



## HEDONISTIC PRICE ANALYSIS OF SHEEP AND GOAT IN BAUCHI STATE, NIGERIA

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### ABSTRACT

The study evaluates hedonistic price analysis of sheep and goat in Bauchi State, Nigeria. Hedonic price models were fitted to a sample of 6,118 sheep and 4,518 goats, respectively, for which data were collected from 14 markets over a 12-month period. General linear model was employed for the study. The result of the estimated hedonic price regression model explains 74.1% of the variation in prices of sheep and 88.4% variation in the prices of goats was influenced by the combined effects of the independent variables (age of animal, live weight, sex, body condition, breed, coat colour and season) included in the hedonic model. The result further revealed there was significant difference ( $P < 0.05$ ) in the price of Ram, when compared with the price of ewe and castrated sheep. Ram attracted the higher price than ewe. The reason was probably because male sheep were preferred than female because of Caracas quality. Live weight of sheep significantly influences market prices of sheep at  $P < 0.05$ . Live weight range between 10-20Kg was used as reference group. Sheep with live weight of 21-30Kg and above significantly influenced prices of sheep at  $P < 0.05$  and attracted higher prices compared to the reference group (10-20Kg). This is a clear indication of the interests of sheep producers/buyers in the study areas probably because of the reproductive functions they are expected to perform to ensure herd growth and continuity. However, the result further revealed there was significant difference ( $P < 0.05$ ) in the price of Does, when compared with the price of Bucks and castrated goats. The reason was probably because Does were preferred than Bucks because of Caracas quality. Body condition of goats was another factor that influence market prices in the study area. The price of moderate goat was found to significant at  $P < 0.05$  and attracted higher price when compared with price lean goats. The study concluded that, phenotypic character significantly influences prices of sheep and goats. The study recommends that, live weight is considered a very important variable in determining the price of sheep and goats. Separate weighing machine for small and large animals should be installed at the entry point of market. This will help traders to know the exact weight of animal and brings them at par with other market agents in price bargaining. So, the good quality animals will bring more if they are sold by grade and weight.

**Keywords:** Goats, Hedonic, Markets, Price and Sheep

### INTRODUCTION

A hedonic price function relates the price of a product to the various attributes embodied in the commodity (Ramesh *et al.*, 2012). The underlying hypothesis is that products have utility-bearing attributes and the values of those attributes contribute to the price of the product. The observed price of a good is therefore a composite of the implicit values of the product's attributes. According to Kassie *et al.* (2011) characteristics that are likely to influence the price of live cattle include age, sex, grade as well as other related factors such as weather or seasons.

Hedonic models have been widely used to evaluate the implicit prices of many agricultural commodities, especially livestock (Ramesh *et al.*, 2012). The theoretical foundation of the hedonic price model is mainly made up of two parts: Lancaster preference theory and Rosen's characteristic supply-demand equilibrium model. American scholar Lancaster first put forward a new consumer



theory. The theory was expanded from the consumer theory of classical economics, also known as Lancaster preference theory.

From the product heterogeneity, Lancaster analyzed basic “element” spaces that formed the product, and argued that the demand for the product was not based on the product itself, but on its characteristics. He noted that heterogeneous goods have a series of integrated characteristics, and the goods are sold as the gathering of inherent characteristics. And that households purchase these goods, use them as a kind of “investment”, and turn them into utilities. Therefore, he asserted that level of utilities depends on the quantity of different characteristics, hence it is difficult to analyze such goods market with the traditional economic model, because it cannot be considered by a single total price. It is against that backdrop that, Lancaster thought to adopt a series of prices (hedonic price) to express corresponding product characteristics. Therefore, the product price is made up of hedonic prices, with each product characteristic having its own implied price, and all hedonic prices form a price structure (Bassey, 2013).

Later, American economist Rosen put forward the equilibrium model of market supply and demand based on product characteristics. Under the condition of perfect competitive market, with maximizing consumers’ utility and producer’s profit as the goal, Rosen analyzed theoretically the long term and short-term equilibrium of the heterogeneous product market. Rosen’s work established the modelling foundation for the hedonic price theory, based on which, econometrics method can be used to estimate the hedonic price function, get implicit prices of product characteristics, and then analyze the demand of product characteristics.

Kassie *et al.* (2011) classified five general categories of factors that can influence the supply of livestock to markets. These factors are economic, ecological, technological, institutional and uncertainty. Economic determinants involve the process of acquiring inputs and the disposal of the product in the market. Theoretically, the prices traders receive are reflections of the utility anticipated by the buyers and this utility is derived from the attributes of the product as livestock’s can be considered as quality (attribute) differentiated goods (Tibi and Aphunu, 2010).

Various studies (Kadigi *et al.*, 2013; Ramesh *et al.*, 2012; Alemayehu, 2011 and Kassie *et al.*, 2011) have been undertaken to determine factors that influence market prices of live livestock especially cattle. Kadigi *et al.* (2013) used several variables as the basis of attributes used in hedonic pricing models. Characteristics used include sex, breed, lot size, frame size, muscling score, body condition, weight, time of sale, market location, among other factors. A hedonic price model was fitted to determine the factors influencing live cattle prices.

Asfaw and Jabbar (2008); Gizaw *et al.* (2010) and Hassen *et al.* (2013) study of small ruminants in southern Nigeria made use of detailed, transactions-level data to disentangle the effects of various factors on livestock prices in Africa. The studies showed that attributes such as condition, breed, age, size, and castration affect the prices livestock fetch at market. These findings are consistent with findings of Berhanu (2012). Parish *et al.* (2017) employed a hedonic pricing model to establish indices of genetic worth of a dairy bull in Alberta, Canada. Their study indicated that the most important factors used by dairy farmers in valuing dairy bulls are milk volume, protein and fat content, general conformation, body capacity, and popularity of the bull.

Barret *et al.* (2005) used a structural-heteroscedasticity-in-mean estimation method to identify the determinants of livestock producer prices in the dry lands of northern Kenya. Their result showed the importance of animal characteristics, periodic events that shift local demand or supply, and rainfall in determining prices producers receive. Williams *et al.* (2006) similarly used a hedonic model using weekly sales transactions to analyze cattle prices in West Africa and reported that location, season, and cattle attributes influence prices. Gezahegne *et al.* (2006)



employed hedonic price modelling and reported significant differences in prices between seasons and markets, controlling for attributes of animals. Kassie *et al.* (2011), similarly applied heteroscedasticity consistent hedonic price modelling to examine factors that influence cattle prices in the rural markets of central Ethiopia. The results of the study showed that season, market location, age, sex and body size are very important determinants of cattle price.

This research focuses on the main phenotypic attributes that buyers inspect when buying sheep and goats in addition to external factors such as seasonality. The external features farmers look at and attach value to, are age, color, body size, sex, and the place where the sheep and goats were brought from. As discussed above, experiences with some of these characteristics have shown that they significantly influence market prices of livestock.

## MATERIALS AND METHODS

### 3.1 The Study Area

Bauchi State is one of the States in the northern part of Nigeria located in the Sudan savannah and the Sahel savannah zones between latitudes  $9^{\circ} 3'$  and  $12^{\circ} 3'$  north and longitudes  $8^{\circ} 50'$  and  $11^{\circ}$  east of the Greenwich meridian. The Sudan savannah type of vegetation covers the southern part of the state. While The Sahel type of savannah, also known as semi-desert vegetation, becomes manifest from the middle of the State as one moves from the State's south to its north. It occupies a land mass of about  $49,119\text{km}^2$  representing about 5.3% of Nigeria's total land mass (BSADP, 2015). Temperature ranges from a minimum of  $9.11^{\circ}\text{C}$  in December/January to a maximum of  $40.55^{\circ}\text{C}$  between April and May (BSADP, 2015). According to National Bureau of Statistics (NBS, 2017) Bauchi State has a total estimated population of 4,826,112.

The State has a large number of sheep and goats markets categorized into rural and urban markets where sheep, goats and cattle are assembled. Most of the rural markets are periodic in nature (weekly) except urban markets which operate most often. This attracts market participants not only from within the state but from all over Nigeria and neighboring countries. The State is bordered by seven States, Kano and Jigawa to the north, Taraba and Plateau to the south, Gombe and Yobe to the east and Kaduna to the west. The State comprises of twenty (20) Local Government Areas (LGAs) and 212 political wards. Bauchi State is divided in to three Agricultural Zones namely: Northern Zone (9 LGAs) Central Zone (4 LGAs) and Western Zone (7 LGAs) (BSADP, 2015). This large peasant population of the State engages in crop and livestock production. The major livestock reared include cattle, sheep, goats and poultry. However, the two distinctive vegetation zones (Sudan and Sahel Savannah) are supportive to especially large ruminants and small ruminant production, the State has a total of 14 gazetted grazing reserves. Most of the livestock are reared under extensive management system. The predominant small ruminants are goats (breeds includes Red Sokoto, Sahel and West African Dwarf) and sheep (breeds include Uda, Yankasa and Balami) while few other breeds are also found. Rearing of Small ruminants, crop production and marketing form the major economic activities in the study area.

### 3.2 Sampling Techniques and Sample Size

The sampling technique was multi-stage sampling techniques. In the first stage, Bauchi State was clustered into three agricultural zones based on Bauchi State Agricultural Development Programme (BSADP) classification namely: central (Darazo, Ganjuwa, Ningi, and Warji), northern (Dambam, Gamawa, Giade, Itas-gadau, Jama,are, Katagum, Misau, Shira and Zaki) and western (Alkaleri, Bauchi, Bogoro, Dass, Kirfi, Tafawa Balewa and Toro).

In the second stage, three (3) urban livestock markets were purposively selected from each cluster (northern and western zones) while in the third cluster (central zone) only 2 urban

livestock markets were selected. This is because in the zone only two livestock markets were located in urban center. This gives a total of nine (8) urban livestock markets.

In the third stage, two (2) rural livestock markets were purposively selected from each cluster giving a total of six (6) rural livestock markets. This was based on sufficient supply and concentration of sheep and goat traders. The total number of livestock markets selected for the study is 14.

In the final stage, 321 sheep and 220 goat traders from each market were selected using simple random sampling techniques based on proportional allocation technique. The sample size for the study was calculated using proportional allocation technique. In determining the sample size appropriate for the study, the Barlett *et al.* (2001) model as modified by Alamu and Olukosi (2010) was adopted, where 5% of the estimated population was selected, if the sample frame was more than 10,000. Therefore, in this study 5% percent of the sample frame was selected which gives a total of 541 sample for the study as presented in Table 1.

**Table 1:** Sample size determination and selection plan for the study

Agricultural zones	Markets	Population		Sample size (5% proportion)	
		Sheep traders	Goats traders	Sheep traders	Goats traders
Northern	Gamawa	844	760	42	38
	Azare	795	520	40	26
	Dambam	424	342	21	17
	Hardawa	205	184	10	9
	Sakuwa	443	402	22	20
Central	Darazo	243	203	12	10
	Katangar Warji	235	151	12	8
	Soro	521	203	26	10
	Gadan Maiwa	445	241	22	12
Western	Alkalari	680	400	34	20
	Bogoro	240	121	12	6
	Toro	234	200	12	10
	Mararraba Liman	800			
	Katagum		451	40	23
	Lariski	322	221	16	11
	<b>Total</b>	<b>6,431</b>	<b>4,399</b>	<b>321</b>	<b>220</b>

**Source:** Author's Computation, 2016

### Data Collection Techniques

Survey constitutes an acceptable convenient technique for measuring the impact of specific economic observation in quantitative terms. Reconnaissance survey was carried out in order to identify the existing system of marketing and to know the estimated number of sheep and goats traders present in each market. Informal interviews were conducted using key informants such as *Sarkin Tike*, elders, popular and experienced traders.

Data were collected from 321 sheep traders and 220 goats' traders with aid of structured questionnaire. Similarly, data were collected from 6,118 sheep and 4,518 goats from 14 markets over a 12-month period. In addition, a check list was used for observation, inspection and asking the traders verbal questions regarding price as well as sheep and goats characteristics that determine selling price such as age, sex, coat colour, size, breed and body condition. Age was measured approximated by the type and number of teeth following Fikru and Gebeyew (2015)

estimation guideline. Information on sex, coat colour and breed was observed through inspection of the sheep and goats. Live weight of sheep and goats was measured in Kilogram using measuring weigh scale (1000kg). The study classifies sheep and goats based on their sizes into small, medium and large, each category weighing approximately 1-30kg, 31–50kg and 51-70kg, respectively. This classification was adopted and modified from Mohammed *et al.* (2013<sup>b</sup>) that classified cattle based on their sizes into small, medium and large, each category weighing approximately 220-350kg, 350–480kg and 480-600kg, respectively in Gombe metropolis.

Data for body condition scoring in sheep and goats was an estimate of the muscle and fat cover of animal by palpation of different regions of the body. Body condition was assessed by certain physical characteristics apparent in goats of different degrees of fatness, i.e., on and around the backbone in the loin and the last rib, and above the kidney (Asefa *et al.*, 2015). Similarly, Sezenler *et al.* (2011) reported that, body scoring is based on a subjective assessment of the fat level and muscle thickness on the backbone behind the last rib. Body condition score and its use are important in terms of achieving the desired performance in certain physiological characters in small ruminants breeding. The method adopted for this study was originally described by Nsoso (2003). The method consists of a scale of six scores, from 1 to 5, based on the fat coverage in the lumbar region. This method was subsequently modified by Khan *et al.* (2006) where sheep and goats body condition were determined by visual assessment to identify any physical deformity. It is done by feel with hand thoracic, hind leg, hump parts and tail of the animal to assess the fat content which indicates the state of health and nutrition of the animal as well as quantity of meat and fat deposited.

### Data Analysis

There are many analytical techniques available for use in research of this nature, and the choice of a particular one depends on the type of data collected in order to achieve the specified objectives.

### Hedonic price regression model

A hedonic price regression model was fitted to determine the factors influencing sheep and goat prices (objective eight). A hedonic price function relates the price of a product (sheep or goats) to the various attributes embodied in the commodity. The observed price of a sheep or goats is therefore a composite of the implicit values of the product's attributes. The model was adopted to achieve the eight objective which is to determine the factors (live weight, sex, coat color, age of animal, breed, body condition and season) that influence price of sheep and goats.

$$P = f(X) \text{ or } P = f(X_1, \dots, X_n) \quad \dots(1)$$

where;

$P_s$  = Price of Sheep or Goat       $D$  = ranges from  $D_1, \dots, D_n$  = Factors

Considering  $f(X)$  as a linear function. The hedonic price regression model for sheep is express as:

$$P_s = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4D_4 + b_5D_5 + b_6D_6 \dots b_nD_n + e \quad \dots(2)$$

Where;

$P_s$  = Price of Sheep (₦)

$a$  = Constant

$D_1$  = Age (1=Immature <1 year, 2= Young 1-3 year, 3= Matured 4-6 year and 4=Aged >6 years)

$D_2$  = Live weight (kg) (1= <10kg, 2= 10-20kg, 3= 21-30kg, 4= >30kg)

$D_3$  = Sex (1=Ram, 2= Ewe and 3= Castrated)

$D_4$  = Body condition (1= Lean, 2= Moderate, 3 =Fat and 4= Very fat)





D<sub>5</sub>= Breed (1= Yankasa, 2=Uda, 3= Balami and 4= West Africa Dwaft and 5= Otherwise)

D<sub>6</sub> = Coat color (1= White, 2=Black, 3=Brown and 4 = Otherwise)

D<sub>7</sub> = Season (1= Early dry, 2= Late dry, 3= Early rainy and 4= Late rainy)

The reference group in the hedonic price regression model of sheep: D<sub>1</sub> = Age (2= Young 1-3 year) D<sub>2</sub> = Live weight (kg) (2= 10-20kg), D<sub>3</sub>= Sex (1=Ram), D<sub>4</sub> = Body condition (2= Moderate), D<sub>5</sub>= Breed (1=Yankasa), D<sub>6</sub> = Coat color (1= White), D<sub>7</sub> = Season (2= Late dry)

The hedonic price regression model goats is express as:

$$P_G = a + b_1D_1 + b_2D_2 + b_3D_3 + b_4D_4 + b_5D_5 + b_6D_6 + \dots + b_nD_n + e \quad \dots(2)$$

where;

P<sub>G</sub> = Price of goats (₦)

a = Constant

D<sub>1</sub> = Age (1=Immature <1 year, 2= Young 1-3 year, Matured 3-5 year and Aged >6 years)

D<sub>2</sub> = Live weight (kg) (1= <5kg, 2= 5-15kg, 3= 16-25kg, 4= >25kg)

D<sub>3</sub>= Sex (1=Bucks, 2= Does and 3= Castrated)

D<sub>4</sub> = Body condition (1= Lean, 2= Moderate, 3 =Fat and 4= Very fat)

D<sub>5</sub>= Breed (1= Red Sokoto, 2= Sahel, 3= West Africa Dwaft and 4=Otherwise)

D<sub>6</sub> = Coat color (1= Red, 2=Black, 3=Brown and 4 = Otherwise)

D<sub>7</sub> = Season (1= Early dry, 2= Late dry, 3= Early rainy and 4= Late rainy)

The reference group in the hedonic price regression model of goats: D<sub>1</sub> = Age (2= Young 1-3 year), D<sub>2</sub> = Live weight (kg) (2= 5-15kg), D<sub>3</sub>= Sex (2=Does), D<sub>4</sub> = Body condition (2= Moderate), D<sub>5</sub>= Breed (1=Red sokoto), D<sub>6</sub> = Coat color (1= Red) and D<sub>7</sub> = Season (2= Late dry)

## RESULTS AND DISCUSION

### *Estimated factors that influence prices of Sheep*

The Hedonic price model was adopted to examine the factors that influence prices of sheep. Prices of sheep was the dependent variable for sheep hedonic price model. The specified independent variables (dummies) include age of animal, live weight, sex, body condition, breed, coat colour and season. In the overall model, the reference groups for sheep price model was specified as age =young 1-3 year, live weight =10-20kg, sex=male, body condition = moderate, breed=Yankasa, Coat color =white and season= late dry season.

The result of the estimated hedonic price regression model explains 74.1% of the variation in prices of sheep. This shows that about 74.1% of the variation in the prices of sheep was influenced by the combined effects of the independent variables (age of animal, live weight, sex, body condition, breed, coat colour and season) included in the hedonic model. The remaining proportion can be attributed to error term. F-statistics (12.66) was significant at P<0.05, this statistic suggest goodness of fit of the model. Durbin Watson p-value of 1.02 was also reported. Which indicates there is a positive first order auto correlation as presented in Table 2.

The location of the 14 weekly markets also has an observed effect on the prices of sheep. Market location where enter as dummy variable. The reference market was Azare market because of sufficient supply and concentration of sheep traders. The estimated coefficient for market locations shows prices are lower in markets located in distant areas than those located in close distance areas. The result of the model also shows that sheep fetch higher prices in Bogoro, Toro, Marrarraba-liman Katagum and Laraski livestock markets when compere to Azare market. This is likely due to the relatively high potential for sheep population in the northern and central zone of



**Table 2:** Estimated hedonic regression of factors that influence price of sheep

Variable	Coefficient	SE	t-statistic
<b>Market location</b>			
Azare (Reference group)	0	0	0
Gamawa	292.119	1043.613	0.28 <sup>NS</sup>
Dambam	744.7455	1015.047	0.73 <sup>NS</sup>
Hardawa	-510.7142	1135.698	-0.45 <sup>NS</sup>
Sakuwa	306.9694	1152.278	0.27 <sup>NS</sup>
Darazo	2586.576	1133.279	2.28 <sup>**</sup>
Katangar warji	1543.554	1141.130	0.48 <sup>NS</sup>
Soro	55.49353	1143.269	0.05 <sup>NS</sup>
Gadan maiwa	989.9098	1175.361	0.84 <sup>NS</sup>
Alkalari	-793.3391	168.536	-4.71 <sup>***</sup>
Bogoro	2326.3397	1146.361	2.02 <sup>**</sup>
Toro	3374.2348	1056.547	3.20 <sup>***</sup>
Mararraba L/ katagum	1454.925	701.568	2.07 <sup>*</sup>
Laraski	201.4143	126.609	1.59 <sup>*</sup>
<b>Sex</b>			
Ram (Reference group)	0	0	0
Ewe	-778.653	562.344	-1.38 <sup>*</sup>
Castrated	840.923	557.137	1.51 <sup>*</sup>
<b>Age of sheep</b>			
Immature (<1 year)	-925.3075	642.3107	-1.44 <sup>*</sup>
Young (1-3 year) (Reference group)	0	0	0
Matured(4-6 year)	1202.41	649.7913	1.44 <sup>*</sup>
Aged (>6 years)	1404.3715	642.0086	2.19 <sup>*</sup>
<b>Live weight</b>			
<10kg	-972.4376	640.1296	-1.52 <sup>*</sup>
10-20kg (Reference group)	0	0	0
21-30kg	1032.862	644.4651	1.60 <sup>*</sup>
>30kg	1520.3454	647.4619	2.35 <sup>**</sup>
<b>Breed</b>			
Yankasa (Reference group)	0	0	0
Uda	-138.4526	729.0277	-0.19 <sup>NS</sup>
Balami	1435.632	728.1231	1.97 <sup>*</sup>
West African dwarf sheep	-2397.0349	716.35	-3.35 <sup>***</sup>
Other wise	397.0349	731.3145	0.51 <sup>NS</sup>
<b>Coat color</b>			
White (Reference group)	0	0	0
Black	-646.4775	652.3576	-0.99 <sup>NS</sup>
Brown	-61.50292	644.1884	-0.10 <sup>NS</sup>
Otherwise	-417.393	640.0613	-0.65 <sup>NS</sup>
<b>Body condition</b>			
Lean	-1385.282	728.8026	-1.90 <sup>*</sup>
Moderate (Reference group)	0	0	0
Fat	1042.386	722.6943	1.44 <sup>*</sup>
Very fat	1171.043	739.3885	1.58 <sup>*</sup>
<b>Season</b>			
Early dry	-1899.569	733.1033	-2.59 <sup>**</sup>
Late dry (Reference group)	0	0	0
Early rain	-1386.7376	723.1841	-1.92 <sup>*</sup>
Late rain	-1353.2787	722.6815	-1.49 <sup>*</sup>
<b>Constant</b>	37990.17	1297.949	29.27 <sup>***</sup>
<b>R<sup>2</sup></b>	<b>0.741</b>		
<b>F-statistic</b>	<b>12.66<sup>*</sup></b>		
<b>DW</b>	<b>1.02<sup>*</sup></b>		

Source: Field survey, 2017

Note: \*\*\*Significant at  $p \leq 0.001$ , \*\*Significant at  $p \leq 0.01$ , \*Significant at  $p \leq 0.05$  and NS= Not Significant, DW= Durbin Watson.



Bauchi State and hence high supply. Another reason is that, Azare market is the major market where traders buy sheep (supply) and resale in other markets in Bauchi State. These results imply that buyers and sellers would benefit if they carefully choose market location.

The result further revealed there was significant difference ( $P < 0.05$ ) in the price of Ram, when compared with the price of ewe and castrated sheep. Ram attracted the higher price than ewe. The reason was probably because male sheep were preferred than female because of Caracas quality. The result obtained here is also consistent with the findings of Mahmud *et al.* (2014), confirms that other things being equal, price per animal was significantly higher for males as compared to female sheep. The lower price offered for female sheep is mainly because producers only sell female animals at the end of their productive life, which makes them older than Ram and castrates offered for sale. In other hand, castrated sheep attract higher price than Ram and ewe. This is probably because castration is a widely used practice for adding value to the animals.

In the overall model, there was a significant difference ( $P < 0.05$ ) in the prices of young sheep (reference group) when compared with the price of immature. While the price of matured and aged sheep is higher than the price of young sheep. This can be attributed to carcass difference. Tsedeke *et al.* (2011), also confirms that prices are highest for matured sheep relative to the immature and young sheep. However, Terfa *et al.* (2013), also confirms that age influenced sheep price significantly and negatively, implying that sheep command a higher price up to a very old age and the price will fall down as age goes up.

Live weight of sheep significantly influences market prices of sheep at  $P < 0.05$ . Live weight range between 10-20Kg was used as reference group. Sheep with live weight of 21-30Kg and above significantly influenced prices of sheep at  $P < 0.05$  and attracted higher prices compared to the reference group (10-20Kg). This is a clear indication of the interests of sheep producers/buyers in the study areas probably because of the reproductive functions they are expected to perform to ensure herd growth and continuity.

#### **Estimated hedonic price regression of factors that Influence price of Goats**

The Hedonic price model was adopted to examine the factors that influence prices of goats. Prices of goats was the dependent variable for goat hedonic price regression model. The specified independent variables (dummies) include age of animal, live weight, sex, body condition, breed, coat colour and season. In the overall model, the reference groups for goats price model was specified as age = young 1-3 year, live weight = 5-15kg, sex = female, body condition = moderate, breed = Red Sokoto, coat color = red and season = late dry season.

The result of the estimated hedonic price regression model explains 88.4% of the variation in prices of goats. This shows that about 88.4% of the variation in the prices of goats was influenced by the combined effects of the independent variables (age of animal, live weight, sex, body condition, breed, coat colour and season) included in the hedonic model. The remaining proportion can be attributed to error term. F-statistics (11.8) was significant at  $P < 0.05$ , this statistic suggest goodness of fit of the model. Durbin Watson p-value of 1.04 was also reported. Which indicates there is a positive first order auto correlation as presented in Table 3.

The location of the 14 weekly markets also has an observed effect on the prices of goats. Market location where enter as dummy variable. The reference market was Azare market because of sufficient supply and concentration of goats' traders. The estimated coefficient for market locations shows prices are lower in markets located in distant areas than those located in close distance areas. The result of the model also shows that goats fetch higher prices in Bogoro, Toro, Marrarraba-liman Katagum and Laraski livestock markets when compare to Azare market. This is likely due to the relatively high potential for goats' population in the northern and central zone of





**Table 3:** Estimated hedonic regression of factors that influence price of goats

Variable	Coefficient	SE	t-statistic
<b>Market location</b>			
Azare (Reference group)	0	0	0
Gamawa	1162.98	1225.616	0.95 <sup>NS</sup>
Dambam	163.0691	1199.693	0.14 <sup>NS</sup>
Hardawa	-474.8455	1315.562	-0.36 <sup>NS</sup>
Sakuwa	30.00516	1342.867	0.02 <sup>NS</sup>
Darazo	2464.075	1310.865	1.88 <sup>*</sup>
Katangar warji	1135.4	1326.375	0.86 <sup>NS</sup>
Soro	62.03606	1336.116	0.05 <sup>NS</sup>
Gadan maiwa	1513.512	1079.587	1.31 <sup>*</sup>
Alkalari	793.9633	1366.37	0.58 <sup>NS</sup>
Bogoro	1795.3818	1034.672	1.74 <sup>*</sup>
Toro	1654.7397	1149.561	1.44 <sup>**</sup>
Mararraba L/ katagum	1585.0813	1009.862	-1.57 <sup>*</sup>
Laraski	1630.9361	1117.533	1.46 <sup>*</sup>
<b>Sex</b>			
Bucks (Reference group)	0	0	0
Does	-1215.848	652.4901	-1.86 <sup>*</sup>
Castrated	1114.0505	648.3031	1.72 <sup>*</sup>
<b>Age of sheep</b>			
Immature (<1 year)	-1366.9706	742.3866	-1.84 <sup>*</sup>
Young (1-3 year) (Reference group)	0	0	0
Matured (4-6 year)	1471.279	754.3814	1.95 <sup>*</sup>
Aged (>6 years)	-1155.93797	747.4525	1.55 <sup>*</sup>
<b>Live weight</b>			
<10kg	-1483.5217	643.9503	-2.30 <sup>**</sup>
10-20kg (Reference group)	0	0	0
21-30kg	1463.2181	643.9503	2.27 <sup>**</sup>
>30kg	1184.6814	655.8107	1.81 <sup>*</sup>
<b>Breed</b>			
Red sokoto (Reference group)	0	0	0
Sahel	832.3646	844.9169	0.19 <sup>NS</sup>
West African dwarf goat	-1209.4717	830.5463	-1.46 <sup>*</sup>
Other wise	334.3254	849.547	0.39 <sup>NS</sup>
<b>Coat color</b>			
Red (Reference group)	0	0	0
Black	521.7179	760.5353	0.69 <sup>NS</sup>
Brown	-511.0618	751.9642	-0.68 <sup>NS</sup>
Otherwise	-325.2574	741.6716	-0.44 <sup>NS</sup>
<b>Body condition</b>			
Lean	-423.1406	924.8362	-0.46 <sup>*</sup>
Moderate (Reference group)	0	0	0
Fat	1627.239	932.704	1.74 <sup>*</sup>
Very fat	1242.589	933.1107	1.33 <sup>*</sup>
<b>Season</b>			
Early dry	-1211.8504	832.3874	-1.46 <sup>*</sup>
Late dry (Reference group)	0	0	0
Early rain	-1318.4442	836.3747	-1.58 <sup>*</sup>
Late rain	-1358.7319	835.7247	-1.63 <sup>*</sup>
<b>Constant</b>	29522.56	1549.107	19.05 <sup>***</sup>
<b>R<sup>2</sup></b>	<b>0.884</b>		
<b>F-statistic</b>	<b>11.18<sup>*</sup></b>		
<b>DW</b>	<b>1.06<sup>*</sup></b>		

Source: Field survey, 2017

Note: \*\*\*Significant at  $P \leq 0.001$ , \*\*Significant at  $P \leq 0.01$ , \*Significant at  $P \leq 0.05$  and NS= Not Significant, DW= Durbin Watson.

Bauchi State and hence high supply. Another reason is that, Azare market is the major market where traders buy goats (supply) and resale in other markets in Bauchi State. These results imply that buyers and sellers would benefit if they carefully choose market location.

The result further revealed there was significant difference ( $P<0.05$ ) in the price of Does, when compared with the price of Bucks and castrated goats. The reason was probably because Does were preferred than Bucks because of Caracas quality. The result obtained here is also consistent with the findings of Mahmud *et al.* (2014), confirms that other things being equal, price per animal was significantly higher for Does as compared to Bucks. In other hand, castrated goats attract higher price than Bucks. This is probably because castration is a widely used practice for adding value to the animals.

In the overall model, there was a significant difference ( $P<0.05$ ) in the prices of young goats (reference group) when compared with the price of immature ( $<1$  years). While the price of matured goats (4-6 years) and aged goat ( $>6$  years) was higher than the price of young goats (1-3 years). This can be attributed to carcass difference. Tsedeke *et al.* (2011), also confirms that prices are highest for matured goats relative to the immature and young goats. However, Terfa *et al.* (2013), also confirms that age influenced goat price significantly and negatively, implying that goats command a higher price up to a very old age and the price will fall down as age goes up.

Live weight of goats significantly influences market prices at  $P<0.05$ . Live weight range between 10-20 Kg was used as reference group. Goats with live weight of 21-30 Kg and above significantly influenced prices of goats at  $P<0.05$  and attracted higher prices compared to the reference group (10-20 Kg). This is a clear indication of the interests of goat producers/buyers in the study areas probably because of the reproductive functions they are expected to perform to ensure herd growth and continuity.

In Table 2, the result shows that price of *Red Sokoto* breed of goats were compared with price of *Sahel*, and *West African Draft* goat, the result shows that, the price of *Red Sokoto* breed were found to be statistically significant at  $P<0.05$  with negative coefficient, which implies that, prices of *Red Sokoto* were higher than that of *Sahel* and *West African Draft* goat. However, price of *Sahel* and other cross breed of goat were significantly ( $P<0.05$ ) higher when compare with price of *Red Sokoto*. This probably may arise because of the meat quality and taste of *Red Sokoto* and *Sahel* breed as confirm by butchers. Another reason is that *Red Sokoto* was the most commonly breed of sheep reared in the study area, in addition, *West African Dwarf* goat placed in the markets by traders lack sufficient feeding. However, coat color of goats where not statistically significant at  $P<0.05$ . In most cases, coat color is not given special attention in the study area for goats. Although some colors are preferred for some ritual ceremonies.

Body condition of goats was another factor that influence market prices in the study area. The price of moderate goat was found to significant at  $P<0.05$  and attracted higher price when compared with price lean goats. Furthermore, the price of fat and very fat goats was found to significant at  $P<0.05$  with positive coefficient. This implies that fat and very fat goats attracted higher prices when compared with moderate (reference group) and lean goats. The variation in the prices of goats with different body condition score in the study area may be as a result of assessment carried out by buyers in terms of quantity of fat deposit found in very fat animal when compared with moderate and lean.

In the empirical model, the early dry season corresponds to December – February; late dry season (March – May); early rainy season (June – August) and the late rainy season (September – November). The late dry season was used as the reference group for comparison of the influence of season on prices goats. The results show there was a significant difference ( $P<0.05$ ) in the price



of goats across season. All the coefficients were negative, meaning that prices of goats were higher around March to May (late dry season) when compared to price of goats around December to February (early dry season). This is probably due to shortage feed and high cost of feed at late dry season linked with poor financial position of rural producers. Similarly, prices of goats were lower around June to August (early rainy season) and around September to November (late rainy season) when compared to price of goats around March to May (late dry season). It is the period of rainfall, marketing activities during this time is usually low and therefore prices tend to be low due to low demand.

## CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it was concluded that, age of animal, live weight, sex, body condition, breed and season significantly influence prices of sheep and goats. The study recommends that, live weight is considered a very important variable in determining the price of sheep and goats. Separate weighing machine for small and large animals should be installed at the entry point of market. This will help traders to know the exact weight of animal and brings them at par with other market agents in price bargaining. So, the good quality animals will bring more if they are sold by grade and weight.

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