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Small-scale Farmers' Trait Preferences: Rearing Priority Setting for Small Stock in Bushbuckridge, South Africa

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Abstract
In most communal areas of Mpumalanga, goat rearing is predominant, with free range and intensive system of management. The study highlighted the socio-demographic characteristics of goat farmers, categorised local goat production and determined trait preferences of small-scale goat farmers in Bushbuckridge, Mpumalanga Province South Africa. The questionnaire survey elicited information from 330 smallholder goat farmers on a predetermined breeding objective, desirable traits preferences, with viable reasons considered when selecting goats (buck and does). The trait preference ranked and considered for this study were phenotypic traits. Choice experiment model which is an empirical application of the Lancaster consumer theory was employed for this study. The appropriateness of the choice technique lies in the ability to breakdown preference data into marginal values.In choice experiment, preferences were measured directly and thereafter allied to utility. Goat farmers value a wide range of traits for buck and doe. The study found that production preferential traits and early maturity characteristics, such as body weight, were highly preferred and rated as important. Farmers also appreciated several attributes such as kidding survival, disease resistant, twinning rate, ease of kidding, milk production and sexual maturity for both buck and doe. Additionally, adored traits among all goat breeds surveyed were weighty body, fast growth, ease of kidding and prolificacy. Furthermore, thestudy recommended the amalgamation of breed-specifications and performance testing which may beassociatedwith goat selection.
Keywords: Framers, Priority setting, Consumer theory, Desirable traits, Buck, Doe,Goats

Introduction

In south Africa, smallholder goat farmers mostly produce for home consumptionwith marginal herd size.At the communal level, goats are usually left to fend for themselves and often supplemented with left over from households (Salami, 2010). Boer, Savanna, and the Kalahari Red goats are reared for chevon productionwith one third of the total goats produced slaughtered annually. Thoughsome of the chevon produced is consumed locally, exports of chevon to countries like Angola, Congo, Democratic Republic of Congo, and Nigeria contributed about R3.6 billion in revenue between 2001 to 2011(DAFF, 2013).

The common breeds of goats found in South Africa include Alpine, Angora, Boer goat, Gomo Altai, Kalahari Red, Saanen,Savanna, Toggenburg and the indigenous Veld goat (DAFF, 2012). The KalahariRed, Savanna and Boer goats are indigenous to South Africa and are mainly reared for meat while the Angora goats introduced into South Africa from Turkey in1838 possess some of the

desirable trait in mohair production. Saanen breeds is a native of Switzerland, a dairy goat species found inSouth Africa with peculiar characteristics of low lactation during summer. There arevariations in milk yield among the same breed and sensitive to weather vagaries ((Norris et al., 2011). Indigenous veld goats are known for its beautifulmulti-coat colours, tolerance to diseases, well adapted to hot weather, early puberty and considered very fertile as compared to other breeds of goats (Miles, 2007).

The livestock farming sector in South Africa accounts for about 40% contribution to farm income, with approximately 80%of available land considered suitable for livestock production (DAFF, 2018). The sectorhas over 6 million goats which comprise 55% of the total number of goats in Southern Africa (FAOSTAT, 2013). The locally developed breeds in South Africa include Boer, Kalahari Red and Savanna goat, with good production traits, and are confined mainly to commercial farmers. These breeds of goats seldom perform very well in the hands of small-scale farmers where feeding and management is done using the extensive system (Caseyand Webb, 2010). Over 60% of goats in South Africa differ in characteristics and are reared under small-scale farming methods. The manifestation of erratic weather events and scarcity of production resources, call for the development of breeds that can perform optimally under harsh environmental condition. Subsistence goat producers has a challenge in terms of improvement in growth rate, health of herd and reproduction particularly for the local types (Mohlatlolea, *et.al*. 2015). However, some local breeds of goats possess qualities which are not found in the commercial specie andcould be used for breeding stock for optimal performance.Breeding for trait attributes in the case of larger stock like the cattleappears more pronounced than that of the goat hence the beef and dairy sectors are more competitive. The slothful progress ingoat breeding is attributed to inadequate information on the economic importance of keeping trait records (Van Marle-Koster*et al.,* 2013).

Figure 1: A cross section of goats in the study area

In the smallholder segment, goats have not been genetically upgraded for meat yield or quality. The quantity and quality of mohair varies from season to season. Mohair from goat varies significantly in quantity and quality with negative effects of traits fitted for the breeds. There are reports of low body weights, poor growth, low conception, and increased diseases amongst most goat breeds in South Africa (SAMGA, 2014; Aziz, 2010). Achieving adequate milk from dairy goats has been a challenge.Generally, subsistence farmers prefer rearing goat than other small stock because of the ease of management, low feed consumption, and ideal metabolism rate (Silanikove and Koluman, 2015). However, there are distinct species of goats with varying body size and other phenotypic features, and comparable genetic constitution in South Africa (Mdladla*et al.,* 2016). In most communities, there are limited number of goats per unit area or kraal characterized by uncontrolled mating, and low productivity. In South Africa, attempts have been made to improve goat production for smallholder farmers in most communities. Livestock improvement strategies in South Africa has been before now focused on high and desirable breeds like the Boer, Kalahari Red, Savanna, and other exotic breeds with less concerted effort to improve the local breeds (Marshall *et al.,* 2019). In addition, local farmers breeding traits, preferences and objectives were rarely considered in most improvement programmes thus generating the need for inclusive community centred approach to allow for phenotypic and genetic diversity of local breeds of goats. In South Africa, the National Small Stock Improvement Scheme has been established to improve and sustained traits that are desirable (Olivier, J.J 2002).Although community-based breeding programme (CBBP) also exist, nevertheless, smallholder farmers have inadequate access to improved breeding stock and other infrastructures (Getachew et al., 2018), and often depend on sharing of buck (male) for service (Gwaze*et al*., 2009). In South Africa, the breed standard and traits are the main consideration for goat breeders with the aim of breeding what is referred to national champions during auction that will give high prices. However, the trait preferences exhibited by these national champions includes phenotypic attributes like high reproductive performance, hardiness, adaptability under adverse and unfavorable condition.However, smallholder farmers cannot influence the price payable to their animals, and to maximizeprofit, is pertinent to produce at very low cost. Therefore, traits preferences for hardiness, adaptability, body size, feed conversation rate, diseases resistance, and survival rate are vital for consideration by local smallholder goat breeders.

Most indigenous goats are adaptive to climatic and local conditions, but still considered as less performing than the imported breeds.Therefore, selection for traits preferences becomes justified to improve productivity and value addition. CBBP has been identified as a strategy for supporting breeding and improvement efforts in rural areas where flock sizes are relatively small. The adoption of CBBP entails defining breeding objectives, listing selection criteria, genetic assessments, choice of animals, choice of mating systems, and methods for spreading or distribution of desired genes (Lamuno, *et.al*, 2018). Smallholder goat farmersadd indigenous ideas in identifying breeds that meet their objectives and selection criteria. The selection of breed objectives is normally aligned with increased production and market requirement to improve competition and other required traits preferences.

In many communities,trait preferences such as colours, mothering ability, body size, survival rate after parturition are considered, as necessary. CBBP, advocate the practice of establishing a communal open breed system were proven males used breeding are selected and used to service other ready stocks (heat) in the community (Kohler-Rollefson, et.al 200). Other breeding practices used include castration of males that are not desirable, and selection based on pedigree account and

progeny testing. There are variations in the quality of mohairin Agora goats which is dependent on seasons of the year. The Angora goats are very reactive toweather conditions and are not able to survive under bad climatic conditions and poor nutrition. There is deficit of milk yield from dairy goat sector globally because of seasonal breeding, inadequate adaptive capacity, and adverse production environment (Aziz, 2010). Modification and upgrading in South African goat sector are still required, notwithstanding thewell-developedgoat breeds for meat. There is enormous gap in improvement of goats that fit the smallholder production system in South Africa. The conventional methods and estimated breeding values(EBV) are still confronted with a mirage of challenges, even though it has showcased noticeable progress.The peculiar challenges that characterize the development of goat rearing by smallholder farmers include incidence of diseasesand inadequate nutrition. At present, no breed of goat has been developed to suit smallholder taste and preferences (Morrison, 2007).Against this backdrop, the study highlighted the socio-demographic characteristics of goat farmers, categorised local goat production and determined trait preferences of small-scale goat farmers in Bushbuckridge, Mpumalanga Province South Africa.

Characteristics of goat production in the study area

In most communal areas of Mpumalanga, goat rearing is predominant, with free range and intensive system of management. Goat rearing is generally practiced where land is not fertile for the purpose of crop production (McMillin et.al, 2012). It is less labour intensive as compared to other livestock, and characterizedby variations in herd structures, flock sizes and hardiness. In the free-range system, there is usually no mating control andtherefore, the buck are allowed to run after the doe on the field throughout the day whichresults to inbreeding. This system is usually practiced during the dry season after crop harvest (Chikwanda, 2004). In this practice, the goats are released in the morning to fern for themselves at the mercy of the rain, sun, and predators. The tethering of goats occurs most often to disallow them from going round and damaging crops (Gwaze, 2009). Tethering involves tying or pegging the goats to a rope of about 2-3meters long along roadsides in range land or alleyways, with water provided at the end of the day. As a common practice in most communities, herding of goats is practiced by women or school children in the day and goats returned to the kraal in the evening(Gizaw*et al.*, 2010).

The selection of breeding stock differs amongst households. However, most households retain young buck for mating and the selection criteria are usually based on body conformation and performance history. The indigenous breeds of goats known to have low productivity, with the age of first kidding put at 15months or more. Gestation periodsvary from vary from 145-148 and kidding interval of 258-394 depending on the breed.Age at first kidding is usually between 16-18 months and the average litter size 1.7% with 75% of birth occurring in autumn(Mamabolo and Webb 2005).

The increased demand for animal protein has generated a high demand for goats, and there is a need for efficient marketing system to allow a sustainable production in most communities in Mpumalanga. An improved market access and infrastructures has assisted farmers in the past to plan for breed selection and breed preferences (Ehui, *et.al*, 2000).

Method

Study site

Ludlow and Hluvukani are both within Bushbuckridge Local Municipality. The Municipality form part of the five constituency of Ehlanzeni District Municipality in Mpumalanga Province.

Bushbuckridge Municipality is bonded by Kruger National Park in the East and Mbombela to the South. It provides a gate way to Limpopo Province and consisting of 135 settlements divided into 34 wards. Bushbuckridge local Municipality has a total population of 541 248 with 99.5% black community and other population group accounting for 0.5%. Agricultural household activities are diverse with 17.9% livestock farmers, 37.5% poultry, 18.8% vegetables, and other crops 20.6%. Ludlow is in Bushbuckridge Local Municipality, with a total population of 5,766, GPS coordinates of 24.6716 S, 31.278 E. The number of households is put at 53,204 with 13,103 livestock farmers. Hluvukani is also in Bushbuckridge local municipality, with GPS coordinates: 24.6475 S, 31.3505 E) and a total population of 9631(South African National Census of 2011).

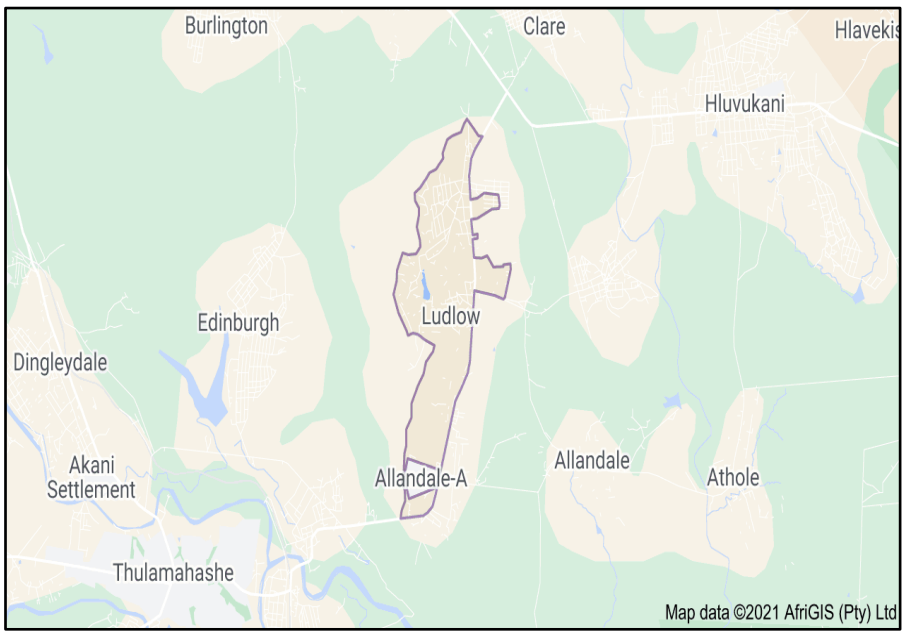

Figure 1. Map of the two study areas

The approach

The Participatory Rural Appraisal (PRA) tools was implored for this study. Transect walkwere used by the researchers in observing the entire community with the aid of community mapto identify the areas where goat rearing iscommon. Other PRA tools used werematrix scoring and ranking (used primarily to evaluate and measure the preferences of farmers over choicebetween alternatives), and pairwise ranking (used to identify and assign priorities to variables or options, while comparing the alternatives in pairs to judge which unit is preferred over others), timeline and trend analysis (used to interpret or indicate the changes and trends in the community while timeline captures the sequence of events as recalled by local community), and Venn diagram (used to showthe main institutions, and individuals, opinion leaders and their relationship with the local community). Focus group discussionswere heldduring the reconnaissance survey to understand the goat production pattern, indicate preferredattributes, andspecify their objectives for goatproduction depending on their conditions. The pairwise ranking approach was used for the attribute'sidentification andin the construction of choice experiment. The choice experiment illustrates the variously indicated preferences and levels(high or low). After the attributes and levels classifications, they weremerged and handed to respondents as profiles.The questionnaire survey elicited information from 330

smallholder goat farmers on a predetermined breeding objective, desirable traits preferences, and viable reasons considered when selecting goats (buck and does). The trait preference ranked and considered for this study were phenotypic traits: (i) body size, hair type, coat colour, coat colour design, (ii) conformation: ears, horns, teats, wattle, beard. (iii) Life history: growth rate, aggressiveness/temperament,diseases resistant, diseases, disease susceptibility.(iv) Reproduction: ease of birthing, milk production, mothering ability, longevity, twining rate, kid sex ration, kid survival, kidding interval/circle, and early sexual maturity.

Conceptual approach

The study adopted the conceptual framework for choice experiment that emanated from the consumer theory enunciated by Lancaster (1966). The theory stated that the preference for goods remains a function of the traits or attributes possessed by the good instead of the goods itself. The theory implies that overall utility of a good can be broken down into separate utilities for its component attributes or traits. A good may be defined by the characteristics that create utility or non-utility for an individual. In the case of goat rearing, the preferences perceived by the farmers is indicated by various goats' attributes. Thus, choice experiment is essentially based on consumers making choice of option 1, if and only the option 1 generates utility that is more than other options congruent with assessed utility by balancing-off or rejecting the traits of alternative options available. The utility obtained by any option chosen is dependent on the attributes or traits of the good (x), the characteristics of the individual (z) and an unobserved component (e). Therefore, the utility of choosing option 1 can be stated as:

$$U_A = V(X_A, Z) + e_A \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where *V* is an indirect utility function.

Hence the likelihood that a farmer*i*will choose option Afrom the set of choices *J* is:

$$P(A/A, A\epsilon\ J) = P[V_{Ai} + e_{Ai}) > (V_{ji} + e_{Ji})] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Therefore, the likelihood that a farmerwill choose A from the set of options Jis equal to the likelihood that the utility derived from A is higher than for any other element of J.
Choiceexperiment is an empirical applicationto the Lancaster consumer theory. The appropriateness of the choice technique lies in the ability to breakdown preference data into marginal values. In choice experiment, preferences are measured directly and thereafter allied to utility. Subsequently, choice experiment approach was used for this study.

The empirical model

The choice of suitable method for estimation of choice is dependent on the spread of the random error *e* as stated in equation 2. In the study of Train, 2003, found that error termis assumed either as independent or randomly spread random variables. In this approach, the assumption was that the errors are independent and identically distributedto allow for ease of computation. The independent error termas stated allow our estimation using multinomial regression modelsince the responseswere

ordered. However, the *Vj* in equation 1 is regarded as additive function of the attributes, demographic characteristics and the error term as indicated in equation 3.

$V_{Ai}=^{\beta}m\ X\ m\ +\beta\ _nZ_n + e_{mn}$ ……... (3)

Where $m = 1, \ldots\ldots\ldots$ *k*attributes
$n = 1, \ldots\ldots\ldots P$ socio-demographic and attitudinal traits.

Therefore, the multinominal model used to indicate the impact of the attributes on the likelihoods or probability of choice can be stated thus:

$$P\ mi = \frac{e^{vmi}}{\sum_j^{evmj}} \quad \ldots\ldots\ldots\ldots (4)$$

Where $V_{mj}= \beta_{mj}\ X_{\ mj} + \beta_nZ_n$ *and* X_{mj} is a vector of observed attributes relating to alternative *j* andZ_n isa vector of socio-demographic characteristics.

RESULT AND DISCUSSION

Table 1. Socio-demographic characteristics of goat farmers in the study area

	Variables	N =330%	
Gender	Male	108	32.7
	Female	222	67.3
	Total	330	100.0
Age	<20 years	16	4.8
	20-30 years	26	7.9
	31-40 years	43	13.0
	41-50 years	105	31.8
	51-60 years	65	19.7
	>61 years	75	22.7
	Total	330	100.0
Educational attainment	No school	150	45.5
	Primary	67	20.3
	Secondary	97	29.4
	Tertiary	16	4.8
	Total	330	100.0
Marital status	Single	186	56.4
	Married	125	37.9
	Divorced	6	1.8
	Windowed	13	3.9
	Total	330	100.0
Farm size	<1 acre	168	50.9
	1-5 acres	153	46.4
	6-10 acres	9	2.7
	Total	330	100.0
Household size	1-3	83	25.2
	4-7	172	52.1

	>7	75	22.7
	Total	330	100.0
Farm experience	<5 years	85	25.8
	6-10 years	51	15.5
	11-15 years	62	18.8
	>16 years	132	40.0
	Total	330	100.0

Socio-demographic characteristics of goat farmers in the study area

Table2 shows the socio-demographic characteristics of smallholder goat farmers in the area.Finding show that about 33% of males and 68% females were involved in goat rearing. In a study by Agholor (2019) on gender gap in Sub-SaharanAfricafound thatrefining gender equity in agriculture will translate into opportunities amongst farmers in creating an environment for increased agricultural growth in Sub-Saharan Africa. With respect to age, about5% of smallholder goat farmers interviewed were less than 20 yearswhile 23% were above 61 years, and majority of those in goat rearing activities were in the range of between 41-50 years and 51 years. Studiesof Mokoele, Spencer, Van Leengoed, and Fasina, (2014) found that the average age of farmers in South Africa stand at 62. In retrospect,the focus group discussion held with the goat farmersimplicitly show that poor image conceived generally by youths about farming accounts for their poorparticipation inagriculture. Goat farmers with tertiary education were about 4.8% while those who had primary education were approximately 20.3%. Most respondents had no formal education (46%), whereasthose with secondary education were about 29.4%. Goat farmers who were cultivating less than one acre of land were 50.9%. However, farmers who had farm size of 1-5 acres were about 46.4%, while those cultivating 6-10 acres were 2.7%. Result show that about 56.4% of respondents were singlewhile 37.9% were married. About 1.8%were divorced and 3.9% were widow. Household size of 1-3 were 25.3% and 4-7 were 52.1%. Respondents who had household size greater than 7 were 22.7%. The farm experience of goat farmers wasinvestigated and result show that those with 6-10 farm experiencewere 15.5% and 11-15 were 18.8 while those less than 5 years and greater than 16 years were 25.8% and 40% respectively.

Empirical result of the study

The model fitting summary for buckas indicated were-2 Log Likelihood157.135, Pseudo R-Square: Cox and Snellwere0.733, Nagelkerke 0.866, and McFadden 0.706; and the model fitting summary for Doe also indicated -2 Log Likelihood recorded95.725, Pseudo *R*-Square: Cox and Snell of 0.634, Nagelkerke 0.747, and McFadden 0.532 which suggests that the model adequately explained the variables used in the study.

In the multinomial logit regression analysis, the dependentvariable (*Attributes*), takes five discrete values of desirability of traits preferences asindicated in the selection profiles (Most often =1, very often = 2, undecided =3, often = 4, less often =5). As indicated in table 1, all coefficients for buck attributes except the sexual maturity were statistically significant. The body size with a β=14.774 is considered an important and preferred traits for buck selection. This is expected as body size influences the temperature regulatory mechanism of the buck in hot conditions. Logically, bucks that have large body size adjust to water loss and gain heat in cold environment. This finding is corroborated by the study of Berihulay, *et.al* 2019, found that

animals that have larger body size tend to gain heat at slower rate. The hair type is positive with a p<0.003 but negatively related (β = -6.772) to profile selection. This suggest that when all profiles are held constantthere islikelihood of farmers not consideringhair type in making choice. Most often, farmersmay not consider hair type in choosing a preferred buck. Coat colour is considered an important trait of economic, biological, and social implication. The unexpected negative coefficient sign for hair type (-6.772), coat colour (-6.342), growth rate (-4.344), disease resistant (-41.105)and aggressiveness (-5.594) implies that these attributes though significant but are not an important trait to consider if the buck possesses other important preferred attributes. Hair type and coat colour are important economic, cultural, and social attributes in choosing buck profiles. In most communities, coat colour is an important trait for considerations during ceremonial functions. Coat colour is an important feature for determining radiant heat load and how much the solar energy is either radiated or reflected from the buck and how much is retained (Asres, *et.al*, 2014). According to studies (Daramola, *et.al*, 2009; Fadare, 2013)goats with light coat absorb less heat than those with dark coatscolours suggesting that there is the likelihood of farmers selecting of profiles with light coat colour to improve animal wellbeing and production efficiency.

Table 2. The multinominal regressionanalysis for profile selection for Buck

Buck traits	Coefficient	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Body size	14.774	4.156	12.636	1	.000***	6.628	22.919
Hair type	-6.772	2.297	8.695	1	.003*	-11.273	-2.271
Coat colour	-6.342	2.248	7.957	1	.005**	-10.749	-1.935
Growth rate	-4.344	1.455	8.914	1	.003**	-7.195	-1.492
Disease resistance	-41.105	2.877	204.135	1	.000***	-46.743	-35.466
Sexual maturity	.330	2.095	.025	1	.875	-3.777	4.437
Aggressiveness	-5.594	1.650	11.492	1	.001**	-8.828	-2.360
Model Fitting Information:							
-2 Log Likelihood	157.135						
Pseudo R-Square:							
Cox and Snell	.733						
Nagelkerke	.866						
McFadden	.706						

Statistical significance in the multinomial logit regression analysis ***Significant at 1% level; ** significant at 5% level; * significant at 10% level.

In the Doe category (Table 2), the body size ($p<$ 0.001), growth rate ($p<$0.105), kidding survival ($p<$ 0.05), ease of kidding ($p<$ 0.03), milk production ($p<$0.42) and sexual maturity ($p<$ 0.019) had a positive correlation to profile selection. Growth rate and ease of kidding with coefficient of β = 2.202 and β = 5.59 show the likelihood for farmers to consider doe profiles with these traits. However, the coefficient for growth rate is positive and significantly related to profile selection. This suggests very high probability for farmers to select or consider doe profiles that has the potential for growth. Growth rate manifesting in heavy body weight and fast growing are characteristics that were desirable for goat meat production. Fast growing doe implies that the live weight for slaughter may be attained earlier for good market return. Secondly, fast growth rate shows that doe can attain

breeding weight earlier (Christopher & Lu. 2001). The kids for a proven buck and doe attain puberty at six months of age and were usually referred to as early breeders.

Table 3.The multinominal regression analysis for profile selection for Doe

Doe traits	Coefficient	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Body size	2.188	.664	10.843	1	.001**	.886	3.490
Hair type	12.583	2702.501	.000	1	.996	-5284.222	5309.387
Coat colour	-19.523	2702.500	.000	1	.994	-5316.326	5277.281
Growth rate	2.202	1.360	2.621	1	.105*	-.464	4.868
Kidding survival	-2.416	1.238	3.810	1	.051*	-4.843	.010
Twining rate	-2.729	1.480	3.403	1	.065	-5.629	.171
Ease of Kidding	5.599	2.574	4.732	1	.030**	.554	10.645
Milk production	-4.120	2.027	4.134	1	.042**	-8.093	-.148
Sexual maturity	-3.608	1.541	5.485	1	.019**	-6.627	-.589
Model Fitting Information:							
-2 Log Likelihood	95.725						
Pseudo R-Square:							
Cox and Snell	.634						
Nagelkerke	.747						
McFadden	.532						

Statistical significance in the multinomial logit regression analysis ***Significant at 1% level; ** significant at 5% level; * significant at 10% level.

CONCLUSION AND RECOMMENDATION

The Farmers value a wide range of traits for buck and doe. Overall, production preferential traits and early maturitycharacteristics, such as body weight, were highly preferred and rated as important.Farmers also appreciated several attributes such askidding survival, twinning rate, ease of kidding, diseases resistance, milk production and sexual maturity for both buck and doe.The adored traits among all goat breeds surveyed were weighty body, fast growth, ease of kidding and prolificacy.Generally, goats are versatile in foraging and has the potentials for surviving acute weather conditions. The study recommended the amalgamation of breed specifications and performance testing which appears to be the relevant approach for goat selection and improvement.

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