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Determinants of small ruminant farmers' decision to participate in veterinary services in Northern Ghana

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This study analysed the determinants of small ruminant farmers' participation in veterinary services in Northern Ghana. Multi-stage sampling technique was used to collect data on 249 farm households in different locations in Northern Ghana. Analytical tools including frequencies, means and logistic regression model were used to analyse the data. The regression analysis indicates a positive relationship between participation in veterinary services and sex of household head ($p<0.05$), education ($p<0.05$), household income level ($P<0.05$), herd size ($p<0.05$), and affordability of veterinary service ($P<0.01$). In addition, the study shows that diseases and pests menace, insufficient veterinary offices and animal health professionals were the major three constraints affecting animal health management in northern Ghana. In order to improve quality delivery of veterinary service in the area, the result of the logistic model provides a guideline to select farm households for implementation of veterinary extension programs in the region. Such guideline should be based on the important socio-economic and farm-related variables identified from the regression analysis. Furthermore, sustainable livestock production can be enhanced when animal health centers and professionals are made visible at local farming communities. Therefore, policies that provide an enabling environment for more private veterinary practice is relevant. More so, more qualified animal health professionals need to be trained to commensurate with the increasing number of livestock smallholders in the country.

Key words: Small ruminant, farm households, veterinary services, logistic regression, Northern Ghana.

INTRODUCTION

Small ruminant livestock (that is, sheep and goat) are widely distributed across Ghana (Mahama et al., 2003; Ockling, 1987). The West African Dwarf (WAD) or *djallonké* breeds are the most common nationwide, and often used in breed improvement schemes by individual farmers, or parastatal farms and breeding stations in Ghana (Karbo et al., 1997b; Oppong-Anane, 2006). Even though, the WAD breeds do not exhibit dwarfism traits (especially sheep), the animals are biologically adaptable to various vegetations, and demonstrates high typano-tolerance, high prolificacy and ability to breed all year round (Oppong-Anane, 2006; Terril, 1985). Therefore,

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climatic conditions may have little or no effect on the animals' productive capacity, except changes in feed supply that can alter physical and physiological maturity of the animals (Addah and Yakubu, 2008).

Northern Ghana is the hub of livestock production in Ghana. Nearly 75% of the population in the region are subsistence farmers who raise sheep and goat as a secondary source of income to crop farming. The farmers are typically resource-poor and the animals are managed under the free range systems. As a result, use of feed supplements, veterinary healthcare, good housing or quality breeds tend to be limited (African Development Fund, 2001). Farmers' investment in small ruminant livestock is through purchase, inheritance or as gifts to replenish the farm stock (Suleman, 2006). The animals commonly scavenge for food and water around villages or homesteads without a stock herder during long dry seasons. In the wet season (cropping season), the animals are either tethered around homesteads or herdered to communal areas for grazing by older or younger family members (Upton, 1984). Animal mortality rate is high under system mainly due to poor housing, overcrowding, inadequate veterinary stations (to supply drugs/medicines) and poor ventilation, resulting in diseases and parasites such as pneumonia and diarrhoea, especially during the rainy periods (Terril, 1985; Turkson et al., 2004).

The contribution of sheep and goat to food security and poverty reduction is under-exploited in Ghana, especially Northern Ghana (Mahama, 2012; Otchere, 1986). The animals are raised in vulnerable farm households not only for meat (sales), but also as an important source of wealth and savings, and as insurance against crop failure (Dossa et al., 2008; Otchere, 1986). For many subsistent farmers in Northern Ghana, small ruminants help to improve the animal protein requirements in the home. Sheep and goat have distinct advantages over other livestock in converting poor nutritious feed such as straw and grasses, as well as other by-products such as kitchen scrap and other waste products into value-added high quality food products for human consumption (IFAD, 2004; Terril, 1985). In addition, the meat of small ruminants is a source of protein in many local cereals-based diets and can improve the nutrition of vulnerable children and pregnant women (Terril, 1985). The size of small ruminants, which, on average, generate about 20 to 35 kg carcass weight (Oppong-Anane, 2006), allow rural households to conveniently process them easily for home consumption, with little or no need for preservation (Lebbie, 2004; Oluwatayo and Oluwatayo, 2012).

Notwithstanding the immense role of small ruminants in the lives and livelihoods of rural households, the production potential of the animals is limited by various factors in Ghana. Critical among such constraints is insufficient animal health care support (Turkson, 2003). The limited support for livestock health services has a negative effect on livestock productivity in the country (Mahama, 2012). In fact, the annual economic loss associated with livestock mortality and diseases and pest outbreak is estimated at US$50 million (Ministry of Food and Agriculture, 2007). The problem is chronic due to insufficient government budget allocation to animal health care systems in the country. Meanwhile, initiatives to promote growth of private veterinary service delivery is limited by numerous constraints, including poor government legislation to support privatization, the dominance of subsistent farmers (unable to pay for veterinary services), and a shortfall in well trained extension personnel (Turkson, 2003).

The Veterinary Services Directorate (VSD) of the Ministry of Food and Agriculture is responsible for animal health service delivery in Ghana. In addition, many private veterinary service providers have gained recognition since the country adopted the Structural Adjustment Policy (SAP) in the 1980s (Amankwah et al., 2014; FAO, 1999; Turkson, 2003). The importance of the animal health care systems is not only to sustain and improve livestock production through animal disease and parasite prevention, but also to protect humans against zoonotic diseases and infections (Amankwah et al., 2014; Okereke, 2012). Therefore, providing quality animal health care service is essential for efficient livestock production and quality animal products for human consumption (Turkson, 2008). However, the delivery of quality veterinary service remains a major challenge in developing countries (Gbolagade et al., 2013, Meena, 2013). An important reason for the limited success in quality veterinary service delivery is because factors that influence participation in veterinary services are not well known in sub-Saharan Africa (Onono et al., 2013). According to Posavac and Carey (1992) cited by Turkson and Amakye-Ansah (2005), effective services are delivered if only the services are consistent with the needs and objectives of the customer. However, livestock technical staff often places much emphasis on the technical aspects of production with little attention to the actual needs and objectives of subsistent farmers (Bosman, 1995; Schuetterle and Coulibaly, 1987). Various studies for sub-Sahara African countries (Dossa et al., 2008; Fakoya and Olurntoba, 2009; Mahanjana and Cronje, 2000; Verbeek et al., 2007), suggest that local farmers' production objectives and livelihood needs associated with managing livestock are influenced by social and economic factors, as well as farm-related variables. Even though, few studies (Turkson, 2003, 2008; Turkson and Amakye, 2005; Turkson and Naandam, 2003) have been conducted to describe veterinary service utilization among livestock farmers in Ghana, there is no comprehensive analysis of the veterinary needs of small ruminant livestock farmers that explicitly accounts for the effect of socio-economic and farm-related factors in farmer's decision to participate in veterinary services in Northern Ghana. However, studies in Nigeria (Adesope et al., 2006; Okereke, 2012) and

Ethiopia suggest that important farmer and non-farmer characteristics influence farmer's decision to participate in veterinary services. Such technical information is important for customizing and developing rural farmer-relevant veterinary service support programs.

The aim of this study was to investigate the determinants of subsistent small ruminant farmers' participation in veterinary services in Northern Ghana. One objective was to determine the effect of socio-economic and farm-related factors on participation in veterinary services among subsistent small ruminant farmers. An understanding of such factors can help in evaluating veterinary service intervention strategies for less productive farmers in Northern Ghana. In addition, another objective was to examine common livestock health problems that limit sheep and goat production in Northern Ghana. This includes comparing the problems between the two agro-ecological zones.

METHODOLOGY

Study area

The study was carried out in Northern Ghana which comprises of three government administrative regions, namely, Northern Region (NR), Upper West Region (UWR) and Upper East Region (UER). The area shares boundaries with Brong-Ahafo Region (BAR) to the south, Togo to the east, part of Cote d'Ivoire to the west and Burkina Faso to the north. Northern Ghana lies between latitude 80 to 110° N and longitude 00 to 30° W. The area covers a land mass of 97,700 km^2, equivalent to 38.7% of Ghana's total land area of Ghana (or 238,539 km^2) (Ministry of Food and Agriculture, 2010).

Northern Ghana is made of up two agro-ecological zones, including Guinea Savannah (GS) and Sudan Savannah (SS) zone. The climatic conditions of the two zones are typified by high temperature ranges (24 to 38°C for GS and 25 to 36°C for SS), low rainfall amount (1100 for GS and 1000 for SS) and long spells of drought periods. Hence, the vegetative cover is arid in nature. Given this kind of vegetation, the dominant occupation in the area is peasant agricultural production, which includes livestock production (sheep, goat, cattle, pigs, chicken, donkey, among others), and crop production such as sorghum, yam, millet, maize, guinea corn, cassava, rice, cowpea and groundnuts (FAO, 2005; Karbo and Agyare, 1997a).

Research methods and sampling procedure

Both qualitative and quantitative research methods were used to collect data for the study. Quantitative data were collected through pre-tested survey questions. Specifically, data on farmer and farm-related variables were collected. In addition, common animal health problems affecting livestock production in the study area were also solicited. Focus group discussions (qualitative approach) were also held to gain more information and improve on the quality of data. Multi-stage sampling method was used to choose 300 farm households in the study area. Stage one includes purposive sampling of 3 districts under each region based on accessibility and logistic considerations to carry out the study. Then, 2 farming communities were randomly selected from each district under each region totalling 6 villages at stage two. Finally, 300 farm families were randomly selected based on a sample frame provided by the respective rural district assemblies and agricultural offices in the districts and villages. Table 1 detailed information on the sample size and sampled districts and communities. Of the selected households, 249 representing 83.3% reared one or more sheep and goat livestock. Hence, such homes were considered for analysis.

Data analysis

The data were analyzed using both SPSS 16.0 and Stata version 12.0. Descriptive statistics such as frequencies and means were used to describe the data. In addition, inferential statistics including independent sample T-test (comparison of means for continuous variables), test of proportions (comparison of frequencies for discrete variables), Mann-Whitney test (comparison of means for ordinal variables) and logistic regression were used to present and explain the data.

The logistic model was employed to determine predictors for small ruminant farmer's decision to participate in veterinary services. Participation in veterinary service was the dependent variable depicting, whether or not a farmer participates in veterinary services. Farmers' participation in veterinary service was measured on a 4-point Likert-type scale ranging from 1=not accessible, 2=neutral, 3=accessible and 4=very accessible on five veterinary service activities. These activities include participation in vaccinations, advice on animal health care, treatment of diseases, sales of drugs and vaccines as well as castration of animals. An index was calculated from the 4-point Likert-type to determine a dichotomous value for veterinary service participation (that is, whether or not a farmer participates in veterinary services). Based on the 4-point scale, each farmer's index over all the veterinary service activities is calculated. For example, if a farmer's ratings for the above five veterinary service activities are 3, 4, 3, 1, and 1, then such farmer scores 2.4 (that is, (3+4+3+1+1)/5=2.4). Farmers with ratings below 2.5 (that is, (1+2+3+4)/4=2.5) were deemed not to patronize veterinary services and were coded 0. On the other hand, averages closer to 4 or from 2.5 implies those farmers participate in veterinary services and were coded 1. The explanatory variables adopted for the study were based on previous studies (Legesse et al., 2013; Meena, 2013; Okereke, 2012; Onono et al., 2013). Table 2 shows definition of each proposed independent variable that influences veterinary service participation among subsistent small ruminant farmers.

Theoretical model

Random utility maximization

The random utility (RU) function is an ideal theoretical framework to analyze economic agent's choice behaviors (Greene, 2003; Lancaster, 1966). The key assumption of the model (RU) is that economic agents (e.g., farmers) when confronted with a choice (e.g., whether or not to participate in veterinary service), will have preference of one alternative over the other (Greene, 2003; Ouma et al., 2003). Such an agent (or farmer) chooses the alternative with a higher utility over other(s). Assume that Y_j and Y_k are farmers' utility for two alternatives, represented by U_j and U_k, respectively.

The probability that a farmer will choose or decide to engage in veterinary service is that the probability of his/her utility with the new change (alternative = 1) or veterinary service participation is greater over his/her utility without the change (alternative = 0) or without veterinary service participation. In this study, the assumption is that household heads control productive assets in the house and such heads are the key decision-makers which are consistent with existing traditions in Northern Ghana. Mathematically, the household's utility is represented as follows (Ouma et al., 2003):

Table 1. Agro-ecological zones, regions, selected districts, communities, and sample sizes for the study region.

Agro-ecological zone	Region	Selected districts	Selected communities	Sample size
Guinea savannah	Northern	West Mamprusi	Kpasenkpe and Nayoku	174
		Tamale	Vitting and Kamina Barracks	
		Tolon Kumbugu	Tolon and Chirifoyili	
Sudan savannah	Upper west	Wa Municpal	Kpongu and Kolpong	72
		Nadowli	Sankana and Takpo	
		Sissala West	Siybele and Tiiwi	
	Upper east	Bolgatanga	Zuarungu Dachio and Sherigu Dorungu-Agobgabis	54
		Bongo	Adaboya and Gowire-Tingre	
		Bawku	Aneigo and Yarigu	
Total				300

Table 2. Definition of independent variables in the logistic regression model.

Variable	Description	Type
(a) Discrete		
Gender of household head		
Male 1	1= If household head is male	Dummy
Female 0	0= If household head is female	
Education: family-head's formal education		
Has no formal education	1[a]= Has no formal education	Ordinal
Completed primary/JHS/SHS	2= Completed primary/JHS/SHS	
Completed college/university	3= Completed college/university	
Annual income: income of household heads in the past one year		
Less than Gh₵1,000	1[a]= Less than Gh₵1,000	Ordinal
Gh₵1,001-5,000	2= Gh₵1,001-5,000	
Gh₵5,001-10,000	3= Gh₵5,001-10,000	
Above Gh₵10,001	4= Above Gh₵10,001	
Herd size: number of sheep and goat holdings		
Small herd size (less than 10)	1[a]= Small herd size (less than 10)	Ordinal
Medium herd size (10 to 30)	2= Medium herd size (10 to 30)	
Large herd size (above 30)	3= Large herd size (above 30)	
Veterinary affordability: ratings of veterinary service affordability		
Not affordable	1= Not affordable	Categorical
Neutral	2= Neutral	
Affordable	3= Affordable	
Very affordable	4= Very affordable	
(b) Continuous		
Age of household heads	-	Continuous
Household size	-	Continuous

[a]Refers to base category or omitted category in the analysis. JHS: Junior High Senior; SHS: Senior High School.

$$P(j) = P(I_j^* = 1) \quad (1)$$

$$P(U_j + \varepsilon_j > U_k + \varepsilon_k, k \neq j) \quad (2)$$

$$P(U_j - U_k + \varepsilon_j - \varepsilon_k > 0/x, k \neq j) \quad (3)$$

where P is the probability function, and U_j and U_k represent utilities associated with choices in option (j) and without option (k), respectively. In addition, ε_j and ε_k are the random disturbance terms. The utility theory has been applied in numerous studies to study dichotomous choice or participation in decision considerations (Deressa et al., 2008; Duku et al., 2011).

Empirical model specification

In this study, the logistic regression model was used to examine factors that influence farmers' discrete choice of whether or not to participate in veterinary services. Of the 249 small ruminant farmers, 52% participated in veterinary services while 48% did not participate in the service. From the logistic model, the probability that a small ruminant farmer partakes in veterinary service $P(Y = 1)$ is represented as:

$$log\left(\frac{P_i}{1-P_i}\right) = \beta_o + \sum_{j=i}^{k} \beta_j X_{ij} \quad (4)$$

where $log\left(\frac{P_i}{1-P_i}\right)$ is the log-odd ratio, X_{ij} is a vector of independent variables including personal characteristics (age, sex, educational background and household size), economic (household annual income) and farm-related (herd size, affordability of veterinary service and agro-ecological zone) variables. β_o is the constant parameter and β_j the vector of parameters for the independent variables. The estimated parameters show the direction and effect of the explanatory variables (Maddala, 2001; Deressa et al., 2008). However to estimate the marginal probabilities which indicate the marginal change in veterinary service participation with respect to a unit change in the explanatory variables, Equation 4 is differentiated as:

$$\frac{\partial P_i\left(log\frac{P_i}{1-P_i}\right)}{\partial x_{ij}} = \beta_j \quad (5)$$

The effect of each explanatory variable in the logistic regression model is briefly discussed as follows.

Gender: Females, unlike male counterpart farmers face higher constraints in accessing information to increase agricultural production (Asfaw and Admassie, 2004). According to Tankga et al. (2000) and supported by Miller (2009), even though, access to livestock institutions such as extension and veterinary services are insufficient in developing countries, women compared with men are the worst affected. Hence, it can be hypothesized that male farmers will have higher probability to participate in veterinary service than female farmers, all things being equal.

Age: The effect of farmer's age on participation in agricultural technologies such as veterinary service is mixed. Old age is used as a proxy for farming experience and can positively influence farmers' access to improve agricultural technologies. However, Okereke (2012) found a negative relationship between age and participation in veterinary service in Nigeria. On other hand, Meena (2013) and Onono et al. (2013) reported that other factors besides farmers' age influence the participation in veterinary service in developing countries. Similarly, Adam and Boateng (2012) also established no association between small ruminant farmer's age and adoption of livestock technologies. It can be hypothesized that older farmers have higher probability to participate in veterinary services than younger farmers, all things being equal.

Education: It is hypothesized that the probability of farmers' decision to participate in veterinary service increases with the level of education of farmers. Educational background of farmers is an important determinant of agricultural technology adoption, presumably because education increases farmers' capacity to access, analyze and utilize information essential to adopt agricultural technology such as veterinary services (Legesse et al., 2013).

Household size: Family size is synonymous with available labour for agricultural production in developing countries (Sellen, 2003). Okereke (2012) reported a positive relationship between farmers' decision to participate in veterinary service and household size because such farmers have enough labor, especially during peak seasons to adopt technologies such as visiting veterinary offices. However, Legesse et al. (2013) argued that households with larger family membership are less likely to adopt agricultural technologies due to competition for resources. In support of this claim, Yirga (2007) said that household with larger families may choose to engage in off-farm income opportunities at the expense of agricultural production and related technology adoptions. Consequently, it is hypothesized that the probability of participation in veterinary services is lower for farmers with larger family size, all things being equal.

Household annual income: Financial wellbeing of farmers is likely to positively influence adoption of agricultural technologies such as veterinary service. Gbolagade et al. (2013) found that the cost of veterinary service is the fundamental constraint limiting subsistent farmers' participation in veterinary services in Nigeria. The majority of farmers in sub-Sahara African countries are poor, risk averse and as such those farmers may have less access to information compared with rich farmers. Hence, it is hypothesized that the probability of participation in veterinary services is higher for farmers with higher annual household income, all things being equal.

Herd size: The effect of herd/farm size on adoption of agricultural technology, including veterinary services is positive. Studies in Nigeria (Gbolagade et al., 2013; Okereke, 2012) reported a positive relationship between farmers' livestock size and participation in veterinary service. The findings may be associated with the fact that herd size (total number of animals) is a determinant of wealth in subsistent livelihoods (Oluwatayo and Oluwatayo, 2012). Therefore, it is hypothesized that the probability of participation in veterinary services is higher for farmers with medium or large herd size compare with farmers with small herd size, all things being equal.

Veterinary service affordability: The cost of veterinary services may negatively affect farmers' participation in veterinary services (Turkson, 2003). This is so because, livestock, especially small ruminants are raised for subsistence needs rather than market

demand in sub-Sahara African countries (Ayalew et al., 2003). In addition, local breeds are dominant and are on smallholder basis; hence, farmers may not be motivated to participate in veterinary operations if cost of service is high. However, such farmers may be encouraged to partake in veterinary services given that the cost is more affordable. In conclusion, it is hypothesized that the probability of participation in veterinary service is higher for farmers with higher perception of veterinary service affordability, all things being equal.

Agro-ecological zone: A dummy variable for agro-ecological zone (Guinea savannah = 1 and 0 = Sudan savannah) was included in the regression model. The essence is to determine whether differences in veterinary service participation exist between farmers in Guinea Savannah and Sudan Savannah agro-ecological zones.

RESULTS AND DISCUSSION

Table 3 shows the socio-economic and farm-related characteristics of farmers used in the logistic regression model. Differences in proportions between Guinea and Sudan Savannah agro-ecological zones with socio-economic characteristics differed significantly (at least 5% level) for education, annual income, herd size and veterinary service affordability except sex of farm households.

The sex distribution of farm household heads suggests that majority were males representing 81.7% in Guinea savannah and 83.7% in Sudan savannah regions. This result implies that male household heads were dominant among small ruminant farm families and such statistics are consistent with the 80% male family-heads reported in a national survey by FAO (2012) in Ghana. In addition, the data show that more than three-quarters (78.2%) of farmers in Guinea Savannah and halve (57.5%) from the Sudan Savannah zone were uneducated. These statistics are greater than the 28.5% of illiterates reported in the 2012 population and housing census in Ghana (Ghana Statistical Service, 2012). The low literacy rate has dire consequences for agricultural production in the study area, partly because such farmers may face constraints to access and use technologies to improve productivity. Similarly, a greater proportion (63.3%) of homes in the Guinea Savannah compared with Sudan Savannah (46.5%) lives below an annual income of Gh₵1,000 (US$526). The findings imply that there are more poor people (living below $1 a day) in the Guinea Savannah compared with Sudan Savannah agro-ecological zone. This finding is in contrast to the poverty indexes in Ghana reported by Mackay and Ayeetey (2004). However, the study agrees with the livestock data provided by Karbo and Agyare (1997a). The authors reported that more livestock animals were concentrated in Guinea Savannah (that is, entire northern region) compared with Sudan Savannah region (that is, both Upper East and West regions). This study also suggests that a greater proportion (72.8%) of farm families in Sudan Savannah compared with Guinea Savannah regions (56.7%) reared small ruminants with a flock size less than 10 animals.

The study also suggests that both farmers in Guinea (39.2%) and Sudan (47.3%) Savannah areas agreed that the cost of veterinary service is not affordable. In a related study for 4 peri-urban regions in Southern Ghana; Turkson (2008) found out that majority (89.1%) of the bfarmers said the cost of veterinary service is either fairly affordable or affordable. The differences in perceptions of veterinary service affordability for Turkson's study and this survey might be explained by dissimilarities in locations and poverty indexes for the two studies. While the current study was carried out in Northern Ghana which is the most poverty stricken region in Ghana, the study by Turkson (2008) was conducted in Southern Ghana.

Even though, the mean age of farmers for the two agro-ecological zones (that is, 52.0 for Guinea and 52.6 for Sudan Savannah) is not significant at 5% level, family size for the two areas differs significantly. The reported ages are slightly higher than the 47.5 years of small ruminant farmers reported by Duku et al. (2011) in the transitional zone of Ghana. The results give an indication that sheep and goat production in Ghana is dominated by the active workforce population. On the other hand, the household sizes in the two agro-ecological zones are inconsistent with the 4.4 persons documented in a national survey (Ghana Statistical Service, 2012). Subsistent agriculture systems which use family labour are predominant in northern Ghana. Consequently, the high family size indicates available labour force for livestock herding and other farming activities (Adams and Ohene-Yankyera, 2014).

Participation and reasons for not participating in veterinary services in Northern Ghana

Table 4 shows the farmer's participation and reasons for not participating in veterinary services in Northern Ghana. The variable, participation in veterinary service, is a binary indicator variable which represents percentage of farmers who participate in veterinary services. From the surveyed sample, more than half (52%) participated in veterinary services while 48% of the farmers do not use veterinary services. The aforementioned two reasons explaining why farmers do not participate in veterinary services include: (1) veterinary services are too expensive and (ii) veterinary offices are far from farms. These constraints mirror the livelihood situations in the study area. Northern Ghana is the most poverty-stricken zone in Ghana and as a result, it is unsurprising that subsistence farmers face financial constraints related matters in participating veterinary services.

Regression analysis

Table 5 shows the factors that influence farm household decision to participate in veterinary services. The log-

Table 3. Farm households' socio-economic and farm-related attributes.

Variable	Agro-ecological zones		Z-test
	Guinea Savannah (120)	Sudan Savannah (129)	
(a) Discrete			
Gender of household			
1 = Male	81.7	83.7	0.67^{ns}
0 = Female	18.3	16.3	
Education			
1[a] = Has no formal education	78.2	57.5	
2 = Completed Primary/JHS/SHS	19.3	35.4	12.28***
3 = Completed College/University	2.5	7.1	
Annual income			
1[a] = Less than Gh₵1,000	63.3	46.5	
2 = Gh₵1,001-5,000	25.8	31.8	12.15***
3 = Gh₵5,001-10,000	10.0	13.2	
4 = Above Gh₵10,001	0.83	8.5	
Herd size			
1[a] = Small herd size (less than 10)	56.7	72.8	
2 = Medium herd size (10 to 30)	20.8	14.0	7.26**
3 = Large herd size (above 30)	22.5	13.2	
Veterinary affordability			
1 = Not affordable	39.2	47.3	
2 = Neither/not affordable	18.3	24.0	9.60**
3 = Affordable	33.3	27.1	
4 = Very affordable	9.2	1.6	
(b) Continuous			**T-test**
Age	52.0	52.6	0.31^{ns}
Household size	12.8	10.4	-2.5**

One cedi and ninety pessewas is equivalent to one US dollar (Gh₵1.9=US$1) during the study period. J JHS: Junior High Senior; SHS: Senior High School. ***Significance at 1%; **Significant at 5%; *Significant at 10%.

likelihood ratio with Chi-square 131.3 is significant at 1% level. This statistic implies that the application of logistic regression model to the data is justifiable. The variables that significantly influence the decision to participate in veterinary services among subsistent small ruminant producers included sex of household head, Education 2 (completed primary/JHS/SHS), household annual income 2 (Gh₵1,001 to 5,000), annual income 3 (Gh₵5,001 to 10,000), family size, herd size 2 (Medium herd size, 10 to 30 animals) and veterinary service affordability. Other factors, including the age of household head, education 3 (completed college/university), annual income 4 (above Gh₵10,001) and herd size 3 (large herd size, above 30 animals) did not significantly influence household decision to participate in veterinary services. In addition, the family size was dropped from the final model. This family size. A correlation matrix was conducted and the results appear to suggest that households with large family size are associated with large livestock size. Hence, estimating the model with both variables will produce unreliable results.

Effect of personal factors

Sex: The logistic regression supports the hypothesis that male farmers have higher probability to participate in veterinary service than female farmers. Such probability of veterinary participation increase by 8.3%, all other factors held constant. In support of this finding, Adesope et al. (2006) found a significant and positive relationship was due to high multi-colinearity between herd size and between farmers' sex and participation in veterinary services in Nigeria. The results imply that females

Table 4. Participation and reasons for not participating in veterinary services.

Variable	Mean	Standard deviation
Participation in veterinary services[1]	0.52	0.031
Reasons for not participating in veterinary services[a]		
Veterinary services are not accessible	2.85	1.15
Veterinary services are not important	1.60	0.82
No transport to carry animals to veterinary station	2.54	1.02
Veterinary offices are far from farms	3.09	0.94
Veterinary services are too expensive	3.20	0.87

[1]Binary variable representing percentage of farmers participating veterinary services. [a]Reasons for not participating in veterinary services are measured on a 4-point likert scale: 1, Unimportant; 2, Some how important; 3, Important; 4, Very important.

Table 5. Logistic regression results of factors influencing farm households' veterinary service participation.

Variable	Coefficient (β)	RSE (β)	Z-test	Marginal probability
Sex	0.582	0.447	1.30*	0.083*
Age	-0.006	0.013	-0.43	-0.0008
Education 2	0.796	0.416	7.91*	0.115*
Education 3	-0.074	0.840	-0.09	-0.011
Income 2	0.946	0.402	2.35**	0.134**
Income 3	0.775	0.552	1.40*	0.113*
Income 4	-0.973	0.904	-1.08	-0.133
Herd size 2	0.810	0.488	1.66*	0.115*
Herd size 3	0.275	0.489	0.56	0.038
Veterinary affordability	1.822	0.232	7.85***	0.259***
Agro-ecological zone	-0.711	0.391	-1.82*	-0.101*
Constant	-3.96	1.001	-3.96***	-
Goodness of fit and model performance statistics				
Number of observations	-	244	-	-
Likelihood ratio χ^2 (dg=13)	-	122.07***	-	-
Log likelihood	-	-107.96	-	-
Pseudo R^2	-	0.361	-	-

***Significance at 1%; **Significant at 5%;*Significant at 10%.

compared with male farmers are at a disadvantage in participation in veterinary services. Similarly, Miller (2009) argued that even though women are equally important as men in managing livestock; veterinary staff including private input sellers ignore women when providing animal health products.

Age: The hypothesis that older farmers have higher probability to participate in veterinary services than younger farmers was not supported by the data. The finding is consistent with Legesse et al. (2012) who reported no relationship between farmer's age and decision to participate in veterinary services in Ethiopia. Onono et al. (2013) also reported that other factors besides age affect farm families' decision to participate in veterinary service. On the contrary, Okereke (2012) found age to negatively influence veterinary service participation in Izzi local government area of Ebonyi

State, Nigeria. According to this finding from Nigeria, it suggests that younger farmers were more venturous with long term planning and as such, willing to accept innovations compared with older farmers (Adam and Boateng, 2012). However, the marginal probability of age in this study indicates that the probability of participation in veterinary service delivery decreases by 0.08%, all other factors held constant.

Education: There was a positive and significantrelationship between education 2 (completed primary/JHS/SHS versus no formal education) and participation in veterinary services. Thus, farmers with primary/JHS/SHS qualification have higher tendency to participate in veterinary services than farmers without any formal education. The probability of participation in veterinary services for those farmers (primary/JHS/SHS) increases by 11.5%, all other factors held constant. The finding agrees with Adesope et al. (2006) who found that the educational background of livestock farmers is crucial to veterinary service participation. Onono et al. (2013) on the other hand, reported no relationship between farmers with primary/secondary school education and decision to participate in veterinary services. In related studies, Okereke (2012) and Legesse et al. (2013) also concluded that education is not a predetermined factor to participate in veterinary services among subsistent small ruminant farmers. The studies of Okereke (2012) and Legesse et al. (2013) seem to support the finding of no relationship between farmers with higher education levels (completed college/university versus no formal education) and participation in veterinary service reported in this study. It can therefore be concluded that while the data support the hypothesis that the probability of farmers' decision to participate in veterinary service is higher for farmers with primary/JHS/SHS qualifications, such hypothesis is rejected for farmers with college/university certificates.

Annual income: Results of the study indicate that the probability to participate in veterinary service increases by 13.4 and 11.3% for households with annual incomes of Gh₵1,001 to 5,000 and Gh₵5,001 to 10,000, respectively compared with families with incomes less than Gh₵1,000. The finding is in conformity with Okereke (2012) who reported a significant relationship between farmers' annual income and participation in veterinary services. Adesope et al. (2006) also found that farmers' income level plays a significant role in veterinary service participation. Hence, the study supports the hypothesis that the probability of participation in veterinary services is higher for farmers with high annual income compared with low income farmers. On the contrary, there was no relationship between farm households with very high income level (that is,, above Gh₵10,001) and veterinary service participation. In fact, the probability of participation dropped with increase in annual income above Gh₵10,001 by 13.3%, all other factors held constant. The decreased in veterinary participation for households with income above Gh₵10,001 can be explained by the fact that, most households are likely to engaged in non-farm opportunities/activities. As such, such farmers may have little time to participate in livestock technology adoption strategies.

Effect farm-related factors

Herd size: The result demonstrates that the probability to participate in veterinary service increases by 11.5% for farmers with medium small ruminant herd size (that is, 10 to 30). Consistent with this revelation, Meena (2013) in India reported that farmers with medium cattle holdings have the greatest probabilities to participation in veterinary services. It appears to explain that farmers with moderate livestock holdings are more motivated to adopt livestock technologies including veterinary services. Perhaps, the financial demand to meet the veterinary requirements of such animal holdings is within the reach of subsistent farmers whom the descriptive statistics show a majority lives below USS$1 per day. In support of this fact, the data indicate lack of relationship between farmers with large small ruminant holdings (above 30) and participation in veterinary services in Northern Ghana. The finding is in line with Legesse et al. (2013) who found no relationship between farm size (small ruminant holdings) and participation in veterinary services.

Veterinary service affordability: Farmer's perception with respect to veterinary service affordability has the highest increase in the probability (26%) to participate in veterinary service. Therefore, the data confirm the probability that veterinary service participation is higher for farmers with higher perception of veterinary service affordability. The finding is consistent with the observation made by Gbolagade et al. (2013) who reported that high cost of veterinary service is the most limiting factor that hinder livestock farmers from participating in veterinary services. Hence, making veterinary service more affordable is likely to influence many less resource limited farmers to participate in veterinary services.

Agro-ecological zone: The coefficient for agro-ecological zone is negative and significant at 10% significant level. This implies that farm households in Sudan Savannah region have higher likelihood of participation in veterinary services compared with farmers from Guinea Savannah zone. The average number of livestock holdings is higher for Guinea compare with Sudan Savannah agro-ecological zone. Hence, farmers in the region (Sudan Savannah zone) may be able to manage such small or medium size holdings in terms of veterinary provisions, feeds, housing, among others.

Table 6. Mean ranks of common problems associated with health management of small ruminant animals.

Variable	Agro-ecological zones		Mann-Whitney U	Kendall's W	
	Guinea Savannah	Sudan Savannah		Mean rank	Position
Diseases and pest outbreak	126.9	123.2	7509.0^{ns}	3.57	1
Insufficient veterinary offices	102.1	149.3	4993.5***	2.76	2
Insufficient drugs and medicines	108.0	140.8	5701.5***	2.66	6
Insufficient feed stuff	119.8	129.8	7116.0^{ns}	2.46	7
Insufficient of animal health professionals	105.9	142.8	5447.0***	2.75	3
Veterinary services are not affordable	103.3	145.1	5139.0***	2.67	5
Insufficient of extension agents	108.9	140.0	5808.5***	2.71	4
Insufficient of water source	125.5	123.6	7558.5^{ns}	2.19	9
Poor housing	112.2	91.6	4139.0***	2.12	8

***Significance at 1%; **Significant at 5%;*Significant at 10%. Constraints were measured on a 4-point likert scale: 1, Unimportant; 2, Somehow important; 3, Important; 4, Very important.

Common problems associated with health management of small ruminant livestock in Northern Ghana

The mean ranks of constraints associated with small ruminant health management are shown in Table 6. Among the surveyed farm families, diseases and pest attack was ranked as the most important animal health problem affecting subsistent sheep and goat production. The mean difference of disease and pest attack for the two agro-ecological zones is not significant. This result implies that both zones recognized parasitic disease infection as the greatest threat to livestock production. Similar studies in Ghana including Turkson (2008), Turkson and Amakye-Ansah (2005) and Turkson and Naandam (2003) reported disease and pest as the paramount animal health constraint. Adesehinwa et al. (2004) in Nigeria also observed that disease and pest posed the biggest threat to small ruminant production in the tropics. The consequences of animal disease and pest menace are numerous, including high cost of production, reduction in animal holdings and birth rate of animals.

The next two major health constraints include insufficient veterinary offices (ranked 2nd) and insufficient animal health professionals (ranked 3rd). Both constraints are ranked differently for the two agro-ecological regions. According to Turkson (2003), livestock health service stations and health professionals are inadequate in Ghana due to unfavourable policies which restrain new recruitments of veterinarians and a reduction in government technical staff for livestock production. In other related study, Gbolagade et al. (2013) identified inadequate veterinary offices as the second critical problem affecting animal health delivery among poultry farmers in Delta State in Nigeria.

The least ranked problem is insufficient drinking water for animals. The mean difference for water problem is insignificant for both agro-ecological zones. However, mean rank of constraints such as inadequate drugs and medicines, veterinary services are unaffordable, poor housing and insufficient extension agents are significantly different for both agro-ecological zones except insufficient feed stuff for animals.

Conclusion

The essence of veterinary service is to eliminate or reduce the threat posed by animal diseases and pests to both livestock production and public health. To ensure efficient and quality veterinary service delivery among subsistent small ruminant farmers, the study identifies important farmer (sex, education and annual income) and farm-related (herd size and affordability of veterinary service) attributes that influence participation in veterinary services.

Hence, such socio-economic characteristics of farmers could provide guidelines for implementation of veterinary extension programs in the study area. In addition, diseases and pest menace, insufficient veterinary offices and animal health professionals were the three top constraints that affect animal health management. This implies that sustainable livestock production can only be enhanced when animal health centers and professionals are made visible in local farming communities.

Therefore, policies that provide an enabling environment for more private veterinary practice is relevant. More so, more qualified animal health professionals need to be trained to commensurate with the increasing number of livestock smallholders in the country.

Conflicts of interest

Authors have none to declare

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