 2021

Improved feed packages	Freq.	Adoption rates (%) (N = 128)
Oat-vetch	188	58.9
Elephant grass	23	7.2
Sesbania	15	4.7
Rhodes grass	13	4.1
Tree Lucerne	7	2.2
Desho grass	3	0.94
Alfalfa	1	0.30
Fodder beet	1	0.30

Source: Computed from own survey(2021)

4.3. Awareness and sources of improved forage seed technologies

The adoption of new technology and practice is often preceded by knowledge of its existence. Accordingly, 60.5 % of the overall households were aware of improved forage technology and the remaining 39.5% responded households in the study area were not aware of this particular technology as far as the source of improved forage seed in the study area concerned about 56.5% of the households, accessed improved forage seed was mainly sourced from government Office of Agriculture through its channels of extension service provision (figure 4). The second essential source of improved forage seed technology was NGO for about 31% of the households,8.9% of the household also accessed through the private source (revolving seed), and 3.6% of the seed source was from national agricultural research and higher institution. In this regard, agricultural research centers have also contributed to creating knowledge of improved forage technologies of the households through direct engagements so far in the demonstration of the best promising materials to the area. However, the contribution of the national agricultural research systems and international research organizations was fundamental through awareness creation, outreach programs, capacity building, and empowerment means through indirect means as well.

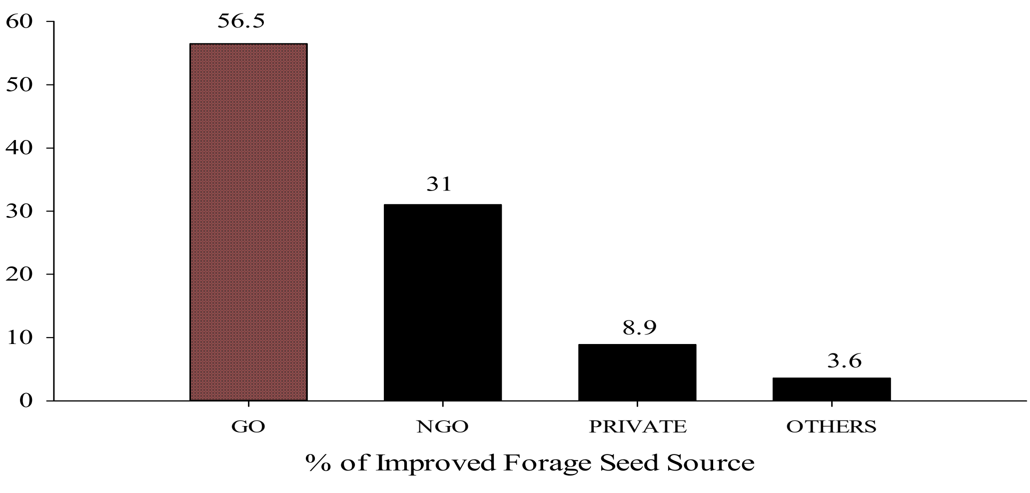

Figure 4: Source Improved Forage Seed Technology, 2021
Source: Computed from own survey (2021)

As presented in (figure 5 below), 4% of the households in the study area were aware of improved forage technologies for more than 10 years. Whereas, there was also a difference among the household in the study areas 25% of the household were aware of it within the last 2 years, 32% within the range of 3 to 5 years, and 38 % in was range from 6 to 10 years where the majority fall in the time Zone that households became aware of improved forage technologies. In general, majority of the household 74% of the overall households got the awareness of improved forage technology within the last 10 years' time. This might be because of the decentralized administrative setup and empowerment of districts with well-organized extension programs designed based on the needs of beneficiaries and prevailing development needs.

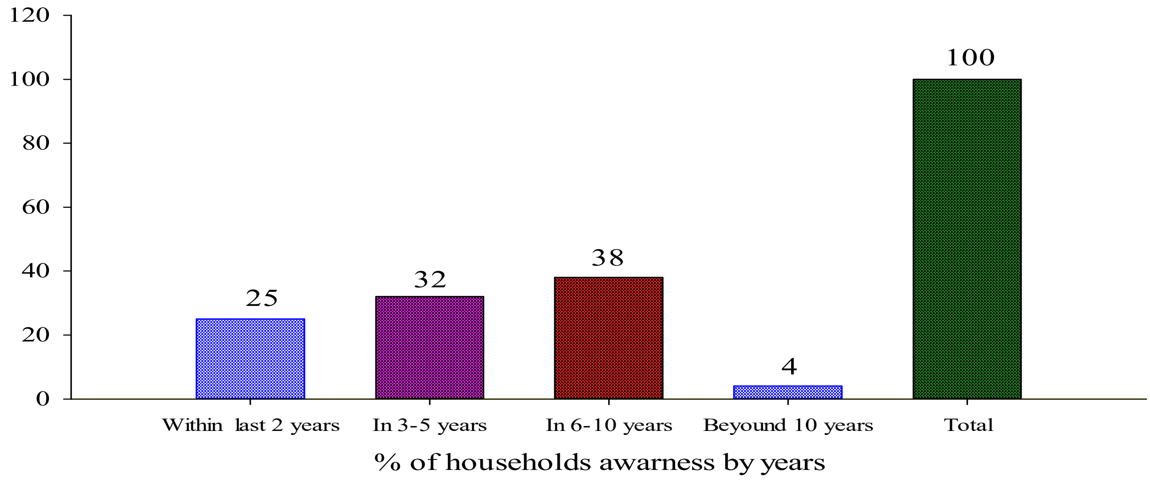

Figure 5: Time since households became aware of improved forage technology
Source: Computed from own survey (2021)

4.3.1. Experiences of improved forage cultivation in the study area

The experience of improved forage cultivation in this study area has shown the different year of experience among the adopter categories (Table 3 below). The adopter household categories have started utilizing different improved forage materials in different years, 9.4% of the respondents of adopters households experienced utilizing improved forage technologies in less than one year, and the other majority (23.2%) of the adopter households experienced within the range of 1 to 5 years, (6.9 %) of them experienced for the last 5 to 10 years and remaining (0.31%) has stayed with the technology since more than 10 years .experience of improved forage is directly associated with households with improved cattle's owned. hence, one without the other is unproductive and this finding is conformity with focus group discussion.

Table 3: Improved forage growing experiences by adopters, 2021

Experiences in growing improved forage	Freq.	%
0	192	60.19
< 1 Year	30	9.4
[1-5 Years)	74	23.2
[5-10 Years)	22	6.9
[> 10 Years)	1	0.31
Total	319	100

Source: Computed from own survey (2021)

4.3.2. Gender perspectives in the adoption of improved forage technologies

The study has also attempted to assess whether there is gender disparity in the adoption of improved forage technology. It was noticed that there was a difference in the adoption rates for male and female-headed male-headed households, as indicated in (Table 4). The result revealed that out of the total adopters' respondents, 115 (89.8%) were male-headed households and 13(10.2%) were female-headed households. This indicates that male-headed households had a higher probability of adopting improved forage technology in the study area than female-headed households. Within both household types, hug variability was observed to be statistically significant. This might be due to the labor-intensive nature of the technology. Thus, the males strongly engaged in forage production and as a result of getting access to information and training males-headed households are better off than female-headed households.

Table 4: Gender perspectives of improved forage technology adoption rates

Study Woreda	With Adopters category				Overall %
	Female-Headed household	%	Male- Headed household	%	
Debre Libanose	13	10.2	115	89.8	100
	Statistical test P<0.01				

Source: Computed from own survey (2021)

4.3.1. Reasons for farmers do not adopt improved forage technologies

The study revealed that Even though a limited proportion of households have already started using it, large proportions of them have not yet started adopting improved forage technology. There are key factors behind this disadoption. As indicated in Figure 6, the six major reasons described by farmers included land shortage as reported by 50.8% of the households, unavailability of sources technology (seed shortage (40.7%), unawareness about improved forage technology (28.1%), labor shortage (24.1%), the problem of other inputs (15.3%) and the problem of health bloating (6.3) had been reported. The first two reasons were found to be critical for the dis adoption of this particular technology in the study area. The basic reason for this occurrence is acute supply shortage due to the unavailability of reliable and capacitated formal improved forage multiplication and distribution centers in the country. The government has given a due focus to the establishment of seed multipliers of improved forage crop variety both at Federal and Regional levels, so far it has been done through small-pack seed delivery via the national agricultural research system and this kind of working platform couldn't able to reach the large mass of the population. The other major reason was related to awareness and knowledge of improved forage technology. Therefore, intensive training should be given to bridge the gap.

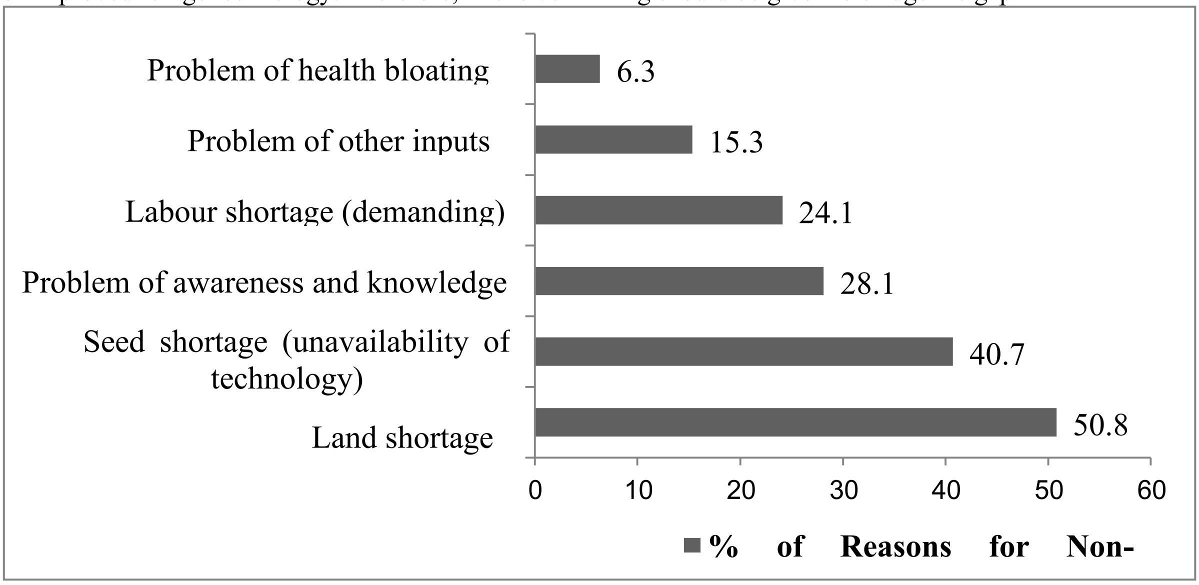

Figure 6: Reason for not adopting improved forage technology, 2021
Source: Computed from own survey (2021)

Conclusion and implication

The ultimate objective of this study is to assess the status of improved forage technologies and factors influencing technology adoption in the Debrelibanose district, North Shewa, Oromia, Ethiopia. In this study, both primary and secondary data were collected from a total of 319 households, and the collected data were analyzed using simple descriptive statistics. Based on result of this study, Farmers depend on various sources of animal feed, most of which are obtained in their locality and from their farms. Farmers rely heavily on crop residues and natural pasture as a source of animal feed, the two sources contributing more than 87.15% of livestock feeds in the area. Whereas improved forage contributed (14.11%), the main sources of improved feed for animals in the study area are oats and vetch.

Different types of improved forages have been available for use for decades. Dairy farmers in the study areas have adopted and implemented these technologies. As a result, 128 (40%) of the 319 respondents are adopters of improved forage, while the remaining 191 (60%) are non-adopters.

According to the level of adoption of improved forage technology adopter households from the total farmland was allocated only 6.4% of farmland (0.17 ha on average) for the production of forage crops. The two most important forage crops grown in the study area were oats vetch and elephant grass, which accounted for a large portion of the improved forage grown (58.9% and 7.2%, respectively). In terms of technological awareness in the study area, 60.5% of the total interviewed households were aware of improved forage technology, while the remaining 39.5% were not and in the study area, 56.5% of households obtained improved forage seed and planting materials primarily from the Government Office. Besides, the study revealed that the experience of adopter categories with improved forage cultivation in the study area varies. Furthermore, the study attempted to assess gender disparities in the adoption of improved forage technology, and the findings revealed that 115 (89.8%) of total adopters' respondents were male-headed households, while 13 (10.2%) were female-headed households.

According to the study, only a small percentage of households have started using improved forage crops, while a large proportion of smallholder dairy farmers have yet to start using improved forage technology. There are several factors that contribute to this disadoption. It was found that land scarcity (50.8%) and a lack of source technology (seed scarcity (40.7%) were critical factors in the study area for the disadoption of this particular technology.

Lastly, from this study's findings, the following recommendation was forwarded;

- The improvement and intensification of improved forage in the study area, particularly need improving accessibility of improved forage seeds and working closely with respective federal and regional research centers, agricultural office, and development organization should be deemed most important to increase smallholder awareness of about the technology and enhance the technology uptake.

Note

1. 'Wereda' is an administration unit equivalent to district, whilst 'Kebele' is the lowest administration unit in Ethiopia

Acknowledgements

The author would like to thank Addis Ababa University and Holetta Agricultural Research Centers for coordination and facilitation during data collection. We also thank enumerators and respondents for their valuable contribution in data collection and response, respectively.

Author contributions

Sole author collected and analyzed both primary and secondary data. Finally read and approved the final manuscript.

Funding

Ethiopian Institute of Agricultural Research (EIAR) provided financial support to complete this study.

Availability of data and materials

The author wants to declare that they can submit the data at any time based on the publisher's request. The data sets used and/or analyzed during the current study will be available from the authors on reasonable request.

Consent for publication

Not applicable.

Competing interests

Not applicable.

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