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Determinants of Factors that Influence Small Ruminant Livestock Production Decisions in Northern Ghana: Application of Discrete Regression Model

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Abstract

The study applied Multinomial Logit (MNL) model to survey data from a sample of 249 farm households in northern Ghana. The model was used to investigate factors that influence farm families' decisions to raise a particular small ruminant species (i.e., sheep or goat or both). The MNL analysis indicates that the probability of raising sheep, goat or both animals was influenced by agro-ecological zone, sex and religious background of farmers, risk attitude and income from small ruminant production. In devising strategies (to select farm households) to improve subsistent small ruminant production system, livestock technical staffs must recognize important demographic and farm characteristics as well as risk and income perceptions associated with sheep and goat of the households. In addition, such programs must be supported with improved livestock housing technology that can provide opportunities to control sheep and goat production risks, including theft or predator attacks, disease infestation and exposure to harsh environmental conditions (rains and sun rays).

Keywords: Multinomial logit model, small ruminant, farm household, northern Ghana

1. Introduction

In Ghana, livestock represent a significant economic activity in the lives and livelihoods of numerous rural smallholder farmers, traders and processors, especially in northern Ghana (African Development Fund 2001; Asafu-Adjei & Dantankwa 2001; Turkson & Naandam 2006). Livestock not only play a significant role in the socio-cultural aspects of the people but also, help to balance human nutrition (Adam *et al.* 2010). Most rural farming communities in northern Ghana use livestock as an important means to improve soil fertility (manure) and increase cultivated farmland area using draught power (African Development Fund 2001; Ghana Environmental Protection Agency (GEPA) 2002; Karbo *et al.* 1999). Vulnerable households, especially rural women who represent half of smallholder farmers' population in Ghana (World Bank 1992), depend on livestock, especially small ruminants, for economic sustenance (Duku *et al.* 2011).

The Food and Agriculture Organisation (FAO) (2012) estimated that the rural population in Ghana represents 62% of the total population of 24,000,000, and 77% are subsistent farmers with about 1 to 2 ha of farmland holdings (Karbo & Agyare 1997). Such subsistent farmers produce food crops and livestock using rainfall. Statistics suggest that 40.5% of Ghana's rural population manage some livestock. The data implies that about 6.02 million households partly depend on livestock for their livelihood (Ghana Statistical Service 2012). Despite such significant contribution of livestock production to Ghana's economy, efforts to increase smallholder productivity are marginal (Asafu-Adjei & Dantankwa 2001; Ministry of Food & Agriculture 2010; Oppong-Anane 2011). The little public investment in the livestock sector has partly led to moderate traditional animal breeding programs which primarily depend on local farmers' knowledge and experience. As a result, only few improved animals have been supplied to farmers, and not many farmers have been trained (African Development Fund 2001). Smallholders, therefore, raise indigenous livestock breeds under the traditional free range production system, characterized by high mortality, high morbidity and consequently, low productivity.

Official livestock statistics suggests that the total domestic meat produced (excluding poultry) in Ghana was 67, 961 tonnes in 2010. Small ruminants (sheep and goat) contribute about 41% of this total (or 28,032 tonnes). However, the limited public support and investment for livestock production in the country has traditionally

focused on large ruminants (particularly cattle) with disregard for small ruminant animals (Oppong-Anane 2011). The input of small ruminants to food security and poverty reduction in vulnerable households is higher than imagined, particularly in northern Ghana (Mahama 2012; Otchere 1986). Sheep and goat are raised by marginalized and landless smallholders not only for meat (market) but also for other important non-market co-products (Dossa *et al*. 2008; Otchere 1986). For many farm households in northern Ghana, sheep and goat serve as a primary form of savings and investment. In addition, the animals provide security against deficits in household earnings. Small ruminants also play an insurance role to overcome unforeseen necessity of rural households, including settling of medical bills and school fees (Oluwatayo & Oluwatayo 2012) especially, among rural women (Devendra 1985).

Few other agricultural outputs/products, including large livestock (such as cattle), can compete with small ruminants as a means of capital growth in poor and landless households in northern Ghana. Initial capital investment for setting up a small business in sheep and goat is low (Upton 1985). Furthermore, the risk of loss from small ruminant deaths is negligible (Oluwatayo & Oluwatayo 2012; Terril 1985). Due to the smaller average size of sheep and goat, the animals are easier and quicker to sell than larger stock such as cattle. Therefore, sheep and goat serve as a potential source of ready or liquid cash in times of financial need for farm households.

More so, small ruminants are biologically adaptable to cope with long spells of drought conditions in northern Ghana better than cattle (Lebbie 2004; Peacock 2005). In addition, the relatively short gestation periods for sheep and goat make them (small ruminants) better able to recover from drought or disease outbreaks. Thus, sheep and goat can generate continuous income to smallholder farmers before, during and after drought periods. Furthermore, the growing market demand for sheep and goat meat than other livestock in urban areas across West Africa (Itty *et al.* 1997; Lebbie 2004; Peacock 2005) presents an opportunity to increase income and sustain livelihoods of rural households.

Within the small ruminants' subgroup, there are significant specie differences. As in the rest of West African sub-region, the total population and spatial distribution of goats are substantially higher than that of sheep (Dossa *et al*. 2008; FAO 2012; Wilson 1991). Similarly, domestic goat meat production in Ghana is greater than sheep (Ministry of Food & Agriculture 2010; Oppong-Anane 2011), partly because of differences in preferences in small ruminant type among farmers (Dossa *et al.* 2008). Yet, to date, there is no comprehensive analysis of the economic and ownership decision choices and considerations of such small ruminants that explicitly accounts for specie type (i.e., sheep alone, goats alone or sheep and goat together). Such technical knowledge is essential for customizing and developing local farmer-relevant agricultural production, and extension support programs. Understanding the household small ruminant ownership and related decision considerations is important in livestock production improvement strategies (Dossa *et al.* 2008). An understanding of such factors can also help in evaluating intervention strategies for less productive farmers (Adam *et al*. 2010; Dossa *et al*. 2008).

The purpose of this study was to investigate factors influencing the probability of raising sheep alone, goat alone or both sheep and goat animals. Small ruminant information on household's decision to raise sheep, goat or both provides valuable insights for policy analysts and agricultural administrators seeking to develop specific interventions for subsistent small ruminant farmers.

2. Research Methods

2.1 Study Area

The study area for this survey is northern Ghana. The area covers 97,700 square kilometers, representing 38.7% of the total geographic area of Ghana (or 238,539 km^2) (Ministry of Food & Agriculture 2010). Move over, nearly 4,228,116 of people equivalent to 17.1% of Ghana's population stay in this region. Of this population, the majority (80%) lives in rural areas with subsistent agriculture as the mainstay economic activity. The zone is divided into three government administrative regions with different population densities: 2,479,461 persons in the Northern region, 1,046,545 persons in Upper East region and then Upper West region has 702,111 persons (Ghana Statistical Service 2012). Northern Ghana consists of two major agro-ecological zones. The zones include Guinea savanna region which is located south of Sudan savanna and Sudan savanna agro-ecological zone which has a common boundary with Burkina Faso in the north (Codjoe 2010; Karbo & Agyare 1997). These areas are arid in nature characterized by shrubs, twigs and grasses conducive for livestock production. The key features and climatic conditions in the two agro-ecological zones are summarized in Table 1.

2.2 Research Design and Data Collection

Data for the study was collected through qualitative and quantitative research techniques. According to De Vaus (1996), a blend of the two methods helps researchers to improve quality and consistency of data collected. A pre-tested survey questionnaire was used to gather quantitative data on farmers' personal and economic variables (e.g., sex of farmer, religion, goat and sheep production risk perceptions, and perceptions about the relative profitability of goat and sheep production), as well as farm-related factors, including agro-ecological zone in which the farm is located. In addition, the veracity of the data was checked through focus group discussions, especially information on farmers' risk and income perceptions from sheep and goat production. Secondary data (unpublished databases, data from the Ministry of Food and Agriculture offices, district assemblies and internet) were also collected.

Table 1 Characteristics of Guinea savanna and Sudan savanna agro-ecological zones

Zone	Average rainfall	Temp (^{0}C)	Soil characteristics	Growing season days	Main food crops
Guinea savanna	1100	24-38	Upland soils, light textured, good fertility and organic matter	180-200	Sorghum, maize
Sudan savanna	1000	25-36	Upland soils, coarse texture, low in fertility and organic matter	150-160	Millet, sorghum, cowpea

Source: Food & Agriculture Organisation (2005)

An index was developed to assess farm household's perceived level of risk and profitability in sheep and goat production. A 4-point Likert-type scale was employed to calculate the average. For the perception of risk in each sheep and goat production, the scale was weighted in order of importance from; 1=very low, 2=low, 3=high and 4=very high on five livestock risk attributes. The risk characteristics include the animal's tendency to be easily missing, stolen, lost, destructive nature and death rate. An index denoting the level of perceived risk for particular specie was estimated by taking the farmer's average score over all the relevant risk attribute statements. For instance, if a farmer scores 3, 3, 4, 2, and 4 for the above risk attributes to sheep production, such farmer scores 3.2, that is, (3+3+4+2+4) /5= 3.2. Index closer to 4 or above 2.5 ((1+2+3+4) /4=2.5)) indicates the production of such animal is riskier. Therefore, the 3.2 index calculated means sheep production is riskier for the farmer. The same methodology applied to the calculation of farmer's profit perception for both animals. However, only two livestock benefit attributes (easier to sell and income return) were considered for both animals.

2.3 Sampling Procedure

Two hundred and forty-nine (249) farm households were selected through multi-stage sampling (William & Bousmaha 2001) for the survey. At stage one, three districts from each region were purposively selected based on accessibility and logistic considerations to study areas. For each district (stage two), a simple random approach was applied to select two communities. Lastly, 300 farm households were randomly (simple) chosen from a sampling frame provided by district assemblies and agricultural office researchers in the various districts. Of these households, 249 (representing 83.3%) raised at least a flock of sheep or goat livestock. Hence, such households were considered for analysis in the study.

3. Theoretical Model

3.1 Random Utility Maximization

To investigate farm household's choice behavior, the random utility (RU) maximization model is the appropriate (Greene 2003; Lancaster 1966). The model (RU) specifies that when an individual (economic agent) (e.g., farm household) is confronted with a choice (e.g., between sheep or goat or both, or production opportunities), such individual chooses one alternative over the other(s) (Greene 2003; Ouma *et al*. 2003). That is; the farmer chooses the option with higher utility (net benefit or well-being) over others. Farm household's utilities are indirectly observed. However, such individual actions are seen through the choices they make. Assume that Y_j and Y_k are

households' utility for two options, denoted by U_j and U_k, respectively. The corresponding random linear utility model may be specified as:

$$U_j = \beta'_j X_i + \varepsilon_j \text{ and } U_k = \beta'_k X_i + \varepsilon_i \quad (1)$$

where U_j and U_k represent utilities associated with choices in option (j) and option (k), respectively; X_i is the vector of explanatory variables that influence the option, β_j and β_k are regression parameters while ε_j and ε_k are error terms assumed to be independently and identically distributed (Maddala 2001). The random utility model has been used in various studies to model dichotomous choice or participation decision considerations (e.g., Deressa *et al.* 2008; Dossa *et al.* 2008; Duku *et al.* 2011; Lugunbu *et al.* 2012).

In the case of small ruminant specie choices (i.e., sheep alone, goat alone or both animals), the probability that a farm household chooses one specie j is represented as (Greene 2003):

$$\Pr(j) = \Pr(I_j^* = 1) \quad (2)$$

$$\Pr(U_j > U_k, k \neq j) \quad (3)$$

$$\Pr(\beta'_j X_i + \varepsilon_j - \beta'_k X_i + \varepsilon_k > 0/x, k \neq j) \quad (4)$$

$$\Pr(\beta'_j X_i - \beta'_k X_i + \varepsilon_j - \varepsilon_k > 0/x, k \neq j) \quad (5)$$

$$\Pr(X^* X_i + \varepsilon^* > 0/x, k \neq j) = F(\beta^* X_i) \quad (6)$$

where Pr is the probability function, and U_j, U_k and X_i are as defined above. In addition, $\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random disturbance term, $\beta_j^* = \beta_j - \beta_k$ is a vector of parameters, interpreted as a net influence of the vector of independent variables influencing the decision to raise sheep alone, goat alone or both sheep and goat animals, and $F(\beta^* X_i)$ is a cumulative distribution function of ε^* evaluated at $\beta^* X_i$. The distribution of F depends on the error term ε^*. If F is assumed to be normally distributed, then equation (1) is consistent with a binary decision choice or model and can be investigated using a Probit model (Greene 2003). On the other hand, if F exhibits a logistic distribution, the logit model can is applied.

3.2 Empirical Model Specification

It is assumed that the research issue confronting household decision makers is a discrete choice problem about either raising sheep alone, goat alone or both sheep and goat animals. Hence, Multinomial logit (MNL) models (unordered categorical outcomes) are frequently used in applications involving several alternative choices (i.e., involving the probability of choosing category 1, 2, 3 or more) (Hoffman & Duncan 1988; Park & Kerr 1990). The MNL model framework has been used in economic applications to investigate factors influencing adoption of technology type (Akinola *et al*. 2011; Nkonya *et al*. 1997), production system type (Burton *et al*. 1999; Ayuya *et al*. 2012), intensity of deforestation (Mahapatra & Kant 2005; Müller *et al*. 2012), and adaptation to climate change (Hassan & Nhemachena 2008; Seo & Mendelsohn 2008).The multinomial logit model identifies the odds of one category relative to other groups, as a linear function of various explanatory variables (Greene 2003; Maddala 2006).

In this study, the MNL regression method was used to determine factors that influence farmers' discrete choice of raising goat alone, sheep alone, or both sheep and goat animals. Among the 249 respondents who reported raising sheep, goat or both animals, 38% raised goat alone, 13% raised sheep alone, and 49% raised both sheep and goat animals. Thus, the dependent variable was investigated with j=3 categories (i.e., respondent raised goat alone, sheep alone, or raised both sheep and goat animals). Thus, y represented a small ruminant type raised (i.e., sheep alone=1, goat alone=2, or both sheep and goat=3), while x represented subsistent farmers' personal and economic variables (e.g., sex of farmer, religion, goat and sheep production risk perceptions, and perceptions about the relative profitability of goat and sheep production), as well as farm-related factors, including agro-ecological zone in which the farm is located. The multinomial logistic model of livestock type raised, with j categories of dependent variable can be represented as:

$$log \frac{Pr(Y=j)}{Pr(Y=j^*)} = \propto + \beta_1 x_1 + \beta_2 x_2 + \cdots \ldots \ldots \ldots \ldots + \beta_k x_k \quad (7)$$

where j represents a given category (i.e., sheep alone, goat alone, or both sheep and goat), and j^* is the reference category or base outcome. Goat alone was considered as the reference category with zero coefficients (Mahapatra & Kant 2005; Norušis 1999). In addition, α is the constant term, and β the parameter estimates. Inferences about the coefficients (β) can be explained as the change in log odds with respect to a unit change in the explanatory variable, assuming other factors are held constant. Hence, a positive or negative coefficient increases or decreases the log odds. Moreover, expressing the log odds (parameter estimates) in odds ratio (exponentiation the coefficient (e^{β})) is better for easier interpretation and understanding (Mahapatra & Kant

2005). The odds ratio compares the odds of one household in choosing a particular small ruminant species with the odds of another household choosing a different species. Thus, for a unit change in the predictor variables, the odds in favor of a household choice for a particular small ruminant type versus different household choice are the proportional odds times larger or lower, given that the remaining factors are held constant. All the analysis was conducted using STATA 12.0 (StataCorp 2011). Explanatory variables used in the MNL are defined in Table 2. Adoption of these variables was based on a study conducted by Dossa *et al.* (2008) in southern Benin. Brief descriptions of these sets of explanatory variables are given as follows.

Agro-ecological zone (*Agro-zone*): Guinea and Sudan savanna agro-ecological zones dominate northern Ghana. The Sudan savanna region is relatively more arid and has long drought periods compared with the Guinea savanna zone (FAO 2005). Consequently, farm households in the Sudan savanna area are more likely to raise goat which is better able to tolerate stress from heat and drinking water deprivation, compared with sheep or both sheep and goat animals, all things being equal (Lebbie 2004; Peacock 2005).

Sex of respondent (*SEX*): In rural regions of sub-Saharan Africa, women traditionally undertake household chores such as food processing. Unlike sheep, goat tends to graze near homesteads, and is also commonly provided with kitchen scraps and food by-products. Therefore, women may have a higher propensity than men to raise a goat compared with sheep alone or both sheep and goat animals, all things being equal (Okali & Sumberg 1986).

Religion (*REL*): Cultural settings of households, including religion and (ethnicity) in most African societies determine the type of livestock species to raise (Ndamukong *et al*. 1989; Schuetterle & Coulibaly 1987). Ndamukong *et al*. (1989) reported that Muslims prefer to own sheep compared with a goat because of the former importance of performing Islamic rituals. In particular, Muslims are noted for slaughtering sheep (ram) to mark *Eid-il Adha* celebrations (Baah *et al*. 2012).

Table 2 Description of Independent Variables

Independent variables	Description	Type
Agro-ecological zone (AGRO-ZONE) of farmer		
Sudan savanna zone1	If a farmer is in Sudan savanna zone	Dummy
Guinea savanna zone0	If a farmer is in Guinea savanna zone	
Sex (SEX)		
Male1	If a farmer is a male	Dummy
Female0	If a farmer is a female	
Religion (REL)		
Islam1[a]	If farmer belongs to the Islamic faith	Categorical
Christianity2	If farmer belongs to the Christian faith	
African traditional faith3	If farmer belongs to African traditional faith	
Goat risk perception (G_RISK)		
G_RISK1	If goat is riskier	
G_RISK0	Otherwise	Dummy
Sheep risk perception (S_RISK)		
S_RISK1	If sheep is riskier	Dummy
S_RISK0	Otherwise	
Goat Profitability perception (G_PROFIT)		
G_Profit1	If goat is profitable	Dummy
G_Profit0	Otherwise	
Sheep Profitability perception (S_PROFIT)		
S_Profit1	If sheep is profitable	Dummy
S_Profit0	Otherwise	

[a]Refers to base category or omitted category in the analysis

In support of this claim, Legesse (2008) in a study for Ethiopia said that the majority of farmers (93%) mainly Muslims from Kofele community manage only sheep compared with goat or both animals. However, Christians and other religious societies equally important use both animals during festive seasons. Thus, it can be hypothesized that Muslim farmers are more likely to rear sheep alone compared with goat alone or both sheep and goat animals, all things being equal.

Risk and profit perceptions: A critical motivation for farm households to diversify their livelihood options is

linked to risk perceptions and expected returns of new or potential economic livelihood activities (Ellis 1998; Evans & Ngau 1991; Reardon 1997). Sheep and goat have various inherent production risks and benefits (Lebbie 2004; Ndamukong *et al*. 1989; Okali & Sumberg 1984). On the other hand, studies of agricultural systems in developing countries suggest that, sheep production tends to be riskier than raising goat (Dossa *et al*. 2008; Fakoya & Oluruntoba 2009). For example, sheep are more susceptible to disease outbreaks and tend to be easily killed by moving vehicles than goat (Ndamukong *et al*. 1989). In addition, free range sheep have a tendency to graze and stray away from homesteads, thereby exposing them to theft or being killed, compared with goat (Dossa *et al*. 2008). By comparison, goat is inherently less docile or more aggressive and in free range grazing systems typically graze near homesteads causing much destruction (Okali & Sumberg 1984). In addition, high death rates have been reported for goat compared with sheep production (Upton 1985). Notwithstanding the increased risk associated with both animals, especially under traditional extensive systems in African countries, studies indicate that the expected returns from sheep production is higher than for goat (Dossa *et al*. 2008; Panin & Mahabile 1997). Goat on the other hand, is more prolific in giving offspring than sheep livestock (Upton, 1985). Consequently, it is anticipated that the probability of managing particular small ruminant specie (i.e., sheep or goat alone) is higher for farmers with low risk perception with respect to such particular animal, all things being equal. Similarly, the likelihood of raising particular small ruminant specie (i.e., sheep or goat alone) is higher for households with higher profit perceptions with respect to such animal, all things being equal.

3. Result and Discussions

4.1 Descriptive Statistics of Variables Use in Regression Analysis

Illustrated in Table 3 are frequencies of the variables used in the multinomial logistic regression. A chi-square ($\chi 2$) test was also reported to assess the existence of any association between the dependent variable (small ruminant specie type) and each of the independent variables. The data suggest that the majority (65.6%) of sheep farmers was found in Guinea savanna agro-ecological zone while goat farmers were dominant (60.6%) in the Sudan savanna zone. However, farmers who own both goat and sheep animals were fairly represented in the two agro-ecological zones. The chi-square of 7.07 is significant at 5% level. The statistics imply agro-ecological is likely to influence the type of small ruminant specie a farmer manages. More so, the statistics indicate that male farmers compared with female counterparts were principal producers of sheep (81.3%), goat (76.6%) and both sheep and goat animals (87.8%). Nonetheless, within female farmers, a greater proportion (23.4%) rears only goat livestock. The chi-square 4.71 is significant at 10%, which suggests that sex of a farmer influences small ruminant type owned. Similarly, the influence of religion on the kind of small ruminant specie managed by farmers is significant (χ^2 =4. 71) at 10% level. The analysis shows that the majority of sheep farmers (81.3%) were Muslims compared with Christians (18.8%). No African traditional believer owns a flock of sheep. Furthermore, a greater section of Muslim farmers also reared goat alone (64.9%) and both sheep and goat (56.1%).

Table 3 Descriptive statistics of variables used in multinomial logit regression

Independent variables	Small ruminant type			χ^2 - test
	Sheep farmers (n=32)	Goat farmers (n=94)	Both sheep and goat farmers (n=123)	
AGRO-ZONE				
Guinea savanna	21 (65.6)	37 (39.4)	62 (50.4)	
Sudan savanna	11 (34.4)	57 (60.6)	61 (49.6)	7.07**
SEX				
Males	26 (81.3)	72 (76.6)	108 (87.8)	
Females	6 (18.8)	22 (23.4)	15 (12.2)	4.71*
REL				
Islamic	26 (81.3)	61 (64.9)	69 (56.1)	
Christianity	6 (18.8)	21 (22.3)	35 (28.5)	
African traditional faith	0 (0)	12 (12.8)	19 (15.5)	8.92*
G_RISK				
G_risk	22 (68.8)	62 (66.0)	79 (64.2)	
Otherwise	10 (31.3)	32 (34.0)	44 (35.8)	0.25^{ns}
S_RISK				
S_risk	21 (65.6)	82 (87.2)	73 (59.4)	

Otherwise	11 (34.4)	12 (12.8)	50 (40.7)	20.46***
G_PROFIT				
G_profit	18 (56.3)	72 (76.6)	87 (70.7)	
Otherwise	14 (43.8)	22 (23.4)	36 (29.3)	4.80*
S_PROFIT				
S_profit	28 (87.5)	89 (94.7)	101 (82.1)	
otherwise	4 (12.5)	5 (5.3)	22 (17.9)	7.72**

***denotes significance at 1%; ** significant at 5%;* significant at 10% and ^{ns} insignificant Figures in parenthesis are percentages for each variable

Even though, a larger proportion of sheep (68.8%), goat (66.0%) and both sheep and goat farmers (64.2%) reported that goat production was risky, there was no significant (χ^2=0.25) relationship between goat risk perception and the type of small ruminant specie owned. Meanwhile, the relationship between sheep risk perception and small ruminant ownership type is significant at 1% level. Indeed, majority of sheep (65.6%), goat (87.2%) and both sheep and goat (59.4%) farmers indicated that sheep production was very risky. The data also suggest that profit perception of both animals (i.e., sheep and goat) is likely to influence the ownership of particular small ruminant specie. The chi-square values 4.8 and 7.72 for goat and sheep profit perception are statistically significant at 10% and 1% level, respectively.

The chi-square analysis (shown above) only describes the strength of association or relationship between each of the explanatory variables and the dependent variable. However, to model the determinants of and predict the likelihood outcome of the response variable on the independent variables, a multinomial logit regression was further conducted.

4.2 Regression Analysis

The parameters of the Multinomial Logit (MNL) regression are represented in Table 4. In addition, the odds ratio of farm household decision to raise a particular small ruminant species is illustrated in Table 5. There are two sets of parameters indicating two binary comparisons made among the three categories of small ruminant animals manage by households. In both cases (binary comparisons), the estimated coefficients/odds ratio are compared with the reference group of goat alone production. The LR chi-square test of the model significance suggests 1% significance level. Three variables, including agro-ecological zone, goat and sheep risk perception were significant at 5%, 10% and 1% level, respectively in the 'decision to raise sheep versus goat alone logit'. Furthermore, all the variables except goat profit perception in the 'decision to raise both sheep and goat versus goat alone logit' were significant.

Agro-ecological zone: The coefficient of agro-ecological zone is positive and significant in both MNL models. The results suggest that the odds in favor of a farm household in Sudan savanna zone to raise sheep alone compared with goat alone is 0.26 times lower than the odds of a farm family in Guinea savanna to raise sheep alone compared with goat, all other factors held constant. The analysis indicates that homes in the Sudan savanna agro-ecological zone were more inclined towards goat production compared with farm households in Guinea savanna zone. The result is consistent with Peacock (2005) who reported that households in very arid environments of Ethiopia are increasingly relying on goat production as compared with other livestock, including sheep due to the high frequency of droughts in the area. Wilson (1991) also supports this argument. The data also indicate that the odds in favor of a farmer in Sudan savanna zone to own both sheep and goat in relation to goat alone is 0.18 times lower than the odds of a farmer in Guinea savanna to manage both sheep and goat compared with goat alone, all other factors held constant. The result implies farmers in Guinea savanna were more likely to own both sheep and goat animals together, compared to farmers in Sudan savanna agro-ecological zone. Perhaps, goat's ability to strive well in various climatic and vegetative conditions, including humid and drier conditions allows farmers in Guinea savanna to manage goat in addition to sheep livestock species (Wilson 1991).

Sex: The hypothesis that women were more inclined to managing goat than men was not supported by the surveyed data from the first model (sheep versus goat) of the MNL regression. However, the odds ratio 2.54 in the second model (sheep and goat versus goat alone) was significant at the 5% level. The result suggests that males compared with female farmers have a higher affinity to raise both sheep and goat compared with goat alone. In other words, women, unlike men were more likely to manage only goat than both sheep and goat animals. In support of this finding, Dossa *et al*. (2008) in southern Benin reported that female farmers were more inclined to raising goat alone compared with other livestock species. Jaitner *et al*. (2001) in Gambia also support

this claim.

Religion: The odds ratio for religion2 (Christian faith) and religion3 (African traditional faith) are both significant in the second (sheep and goat versus goat alone) MNL regression. The statistics imply that the odds in favor of a Christian and an African traditional believer to manage sheep and goat together is 4.95 and 4.53 times greater, respectively than the odds of a Muslim farmer to own both animals compared with goat alone. The implication is that Muslims prefer to raise only goat compared with rearing both small ruminant species. This finding is in contrast to the assertion held by Ndamukong *et al*. (1989). The authors held the view that the significance of sheep in Muslim religion influences such Muslim farmers to manage sheep or a combination of sheep and goat compared with any other livestock.

Table 4 Multinomial logit results of household decision to manage particular small ruminant animal type [1]

Variable	Sheep versus goat alone			Sheep and goat versus goat alone		
	Coefficient	RSE (β)	Z-test	Coefficient	RSE (β)	Z-test
Agro-zone	-1.34**	0.57	-2.34	-1.69***	0.44	-3.85
Sex	0.32	0.57	0.56	0.93**	043	2.19
Religion2	0.51	0.69	0.75	1.60***	0.49	3.29
Religion3	-13.80	749.60	-0.02	1.51***	0.55	2.76
G_risk	0.82*	0.50	1.66	0.60*	0.34	1.73
S_risk	-1.47***	0.54	-2.74	-1.71***	0.41	-4.20
G_profit	-0.78	0.47	-1.64	-0.23	0.37	-0.63
S_profit	-0.59	0.77	-0.77	-1.02*	0.56	-1.82
Constant	2.26*	1.21	1.86	3.46***	0.94	3.67
Goodness of Fit and Model Performance Statistics						
Number of Observations				249		
Likelihood Ratio χ^2 (dg=12, p=0.00)				64.34***		
Log-likelihood ratio				-211.81		
Pseudo R^2				0.13		

***denotes significance at 1%; ** significant at 5%;* significant at 10%.
[1]Base outcome was "raise goat alone". Stata 12.0 reports only one Pseudo R^2

Table 5 Odds ratio of the household decision to manage particular small ruminant animal type[1]

Variable	Sheep versus goat alone			Sheep and goat versus goat alone		
	Coefficient	RSE (β)	Z-test	Coefficient	RSE (β)	Z-test
Agro-zone	0.26**	0.15	-2.34	0.18***	0.08	-3.85
Sex	1.37	0.78	0.56	2.54**	1.08	2.19
Religion2	1.67	1.15	0.75	4.95***	2.40	3.29
Religion3	1.02E0-6	0.0007	-0.02	4.53***	2.46	2.76
G_risk	2.28*	1.13	1.73	1.81*	0.62	1.73
S_risk	0.23***	0.12	-2.74	0.18***	0.07	-4.20
G_profit	0.46	0.22	-1.64	0.79	0.29	-0.63
S_profit	0.55	0.42	-0.77	0.36*	0.20	-1.82
Constant	9.75*	11.60	1.86	9.57*	11.61	1.86
Goodness of Fit and Model Performance Statistics						
Number of Observations				249		
Likelihood Ratio χ^2 (dg=12, p=0.00)				64.34***		
Log-likelihood ratio				-211.81		
Pseudo R^2				0.13		

***denotes significance at 1%; ** significant at 5%;* significant at 10%.
[1]Base outcome was "raise goat alone". Stata 12.0 reports only one Pseudo R^2

Risk perception: The surveyed data did not reject the assertion that the risk associated with each small ruminant animal affects household's decision to manage such particular animal. The odds in favor of farmers with high goat risk attitude to own sheep alone compared with goat alone was 2.28 times greater than farmers with low goat risk perception, all other factors held constant. The analysis suggests that farm households who perceived goat production as riskier were more likely to engage in sheep farming alone compared with goat farming. Such farmers were also more likely to manage both sheep and goat together compared with raising goat alone (odds ratio = 1.81). Similarly, the odds in favor of farm households with high sheep risk attributes to rear only sheep

compared with goat alone was 0.23 times lower in relation to farmers with low sheep risk perception, all other factors held constant. The result indicates that farmers who perceived sheep production as riskier were more likely to own and raise goat compared with sheep alone. More so, the findings suggest that those farm households (with high sheep risk perception) were more likely to rear both sheep, and goat compared to a rearing goat alone (odds ratio=0.18). It appears that the majority of the households prefer to manage both animals as a way of diversifying risk associated with each small ruminant species as shown from the analysis. During focus group discussions, it was noted that sheep production was risky due to the frequent missing nature (i.e., easily stolen or killed by predators) of the animal. On the other hand, goat's high death rates were reported after exposure to rain, a condition not declared in sheep production. Moreover, the male goat (buck) was perceived to be promiscuous and tend to follow other female goats (does) without returning home. In support of these findings, Dossa *et al*. (2008) reported that production risks associated with each small ruminant animals (i.e., sheep or goat) affect a farm household's decision to own and manage sheep, goat or both animals in southern Benin.

Profit perception: The odds ratio for goat profit perception was insignificant for both MNL regressions. It appears that goat profit perception is not a precondition for a household to raise either sheep alone, goat alone or combine sheep and goat animals. However, the odd ratio of sheep profit perception was significant in the second model of the regression analyses (MNL). The finding suggests that farm households with high sheep benefits perception have the greater likelihood to own and manage both sheep and goat together compared with goat alone (odds ratio = 0.36). The finding is consistent with the argument made by Upton (1985). Upton considered that the rate of return on sheep is higher than goat production. Also, sheep has lower mortalities than goat. However, goat is more prolific than sheep production. Thus, it appears to explain the rationale behind farm households' choice of owning both sheep and goat together compared with goat alone. With such ownership, households tend to benefit from the high profitability of sheep, as well as the fecundity of goat production under the traditional system.

5. Conclusion

The study shows that an agro-ecological zone remarkably affects farm household's choice of rearing either sheep alone, goat alone or both sheep and goat animals. Specifically, farmers from the Sudan savanna agro-ecological were more inclined to managing goat alone compared with households in the Guinea savanna zone in northern Ghana. This is so because; goat survives better in harsher environments than sheep livestock. In contrast, farmers from Guinea savanna prefer to own both sheep and goat compared with raising one small ruminant species. Sheep and goat production are carried out under the same traditional extensive system in the two agro-ecological zones. Nonetheless, the production risk and income associated with sheep and goat affect the likelihood that a farmer will rear either one or both animals. In addition, sex and religious background of farm households might also influence the decision to own sheep, goat or both animals. Hence, it will be futile to ignore farmers' personal, economic, as well as farm-related factors in choosing farm households for small ruminant programs. For such programs, the multinomial logistic regression provides the guidelines for choosing the farmers. Moreover, it is recommended that improved housing technology that can provide opportunities to control sheep and goat production risks, including theft or predator attacks, disease infestation, exposure to harsh environmental conditions (rains and sun rays) should be promoted in those programs. Ndamukong *et al*. (1989) recommends an enclosed shed housing method with a raised perforated mud floor as ideal for village circumstances of raising sheep and goat. Such housing process helps to eliminate the possibility of direct contact with animal droppings to cause re-infestation of internal parasites. In addition, the housing technology protects the animals from harsh environmental factors such as rains, wind, excessive heat and cold.

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