DETERMINANTS OF THE ADOPTION OF SMALL RUMINANT RELATED TECHNOLOGIES IN THE HIGHLANDS OF ETHIOPIA

[DETERMINANTES DE ADOPCIÓN DE TECNOLOGÍAS RELACIONADAS CON PEQUEÑOS RUMIANTES EN LAS TIERRAS ALTAS DE ETIOPÍA]

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SUMMARY

This paper takes up the case of two market-sheds in the southern Ethiopian highlands (namely Adilo and Kofele) to examine the factors affecting the adoption of small ruminant related technologies in mixed-farming systems. A survey was conducted using semi-structured questionnaires with 155 randomly selected small ruminant keepers between May and June 2006. Farmers in each site initiated new practices like small ruminant fattening and managing a household 'veterinary kit'. Logistic regression analysis revealed that size of land and livestock holdings significantly affected the adoption of small ruminant technologies in both study sites. Farmer variables such as gender, literacy, age and family size appeared to influence adoption only in one location. In the densely populated area, Adilo, the adoption of more intensive feeding technology of commercial concentrates decreased with increasing farm size only up to a point. Younger farmers, female farmers and literate household heads were more likely to adopt the utilization of commercial concentrates. In relatively resource rich Kofele, treating small ruminants via the household veterinary kit increased with number of livestock, however with farm size only up to the point at which it reached a maximum. The present study showed that location or production system remarkably affects the options of interventions and determines their adoption.

Key words: small ruminants; technologies; adoption; Ethiopia; mixed-farming, logistic regression.

RESUMEN

Este artículo utiliza el caso de dos almacenes de mercado en el sureste de las tierras altas de Etiopía (Adilo y Kofele) para examinar los factores que afectan la adopción de tecnologías relacionadas con los pequeños rumiantes en sistemas de granjas de producción mixta. Se condujo un estudio empleando una encuesta semi-estructurada con 155 pastores de pequeños rumiantes seleccionados al azar entre mayo y junio de 2006. Los granjeros en cada sitio iniciaron nuevas prácticas como el engorde de pequeños rumiantes y manejo de naves con un "paquete veterinario". Los análisis de regresión logística revelaron que el tamaño de la granja y el número de animales afectaba significativamente la adopción de tecnologías en pequeños rumiantes en ambos sitios de estudio. Las variables de los granjeros como sexo, alfabetismo, edad y tamaño de familia parecieron afectar la adopción en una sola locación. En el área densamente poblada, Adilo, la adopción de tecnología más intensiva como la alimentación con concentrados disminuyó únicamente con el incremento del tamaño de granja. Los granjeros jóvenes, granjeras y jefes con educación tuvieron la tendencia a adoptar la utilización de concentrados comerciales. En la relativamente rica en recursos Kofele, el tratamiento de pequeños rumiantes a través del "paquete veterinario" se incrementó con el número de animales, sin embargo con el tamaño de granja únicamente hasta que alcanzó el máximo. El presente estudio mostró que la locación o sistema de producción afecta marcadamente las opciones de intervención y determina su adopción.

Palabras clave: Pequeños rumiantes; Tecnologías de adopción; Etiopía; producción mixta; regresión logística.

INTRODUCTION

In Ethiopian mixed crop livestock systems, sheep and goats are normally kept in small flocks. As a result of the increasing human population in most highland areas, the practice of tethering and housing these small ruminants is on the rise. Consequently, the feeding and fodder production issue is becoming more and more imperative (Peacock 2005). In addition to feed shortage, the losses caused by diseases are also substantial. There is an extensive evidence of helminth parasites becoming a major constraint to productivity of small ruminants in the country that resulted in the loss of millions of dollars (Biffa *et al.* 2006; Abebe *et al.* 2010). These problems require appropriate interventions in order to increase the contribution of the small ruminant sector to the country in general and to the resource-poor farmers in particular.

Without due consideration of socioeconomic and biophysical factors that may affect the adoption of small ruminant technologies, it will be almost impossible to design proper development programs and enhance their contribution to the rural households' economy. Farmers do not normally adopt new practices for two seemingly obvious reasons. They are either unwilling or unable (Nowak 1992). Evaluation of factors influencing the adoption of possible technologies could play a decisive role in developing feasible and sustainable programs. According to Nederlof and Dangbégnon (2007), technologies that are forwarded to resource-poor farmers should meet a variety of needs of these people and be acceptable from a socio-cultural perspective besides technical and economic considerations.

One of the major aims of participatory research is to identify possible intervention areas. Observing the pattern of the farmers' attitude towards adopting certain agricultural technologies would give a basis for the selection of viable interventions. Batz *et al.* (2003) noted that understanding the factors that have determined adoption in the past offers relevant information about the characteristics which will facilitate the quicker and wider adoption of forthcoming technologies. This study attempted to examine factors affecting the adoption of small ruminant related technologies in two mixed-farming systems of southern Ethiopia primarily based on the cases of commercial concentrates and household veterinary kits.

MATERIALS AND METHODS

This study was part of a broader study on the productive and economic performance of small ruminants in mixed farming systems of southern Ethiopia. The study was carried out in two small ruminant market-sheds, namely Adilo and Kofele. Adilo represents the most densely populated areas in the country (more than 500 people km^{-2}) while Kofele represents Ethiopian highlands populated at medium level (about 200 people km^{-2}).

The annual rainfall distribution at both study sites is generally bimodal. During the four years from 2000 to 2003, annual rainfall ranged between 1055 and 1194 mm at the two meteorological sites around Adilo (Shone and Durame) (NMSA 2004). Adilo is an area characterized by land scarcity and food deficiency. The altitude of most of the villages around Adilo is between 1600 and 2000 m above sea level. Rainfall in the mentioned period was about 1200 mm in Kofele (NMSA 2004). Kofele is a typical highland area with a relatively cool climate, food sufficiency and fairly high agricultural potential in terms of land availability and soil fertility. The altitude of the district ranges from 2000 to 3050 m above sea level, and the mean monthly minimum and maximum temperatures for the years 2000 to 2003 were 7.5 and 19.6°C, respectively (NMSA 2004).

Both market-sheds are among the major suppliers of small ruminants, mainly sheep, to the neighboring big cities (*e.g.* Shashemene, Hawassa) and Addis Ababa, particularly during holidays (Legesse *et al.* 2008; Legesse *et al.* 2010). The characteristics of transactions related to small ruminant production, the factors affecting the sale price of small ruminants and the financial profitability of the traditional small ruminant enterprises in the two sites were recently described (Legesse *et al.* 2010). Based on genetic analysis, Gizaw *et al.* (2007) reported that sheep in Kofele and Adilo are from the same fat-tailed Arsi-Bale breed. Nearly all goats in the study area are also from local breeds. Besides small ruminants, farmers also keep cattle, chicken and equines and grow crops like enset (*Ensete ventricosum*), maize (*Zea mays*) and potato (*Solanum tuberosum*). The majority of the people living in Kofele and Adilo are Muslims and evangelical Christians, respectively. Ethnically, nearly all respondents in Kofele were Oromos while the majority of the Adilo respondents belonged to the Kembata and Hadiya ethnic groups.

A single-visit survey on the adoption of small ruminant related technologies was conducted using semi-structured questionnaires in each study site with all randomly selected small ruminant keepers participating in a flock and household monitoring which involved a total of 155 households (*i.e.* 90 in Adilo and 65 in Kofele) (Legesse 2008). Criteria for sampling households for the monitoring were having at least three small ruminants (sheep and/or goats), one or more cattle and willingness to participate. The survey was administered between May and June

2006. Since previous studies indicated that the two market-sheds have differences in the ranking of small ruminant problems (Legesse *et al.* 2008), the questionnaire included site-specific questions.

Prior to the adoption survey, two farmer workshops were organized in March 2006 in the study sites with the small ruminant keepers participating in a flock and household monitoring. Eighty-two farmers from Adilo (out of the total 90) and fifty-five farmers from Kofele (out of the total 65) who were willing and able to attend participated in the workshops. Other than the participating farmers, the team included three researchers, an assistant and two enumerators in each respective site. A checklist was prepared before the workshops. Core observations from a previously conducted diagnostic survey, group discussions and the then on-going flock monitoring as well as potential improvement measures were presented to the farmers. The topics were discussed under the guidance of the moderator (one of the researchers), in order to get the views and perspectives of the small ruminant keepers on a certain issue. Another member of the research team made notes in a discrete way. The enumerators served as translators. Each workshop lasted for about three hours.

The number one problem in Adilo small ruminant market-shed was found to be feed shortage while small ruminant diseases ranked first in Kofele (Legesse *et al.* 2008). In spite of this, fattening small ruminants (particularly sheep) targeting holiday markets has been a common practice in Adilo. In addition to home produced feedstuffs, a large number of small ruminant keepers are using commercial concentrates (mainly wheat bran and oilcake) to fatten their animals. Hence, the utilization of commercial concentrates in the household was taken as a dependent variable to be tested for its adoption in the area. Despite the provision of basic veterinary services principally by government-owned livestock clinics in both sites for small ruminants, Kofele farmers commonly administer injections and/or other medicaments by themselves. Therefore, such practice was taken as a dependent variable to be tested for its adoption in the area. Logistic regression was employed to determine predictors for the adoption of the selected practices. The explanatory variables which were used in the model and their definitions are given in Table 1. The choice of explanatory variables has been made based on findings of past studies (Feder *et al.* 1985; Gebremedhin *et al.* 2003; Feleke and Zegeye 2006). The explanatory variables which are assumed to affect the dependent variables will be briefly described as follows.

Gender of household head: male headed and female headed households could make different decisions whether or not to adopt different types of agricultural technologies. However, male-headed households are assumed to have higher access to information sources than female-headed households and may be generally more likely to adopt a technology.

Literacy: could increase the farmer's ability to acquire, analyze and use information relevant to the adoption of agricultural technology.

Radio: radio ownership is a proxy for access to information, which is expected to have a positive influence on adoption of technologies.

Social participation: this is the involvement of the household head in local administration, community leadership and/or his/her link with non-governmental organizations (NGO). Farmers with extra social activities are hypothesized to have more information networks and are likely to adopt agricultural technologies more easily than those with no social network.

Farmer's age: this variable could have a positive or negative effect on a farmer's decision to adopt agricultural technology. Older age is usually associated with more farming experience and could positively influence the adoption of some technologies. Contrary to this, younger farmers are more likely to take risk and adopt agricultural technologies compared with their older counterparts. Therefore, the effect of age could be positive or negative.

Family size: the effect of family size could also be positive or negative. It influences adoption positively through supply of labor especially during peak seasons of labor demand or negatively through competition for resources, which may be more severe with very high family size.

Farm size: defined as the total farmland owned and/or rented by the household is an indicator of resource endowment; it is expected to be associated with the decision to adopt agricultural technologies positively.

Livestock ownership: Livestock ownership is considered as a proxy for wealth status of a household. Livestock are assets that could be used in the production process or exchanged for cash. Thus, it is expected to positively influence the adoption of agricultural technologies.

Table 1. The definitions of categorical and continuous variables considered in the study.

Variable	Definition
Categorical (binary) variables	
GENDER	The gender of the head of the household (1 if the head is male)
LITERACY	Literacy dummy (1 if the farmer can at least read and write)
RADIO	The presence of a radio in the household (1 if there is any functional radio)
SOCIAL_PAR	Social participation (1 if the household head participates in any social activity)
Continuous variables	
AGE	The age of the head of the household (in years)
AGE_SQ	Square of the age of the head of the household
FSIZE	The size of the family (in caput)
FSIZE_SQ	Square of the size of the family
LAND	The size of the farm (in ha)
LAND_SQ	Square of the size of the farm
TLU	Tropical Livestock Unit owned by the household (in units[a])
TLU_SQ	Square of TLU owned by the household

[a]Tropical Livestock Unit (0.7 TLU=1 head of cattle; 0.5 TLU=1 head of horse, donkey or mule; 0.1 TLU=1 head of sheep or goat).

According to the logistic model, the probability of a small ruminant keeper adopting a specified technology in the respective area is given by:

$$\eta_i = \log[P_i/(1-P_i)] = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_n X_{ni}$$

Where:
η is a function of the mean of the dependent variable known as a link function;
i denotes the i^{th} observation;
P_i is the probability of the i^{th} farmer adopting a specified technology;
X_{1i}, X_{2i}, …, X_{ni} are the identified variables contributing to the decision of adopting the technology;
β_0 is the intercept;
β_1, β_2, ..., β_n are regression parameters (the coefficients associated with each explanatory variable).

The analysis was performed using PROC GENMOD procedure of the Statistical Analysis System version 9.1.3. (SAS 2004). The squared terms of the continuous variables were introduced in the model to capture whether the pattern of the influence of the variables changed with increasing values (Gujarati 2003); the non-significant squared parameters were excluded from the final model.

RESULTS AND DISCUSSION

Farmer feedback workshops

Farmers in both sites confirmed the general observations from the survey and the results from the monitoring phase. Adilo small ruminant keepers highlighted that the major bottleneck of small ruminant production in the study area was feed shortage. During the workshop, farmers stated that there was a need in the area for cheaper feedstuffs (mainly wheat bran and oilcake). Farmers further indicated that fodder trees like *Sesbania sesban* could be important feed sources for small ruminants especially during the dry season in which they mostly face feed scarcity. A woman member of the participants underlined the implication of improved feeding by saying: “a well-managed ewe can give twins and triplets in short intervals”. The farmers exhibited that they did not only know the factors constraining their small ruminant production but also some alternative strategies. Targeting on such strategies may possibly increase the adoptability of technologies.

Sheep fattening is not a common practice around Kofele. On the reasons why they do not fatten sheep, Kofele farmers explained that sheep keeping was generally a secondary activity since they had reasonably large farm size and alternative farm activities. But, with increasing pressure on grazing land and diminishing cultivated land, farmers started to give more attention to sheep. Some farmers already started fattening sheep in recent times. Others started

integrating sheep with maize, one of the major staple food crops in the area, by means of systematic haltering techniques using ropes (but without tying the animal to a particular spot). Such animals could graze in the maize field without damaging the crop. According to Rogers (2003), relative advantage, which can be defined as the degree to which a technology is perceived as better than the idea it replaces, is one of the factors that would determine the adoption likelihood. The advantages should also be worth the additional costs. The attitude of the Kofele farmers towards sheep fattening through the utilization of commercial concentrates clearly confirmed that notion.

In a previous study, parasites and diseases were ranked as the first critical constraint for small ruminant production in Kofele (Legesse *et al*. 2008). Farmers confirmed the result. According to the workshop participants, the major setback in this regard was the pervasiveness of liver fluke (*Fasciola hepatica*) as a result of marshy grazing areas. They use anthelmintic drugs but the effectiveness of the drugs was reported to be limited. That could be due to the use of expired and forged drugs bought from illegal sources in the absence of alternatives or development of resistance as a result of using some medicaments inappropriately and repeatedly. The farmers indicated that veterinary technicians were assigned for each locality by the time of the workshop. But these technicians lacked necessary equipment and medicaments. And they indicated that it might be good to offer training on basic animal health care for the farmers themselves. Avoiding grazing their animals in the marshy areas was not considered as an alternative since those areas were the only grazing land available for most; other forms of land were generally reserved for crop production.

The control of the intermediate snail population is indicated as a good opportunity for the reduction of transmission of fasciola in the fasciolosis endemic areas (Asrat 2004). A study conducted by Eguale and Tilahun (2002) further noted that Endod (*Phytolacca dodecandra*, the African soapberry plant) is a potential plant for the control of fasciola transmitting snails, particularly *Lymnaea truncatula* and *Lymnaea natalensis*. Endod might, therefore, provide the less costly means of snail control though its production on commercial scale has not been achieved yet (Asrat 2004). With this background knowledge, the farmers in Kofele were asked whether treating the marshy grazing area for example with Endod could be a potential solution. The farmers responded that the marshy area in the district is too vast for such an approach. Sheep strains resistant to flukes were also not known by the farmers. So the only partial solution the farmers reported to apply was chemical deworming (*i.e.* providing anthelmintic drugs to the animals).

Determinants of the adoption of feed technologies in Adilo area

Table 2 presents the means and standard deviations of the variables used in the logistic regression. For a binary indicator variable, the mean represents the percentages of farmers of each group with the attribute.

Table 2. Descriptive statistics of the independent variables identified as affecting the adoption of technologies in the two study sites.

Variable[a]	**Adilo** (n=90)		**Kofele** (n=65)	
	Mean (Range)[b]	std[c]	Mean (Range)	std[c]
GENDER	0.83	0.37	0.82	0.39
LITERACY	0.63	0.48	0.17	0.38
RADIO	0.47	0.50	0.50	0.50
SOCIAL_PAR	0.61	0.49	0.59	0.50
AGE	47.7 (28-77)	12.0	50.5 (25-75)	15.4
FSIZE	8.4 (3-19)	2.8	8.4 (2-20)	3.7
LAND	0.84 (0.125-2.9)	0.45	3.0 (0.15-8.5)	1.7
TLU	3.3 (0.4-7.2)	1.5	9.5 (2.5-28.7)	5.2

[a]The definitions of variables (and the units) are provided in Table 1.
[b]For continuous variables the range of the values is given.
[c]std=standard deviation.

For example, the LITERACY variable in Adilo indicates that 63% of the respondents could at least read and write while this percentage was only 17% for the Kofele farmers. For a continuous variable, *e.g.* AGE, the variable represents the mean age of the respondents (*i.e.* 48 in Adilo and 50 in Kofele). The average land holding of Kofele respondents was more than threefold of that of Adilo farmers. The livestock units calculated for Kofele small ruminant keepers were also three times as big as the average units in Adilo.

In Adilo small ruminant market-shed, the feed shortage being the most important problem, the utilization of commercial concentrates reported by 41% of the farmers, was taken to trace the potential factors that could influence the adoption likelihood of technologies or practices. Both linear and quadratic coefficients were significant for farmer's age in Adilo (*i.e.* the linear term negative and quadratic term positive, Table 3), implying that the utilization of commercial concentrate decreased with increasing age only up to a point. This minimum utilization was reached at about 55 years of age. Observations and the farmer feedback seminar also showed that the younger farmers were the ones commonly practicing the fattening, which mostly involved commercial concentrates.

Similarly, both the linear and quadratic coefficients in Adilo were significant for farm size, implying the probability of the adoption of commercial concentrates decreased with increasing farm size only up to the point at which it reaches a minimum. This minimum use of commercial concentrates was reached at 1.75 ha. Farmers with small farm size did not seem to have much alternative other than tethering their animals and feeding commercial feedstuffs. On the other hand, both the linear and quadratic coefficients were significant for livestock holding in terms of TLU (Tropical Livestock Unit; see Table 1 for the definition), implying that adoption increased with livestock holding up to reaching a maximum and then declining as TLU increases further. This maximum was reached at a TLU of about 4. Owning a higher number of livestock (especially cattle) may enable farmers to afford buying commercial concentrates. However, those who own higher numbers of livestock may have other alternatives like fattening cattle, which was also a common practice in the area. Nearly 90% of the farmers in Adilo reported that they had exercised cattle fattening in the past, slightly lower than those reported sheep fattening (92%).

Female farmers were more likely to adopt the utilization of commercial concentrates. Fattening small ruminants, especially the one involving commercial concentrates, requires follow up; women farmers who spend most of their time in their vicinity seemed to increase their benefit by the increased utilization of concentrates rather than taking the animals out for search of better grazing land. Household heads who could read and write were more likely to adopt commercial concentrates, which may be an indication of their access to information or ability to record gain or loss that might in turn affect their decision to utilize certain inputs. Households with bigger families were more inclined to utilize commercial concentrates, probably attempting to improve the income status of the household to satisfy the needs of their bigger families through the practice. The small ruminant fattening that involves commercial concentrates is not exclusively related to wealth in the area although it showed an association with livestock holding. Further investigation of the fattening practice in various wealth categories may help to better understand the situation.

Table 3. Logistic estimates of the adoption of commercial concentrate utilization among small ruminant keepers in Adilo.

Variable[a]	Estimate	Standard error	Significance
INTERCEPT	14.8668	5.1775	0.0041
GENDER	-2.0719	0.9110	0.0162
LITERACY	1.6833	0.7647	0.0194
RADIO	0.3803	0.5474	0.4858
SOCIAL_PAR	0.8795	0.6600	0.1735
AGE	-0.6666	0.2044	0.0002
AGE_SQ	0.0063	0.0020	0.0003
FSIZE	0.2165	0.1042	0.0344
LAND	-6.2657	2.0220	0.0025
LAND_SQ	1.8899	0.7701	0.0138
TLU	1.6452	0.9233	0.0610
TLU_SQ	-0.1920	0.1165	0.0839

[a]The definitions of variables are provided in Table 1.

Two-third of the respondents started to use commercial concentrates for sheep fattening after the year 2000. The earliest adopter started back in 1983. All farmers noted the ever-increasing price of commercial concentrates as a crucial problem associated to its utilization for small ruminant production or traditional fattening. None of them mentioned the availability as a problem indicating its steady availability in the local market. All small ruminant keepers except one believed that forming a cooperative in order to bring commercial concentrates from the primary producers to the locality could be a solution to tackle the affordability of feedstuffs.

The respondents in Adilo were also asked about the utilization of fodder trees for small ruminant feeding as an alternative feed option. Almost all (97%) farmers in Adilo stated that they use native fodder trees (*e.g. Erythrina spp.*) as a feed for small ruminants. More than 41% of them reported using exotic fodder trees (*e.g. Sesbania sesban*). Farmers were also asked about their criteria to choose and grow a certain fodder tree species. More than 92% of the farmers indicated that they consider the yield and palatability of the species. The resistance or tolerance of the fodder tree to diseases and/or moisture stress was cited by more than 85% of the farmers while about 81% of them reported the consideration of managerial and input requirement for the specific fodder tree. Growing backyard horticultural crops being the commonest practice in Adilo, two-third of the farmers said that the matter of shading would be among their criteria of choice. Only 42% of the farmers in Adilo indicated that they would consider the recommendation of extension agents in their decision process. Less than 7% of the respondents reported they did not have any particular criteria. Mekoya (2008) noted that the successful introduction of fodder trees requires the consideration of farmers' multiple criteria in addition to the awareness of growing and feeding fodder trees and resource availability.

One of the factors that affected the utilization of commercial concentrates among farmers in Adilo was its rising price (Legesse *et al.* 2008). The affordability of a new practice or technology should, therefore, be the first factor to be considered. Adugna (2003) reported that the crossbred dairy goats that were originally promoted to improve the welfare of poor farm households found their way into the hands of better-off farmers that could assume the associated risks. Improving the availability of cash in the household and designing a mechanism to have the concentrates at cheaper price may be a prerequisite for their broader utilization in the area.

Gender has been reported to affect the adoption of certain interventions. In Marsabit Mountain of northern Kenya, more women than men ranked labor-saving as an important attribute of a new technology (Ngutu and Recke 2006). Some of the decisions women make to adopt technologies may be also related to their access to resources, benefits and decision making power. Traditionally, Ethiopian families are headed by men if both partners are alive. The adoption of commercial concentrates was higher by women heads in the current study, most of whom were widows. This indicates the potential of rural women to be involved in promising activities if they are given the decision making power.

The issue of poor quantity and quality feedstuffs particularly during the dry season is not only the primary concern in Adilo but also in most mixed-farming systems of the country. Studies indicated the presence of endemic fodder trees that has reasonably high forage potential and can effectively serve as a cheap source of protein supplement (Larbi *et al.* 1993; Mekoya *et al.* 2008). Daily weight gains of sheep and goats almost doubled with *Erythrina abyssinica* leaf supplementation (Larbi *et al.* 1993). But, in addition to quantitative information on nutritive value and animal performance from indigenous and exotic fodder trees, the preference criteria of farmers should be considered. Though there have been several research and development efforts on exotic multi-purpose trees in Ethiopian highlands in the last three decades, their adoption is reported to be limited (Mengistu 1997; Mekoya *et al.* 2008).

Determinants of the adoption of household veterinary kits in Kofele area

The small ruminant keepers in Kofele previously reported that diseases are the major threat for production in their area (Legesse *et al.* 2008), causing substantial morbidity and mortality of their small ruminants. To tackle the problem, farmers are commonly buying anthelmintic drugs and other medical kits (*e.g.* syringes, needles) and administer them to their animals. Farmers were asked whether they had been treating their animals by themselves or not. The contribution of the farm and farmer variables to adoption of this practice was estimated (Table 4).

Table 4. Logistic estimates of the adoption of treating small ruminants through own application of veterinary kits among small ruminant keepers in Kofele.

Variable[a]	Estimate	Standard error	Significance
Intercept	-3.4398	1.8659	0.0653
GENDER	1.4176	1.0514	0.1661
LITERACY	0.8379	1.1088	0.4428
RADIO	-2.4659	1.2326	0.0257
SOCIAL_PAR	0.5732	1.1420	0.6138
AGE	0.0390	0.0295	0.1760
FSIZE	-0.1706	0.1312	0.1869
LAND	1.4704	0.7180	0.0288
LAND_SQ	-0.2608	0.0973	0.0032
TLU	0.2844	0.1361	0.0192

[a]The definitions of variables are provided in Table 1.

Both, the linear and quadratic coefficients were significant for farm size (*i.e.* the linear term positive and quadratic term negative), implying treating small ruminants in the household increased with farm size only up to the point at which it reaches a maximum. This maximum of treating small ruminants was reached at about 4 ha. Since most of the reported diseases are somehow related to the grazing of animals in bottomlands (*e.g.* marshy areas), those farmers with large land holding might have a better chance to graze their animals in safer areas. Those farmers who own higher number of livestock were significantly inclined to undertake the mentioned practice in the household. The adoption of the practice was negatively related to the presence of a functional radio in the household. A possible explanation of this result is that farmers who owned a radio might have got better information through the radio programs about the risk of utilizing unauthorized or expired drugs, since most of the drugs farmers buy from open markets are with unknown expiry dates and dosages. Radio owners might show preference to go to veterinary clinics. The practice of providing treatment to small ruminants was not significantly related to gender, literacy, age and family size.

About 81% of the Kofele respondents indicated that they made use of veterinary clinic services for their livestock; and 62% of the farmers reported they specifically used the service for their small ruminants. Those who did not make use of veterinary clinic services were asked for their reasons. Half of them mentioned that veterinary clinic services and drugs were too expensive; problems related to the accessibility of the clinics were stated by nearly half of (47%) the farmers. A slightly higher proportion of external parasite control was reported to be provided in the household than by the clinic service while slightly higher number of farmers indicated to have internal parasite control in the clinic (Figure 1). Farmers usually go to the veterinary clinic for general medication (*i.e.* non-parasitic diseases). Eighty-nine percent of the respondents indicated they use ethno-veterinary medicines (*e.g.* using natural plants like tobacco) for their sheep.

About three-fourth of the small ruminant keepers reported providing drugs and injections for their small ruminants without any consultation with veterinarians. When they were asked to indicate the reasons for doing so, 59% of them said that veterinary clinic services were unaffordable. Twenty-nine percent of these households also perceived that they knew the diseases and the treatment it needed very well. The long distance of the clinic from their village was also mentioned by nearly 10% of them as a reason for avoiding those services. More than ninety percent of all respondents however reported they did not receive any formal training about those treatments and general livestock disease control.

The farmers were asked how many times they were visited by a veterinarian or a development agent in the past year. Three fourth of the respondents reported they were not at all visited by these professionals while one fourth of them said they were visited once per year. All farmers except one claimed that the agricultural development agent in their community did not have reliable knowledge on small ruminant disease control. No farmer ever knew of any intervention from NGOs in the livestock health sector in the area. Nearly two-third of the farmers thought that training selected farmers in the community on various aspects of livestock health as community health workers could be one solution for disease related problems.

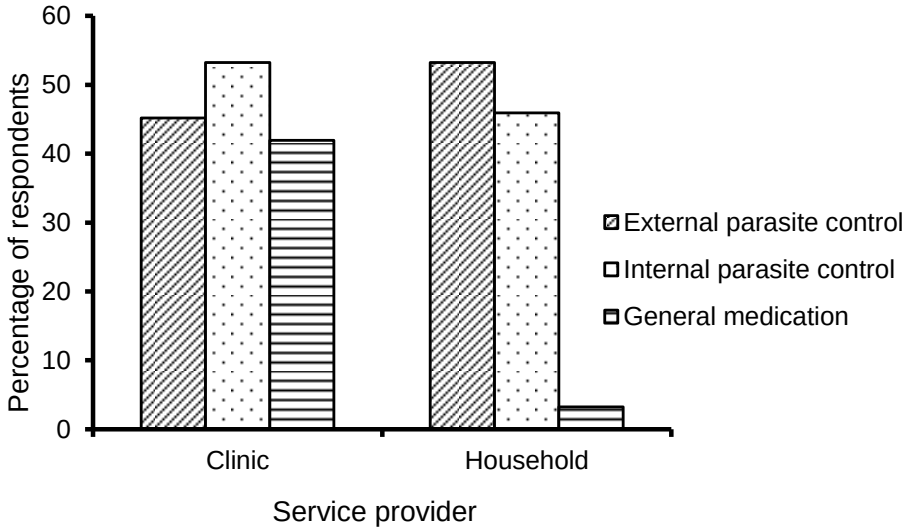

Figure 1. Types of reported medication for small ruminants provided in the clinic or in the household of farmers in Kofele.

According to Curran and MacLehose (2002), community animal health services have a considerable potential for enhancing human health and wealth in addition to their positive impact on livestock health and productivity. In the pastoral areas of the Afar region of Ethiopia, community health workers were reported to achieve better results in the Pan African Rinderpest Campaign than the government teams in terms of vaccination coverage rate and effectiveness (Peeling and Holden 2004). After assessing the impact of a community-based animal health worker project in pastoralist districts of Ethiopia, Admassu *et al.* (2005) reported a significant reduction in the impact of diseases. In small ruminants, there was a significant reduction in the impact of mange, helminthosis, contagious caprine-pleuropneumonia, contagious ecthyma and non-specific diarrhoea. Through the development of strong institutions to support and regulate community initiatives, they can be even more fully exploited (Peeling and Holden 2004). The geographic, societal and cultural set-up of the smallholder farmers in the highlands of Ethiopia is certainly different from those in pastoral systems. The case in Kofele, however, indicates the potential of community-based animal health services. Strengthening the farmers' initiatives through appropriate training of farmers may improve the health and productivity of their livestock. Community-based animal health workers can specially offer preventive and curative services for relatively easier problems such as internal and external parasitism (Catley *et al.* 2004). Previous studies indicated that community-based animal health workers were considered to be highly accessible and more affordable, available and reliable than other service providers (Admassu *et al.* 2005). According to Bamikole and Ikhatua (2009), community animal health workers at village level may also facilitate free flow of information about beneficial small ruminant management practices among farmers.

CONCLUSIONS

The present study has shown that location or production system remarkably affects the options of interventions and the adoption of a specific technology. The study sites are apart a hundred kilometers and they both practice rainfed crop-livestock farming and are also known for their small ruminant markets. Nevertheless, the existing practices that may be an entry point for further intervention and strengthening are apparently different. The relative importance of the factors determining small ruminant keepers' decisions to adopt a specific technology was different in the two sites. In addition to biophysical factors, differences in ethnicity, religion and socioeconomic conditions might have a direct or indirect influence on the decision-making process in the adoption of a new practice. Therefore, making blanket recommendations of technologies for small ruminant keepers in Ethiopian highlands will make the recommended practices unsuitable for local or household conditions and ultimately results in the non-adoption of the technologies forwarded. When opting for more tailor-made solutions, the results of the logistic regressions can be used to identify and address those farmers that carry more of the system- or topic-specific characteristics of adopters.

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