Greener Journal of Agricultural Sciences
ISSN: 2276-7770
Vol. 14(1), pp. 50-57, 2024

https://gjournals.org/GJAS

Analysis of Demand within the Beef Value Chain in Maiduguri, Borno State, Nigeria.

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ARTICLE INFO

Article No.: *021324021*
***Type*:** *Research*
Full Text: *PDF, PHP, HTML, EPUB, MP3*

Accepted: *22/02/2024*
Published: *15/03/2024*

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Keywords: *LA/AIDS, Price elasticity, Expenditure elasticity, Cross price elasticity, Beef products*

ABSTRACT

The study examined the beef value chain with a view of measuring the elasticities of demand within the chain. Specifically, price elasticity of demand, cross price elasticity and expenditure elasticity were measured using the LA/AIDS Model. Data for the study were obtained through structured questionnaire administered to buyers of beef and processed beef products which include *tsire, balangu* and *kilishi*. A total of 400 respondents were selected through convenience sampling. The results of the study revealed uncompensated own price elasticity of beef was unitary elastic (-0.9664), compensated own price elasticity was inelastic (-0.0526) and expenditure elasticity (1.3752) showed beef was a luxury good. Uncompensated cross price elasticity showed beef was complement with mutton, chevon and camel while compensated cross elasticity showed beef and mutton were complements and beef was substitute to chevon and camel. Uncompensated own price for *kilishi* was unitary (-0.9755), *tsire* (-2.6837) and *balangu* (-3.8467) were elastic while compensated own price for *kilishi* (-0.0866) was highly inelastic and *tsire* (-2.4315) and *balangu* (-3.4834) were elastic. *Kilishi* (1.4349) and *balangu* (3.2058) were luxury goods and *tsire* (0.9439) was a necessary good. Uncompensated cross price elasticity showed *kilishi* and *balangu* were substitutes, *tsire* and *kilishi* and *tsire* and *balangu* were complements while compensated cross price elasticity showed *balangu* and *kilishi* were substitutes, *balangu* and *tsire* and *tsire* and *kilishi* were complements. It was recommended that since the products studied were mostly luxury goods, policy measures geared at ensuring increased incomes such as increased minimum wage and employment creation which would concurrently increase purchasing power of consumers should be exploited.

BACKGROUND OF THE STUDY

The beef value chain is an important sector to Nigeria's economy as it provides employment and income generating activities to many Nigerians. It is a source of livelihood to millions of people through beef cattle production and marketing, beef marketing and processing. The value chain consists of input suppliers, producers, marketers, transporters, middlemen and processors who are interrelated to provide beef cattle and its by-products to consumers. Kaplinsky and Morris (2002) defined value chain as the "full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use". Thus, beef value chain can be viewed as the series of activities and links required in the movement of beef products to final consumers passing through diverse stages of production, processing, transformation and delivery. The consumers being the end users of the resultant products of the chain are important actors.

Consumer behaviour, wants and needs significantly define demand and supply of products in value chains. As consumers are empowered by greater knowledge and changing needs, powers in value chains are said to be shifting from the supply side to the consumer side (Labuschagne et al., 2010). Demand for products are also determined by a multitude of factors such as own price, availability of substitutes, household income, consumer preferences (Eastin & Arbogast, 2011), expected duration of price change, the product's share of household's income, as well as demographic factors such as changes in household size, age distribution of the population and sex (Udoh et al., 2013). Consumption patterns are also changing due to a combination of population growth, rising incomes, urbanisation (Bénard et al., 2010) and changing food preferences (Food and Agriculture Organization [FAO], 2018). A combination of these factors can lead to changes in meat demand especially beef. This can have impact on all segments of the beef value chain, which include input supply, production, processing and distribution.

The Nigeria's domestic market opportunity for cattle is large and expected to continue growing with increase in population. Available statistics on the number of cattle slaughtered in the country have shown that beef consumption in 2014 amounted to 380,000 tonnes and is projected to grow up to 1.3 million tonnes by 2050 (Federal Ministry of Agriculture & Rural Development [FMARD], 2015). Beef alone accounts for about 70% of total national meat supply (Mafimisebi et al., 2013). Despite the large national herd of cattle (19.5 million) as well as large population of sheep (41.3 million) and goats (72.5 million) (National Bureau of Statistics [NBS], 2016), Nigeria is still unable to meet its animal protein demand. The average minimum supply of animal protein per capita per day was about 14g, far below the recommended minimum of 35g of protein expected to come from animal products (FAO, 2019). Hence, the livestock sector is expected to meet the growing demand for high-value animal protein most particularly cattle.

Borno State is a major supplier of cattle to the country. Cattle population in the State is estimated at over 2 million (Borno State Ministry of Animal Resources and Fisheries Development, 2011). Beef is the most preferred source of animal protein in the State (Maina & Baba, 2012). The beef value chain provides employment and income to a large percentage of the stakeholders involved from production to consumption. The value chain involves fattening or raising of beef cattle (production), distribution to markets, processing into beef, further processing into several beef products and onward movement to consumption points. Beef and its products pass through successive actors who are serially linked before reaching its end-users. At each point in the link, as value is added to the products, more products are formed attracting more consumers. These products include cattle (live animal), beef (raw), processed beef products such as *suya* (*tsire, kilishi* and *balangu*), *dambun nama* (fried shredded meat) among others. Actors in the beef value chain take into consideration purchasing behaviour of their potential consumers in order to provide desired products.

Understanding the extent to which consumer needs and preferences play on demand for beef and its products as well as how it influences production (or prices) will have impact on all segments of the value chain. Due to the interdependence of products in the beef value chain, the whole system needs to be studied together. However, demand studies in the study area (Maina & Baba, 2012) only examined the retail node of the chain thus, negating the interdependence of the various nodes of the beef value chain. Related value chain studies in the study area (Ghide & Mohammed, 2016; Ghide et al., 2017) emphasised the supply side of the market with emphasis on costs, revenues and margins without recourse to the demand side of the market; the consumers. This study focused on the consumption points of the retail and processing nodes of the beef value chain. Own price elasticity, cross price elasticity and expenditure elasticity were estimated for beef as well as processed beef products.

MATERIALS AND METHODS

The Study Area

The study was carried out in Maiduguri, Borno State, Nigeria. It is located in north eastern Nigeria between latitudes 13^0 06^l and 13^0 14^l E and longitudes 11^0 46^l and 11^0 54^l N (GEONETcast Unimaid, 2015). Projected population of inhabitants of Maiduguri is put at 1,340,438 in 2020 at annual growth rate of 3.2 percent from a population of 732,696 people in 2006 census

(National Population Commission [NPC], 2006). The climate is generally hot with a mean temperature of 37^{o}c and mean rainfall of 647mm per annum (Lake Chad Research Institute, 2019). Trading, farming and civil service are the major occupations of the people of Maiduguri. Common crops grown include groundnut, cowpea, millet, maize and vegetables such as onions, tomatoes, peppers, cucumber, amaranths. Cattle, sheep, goats and chickens are the major livestock reared.

Maiduguri is a major supplier of cattle to the country and has a large livestock market popularly known as *Kasuwan shanu*, where livestock most especially cattle are traded as well as fattened. It also has a large abattoir situated opposite the cattle market which is able to handle 200 cattle a day as well as hundreds of sheep and goats (Maiduguri Central Abattoir [MCA], 2020). Between the cattle market and abattoir, a large number of people are employed as fatteners, input suppliers, traders, transporters, butchers, middlemen, by-products retailers, and processors. These actors ensure that cattle and its products reach the consumers at the right time and form. Road side sales of cattle by-products such as beef and offal and processed beef products are carried out across the study area. Beef is processed into variety of products which could be roasted, cooked, fried, and dried in accordance with consumer preferences and preservation motives. *Tsire* (indigenous name for spicy meat skewer/kebabs), *Balangu* (indigenous name for spicy high moisture roasted meat) and *Kilishi* (indigenous name for beef jerky), collectively referred to as *Suya* are the commonest processed and consumed beef products sold in the study area.

Sources of Data

Primary data was used for the study which was obtained through structured questionnaire that was administered through interview by trained enumerators. Information obtained include socio-economics characteristics and detailed expenditure on products.

Sampling Procedure

For this study, research subjects were selected from the retail node and processing nodes of the beef value chain. The retail node represents the point where beef is handled and the processing node represents the point where processed beef is handled. Since elasticities of demand were measured which involved estimation of budget shares, these two nodes were considered as the most important points were consumers actual responses would be measured. This is because beef and processed beef products are directly part of the food basket or part of consumption in which the amount spent on their consumption can be measured. The production node where live cattle are handled was not considered because it will not reflect budget share since cattle as a whole is not directly part of the food basket.

Two stage sampling were used to select respondents. In the first stage, 10 affluent and 10 less affluent selling points were purposely selected within the Metropolis. This selection was done in order to capture preferences of all classes of consumers. This was done so as to give a good representation of combination of heterogeneous classes of people with different food consumption behaviour and socio-economic conditions (Islam & Jabbar, 2010). In the second stage, in a period of 20 weeks, 100 buyers each of beef, *tsire*, *balangu* and *kilishi* respectively were selected by convenience sampling from the selected affluent and less affluent sales points. The selection amounted to 100 buyers from the retail node and 300 buyers from the processing node. Altogether, 400 respondents were selected for the study. Convenience sampling was used to select the sample for the study as the population was large and there was no sampling frame. For the retail node, beef was considered alongside similar products consumed in the study area which include mutton, chevon and camel meat. For the processing node, the three products studied (*tsire*, *kilishi* and *balangu*) were measured together.

Analytical Techniques

For analysis of data, Linear Approximate Almost Ideal Demand System (LA/AIDS) was used. The LA/AIDS model of Deaton and Muellbauer (1980a) was employed to estimate elasticities of demand. The study assumed three-stage budgeting. The first stage comprised of an allocation of total expenditure to a broad group of goods and at the second stage subsequently allocates to the individual commodities (Deaton & Muellbauer, 1980b). The first stage requires knowledge of total expenditure and appropriately defined group prices while in the second and third stages individual expenditures are functions of group expenditure and prices within the group. The weak separability of the utility function is a necessary and sufficient condition for the broad group and at the stage group (Deaton & Muellbauer, 1980b). A demand function is weakly separable if the marginal rate of substitution between any two goods that belongs to the same group are independent of quantities of goods outside the group (Taljaard et al., 2004). The study assumed the four meat products in the retail node (beef, mutton, chevon and camel) are weakly separable and were modelled together. Similarly, the three *suya* products (*tsire*, *balangu* and *kilishi*) are also weakly separable hence also modelled together. Therefore, the empirical model for the retail node consisted of four budget share equations corresponding to each meat product estimated using the seemingly unrelated regression technique. The same was done for the processing node where three budget share equations corresponding to each *suya* product were also estimated.

Following Sacli and Ozer (2017), the model is expressed as:

$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\{X/P\} + e_i$ 1

Where:

w_i = budget share of the i^{th} good (which include beef, *tsire*, *balangu*, *kilishi*) defined as

$p_i q_i / X_i$.....2

p_i = weighted average price of items in the i^{th}group
q_i = quantity consumed of good i (kg)
X_i = total expenditure on the group of goods analysed (₦) i.e beef, chevon, mutton, camel for retail node and *tsire*, *balangu* and *kilishi* for processing node
p_j = weighted average price of items in the j^{th}group (beef, mutton, chevon, camel for retail node and *tsire*, *balangu* and *kilishi* for processing node)
e_i = error term
α, γ and β = model parameters
P = stone's price index defined by

$P = \sum_{i=1}^{n} \overline{w}_i \log p_i$ 3

Where:
$\overline{w}_i$ = predicted budget share of ith good (beef and the suya products)
The adding up, homogeneity and symmetry restrictions were imposed on equation 1 during estimation.
The own price, cross-price and income elasticities were calculated from the LA/AIDS using the following formulas:

Marshallian own and cross-price elasticity,
$e_{ij} = \frac{\gamma_{ij} - \beta_i}{w_i} - \delta_{ij}$ 4

Hicksian own and cross-price elasticity,
$e_{ij} = \frac{\gamma_{ij}}{w_i} + w_j - \delta_{ij}$ 5

Where:

δ_{ij} = Kronecker delta ($\delta_{ij} = 1$ for own price, $\delta_{ij} = 0$ for cross-price elasticities)

Expenditure/income elasticity,
$n_{ij} = 1 + \left(\frac{\beta_i}{w_i}\right)$ 6

For the estimation of elasticities, Stata 15.1 version was used to run the analysis using the command written by Poi (2008). This Stata command uses Seemingly Unrelated Regression (SUR) by using maximum likelihood estimation technique. Separate analyses were run for the meat group (beef with other meat items) and for the processed beef products group.

A priori expectation

The γ_i parameters (price coefficient) are expected to be negative for own price elasticity. For cross price effects, substitutive relationship will have positive values while complementary relationship will have negative values. Beef is expected to have a positive cross price effect with all the other meat products. *Tsire*, *balangu* and *kilishi* are also expected to have positive cross price effects. The β_i parameters (expenditure coefficient) is negative for inferior goods and positive for normal goods. Beef, *tsire*, *balangu* and *kilishi* are expected to have positive coefficients.

RESULTS AND DISCUSSION

Elasticities of Demand for Beef

Table 1 presents results for the different elasticities for beef alongside mutton, chevon and camel. The diagonal values in bold face represent the own-price elasticity while the other values either side of the diagonal values are the cross-price effects. The uncompensated price elasticity (also called the Marshallian price elasticity) measure the relationship between a change in the quantity demanded and a change in price of a commodity holding total expenditure constant (Henningsen, 2017). It contains both the income and price effects. The uncompensated own price elasticity for beef, mutton, chevon and camel were consistent with economic theory as all had the expected negative signs. The price coefficient for beef was less than one (0.9664) but very close to unitary so could be regarded as unitary elastic. This shows that a 1% increase in the price of beef will result in approximately 1% decrease in quantity demanded. Price elasticity of mutton (0.121), chevon (0.2759) and camel (0.1919) were all inelastic and lower than the price elasticity of beef. Mutton, chevon and camel were more irresponsive to price change than beef.

Regarding cross-price elasticities, beef had a negative and significant relationship with all the other meat products making them complements. This means an increase in the price of beef by 1% would lead to a decrease of about 0.2%, 0.2% and 0.03% of the quantity demanded of mutton, chevon and camel by consumers in Maiduguri. In the study area, cattle, sheep and goat are commonly reared together. Generally, feed and management practices are similar most especially cattle and sheep. Increased feed prices which may result in increased price of cattle will also yield increased prices of sheep and goat. This may make demand for beef, mutton and chevon to move together in the event of price increases. However, the effect of a price change of beef on the other meat items is not the same as the effects of price change of the other meat items on beef. A 1% increase in the price of mutton, chevon and camel meat would decrease the demand for beef by 0.4%, 0.2% and 0.3% respectively.

The compensated price elasticity (also called the Hicksian price elasticity) measure the relationship

between a change in the quantity demanded and a change in price of a commodity, holding the utility level constant (Henningsen, 2017). The Hicksian elasticity is reduced to contain only price effects (substitution effects), and is thus compensated for the effect of a change in the relative income on demand. The results in Table 1 showed compensated own price elasticity for beef and all the other meat items were negative which was consistent with *a priori* expectation. This shows that as prices of all the meat products go up, their quantity demanded decreases. However, the magnitude of the price elasticity coefficients for all the meat products were low. Price coefficient for beef was 0.0526 which showed beef to be highly inelastic, it had very low response to price change. This finding suggest that without considering income, beef consumers in Maiduguri do not reduce quantity of beef consumed much with increase in its price.

Marshallian elasticity generates gross complements and substitutes, where gross denotes both the income and substitution effects. Consequently, Hicksian elasticity generate net complements (or substitutes) when the effect of income is not present at all. Due to presence of the income effect, good i can be a gross substitute for good j, and at the same time j can be a gross complement to i (Piipponen, 2017). The cross price elasticity of beef with other meat items showed beef had a negative relationship with mutton and positive relationship with chevon and camel. This showed beef and mutton were compliments while beef was substitute to chevon and camel. The magnitude of the coefficients of the Hicksian cross price relationship were smaller than the Marshallian cross price relationship which indicate a weaker relationship. The results showed a similar cross price relationship between beef and mutton (complementarity) with and without the income effect. The relationship between beef with chevon and camel with the income effect was complementary but substitutive without the income effect. The cross price effects of beef were significant with only chevon and camel unlike the Marshallian cross price effects that were significant for all the meat items. The consumption of beef showed the strongest substitution response to the price of camel (0.2954) than to the price of chevon (0.1986). This implies that beef consumption in the study area is affected by the price of camel and chevon. It showed no effect to the price of mutton.

The expenditure (or income) elasticity measures the percentage increase in consumption due to a percentage increase in total expenditure (or income). Table 1 shows the expenditure elasticity of beef was positive which showed it was a normal good. The coefficient exceeded unity (1.3752) which showed beef to be considered a luxury good in Maiduguri. This finding implies that beef was income elastic hence affected by income changes. If income increased by 1%, the demand for beef increased by over 1.3%. Considering beef is regarded as the most preferred meat in the study area, it was expected to have an inelastic response to income change. This was not the case as the results showed beef to be a luxury good. Understandably as with all luxury goods, consumers would buy more of beef when their income increases. Cheaper sources of protein such as fish in the study are available which could be among the reasons why beef was considered a luxury good. Expenditure coefficient for mutton (0.6278) was also positive but less than unity, making it income inelastic so a necessity good. The results suggest that although beef is regarded the most preferred meat in the study area, mutton is considered a more important source of protein than beef. Aside its consumption as a healthier protein source, sheep in the study area is used for sacrifice during naming ceremonies and Eid celebrations. This could make consumers have a high regard for mutton irrespective of their income. Expenditure coefficients for chevon (-0.0731) and camel (-0.0563) were negative and very low. This means that both meat products are considered inferior goods in the study area.

Table 1: Estimates for Own Price, Cross Price and Expenditure Elasticity for Meat

Elasticity	Beef	Mutton	Chevon	Camel
Uncompensated Price Elasticity				
Beef	**-0.9664*** **	-0.2235***	-0.1504***	-0.0349***
	(0.0426)	(0.033)	(0.0092)	(0.0082)
Mutton	-0.4435***	**-0.121**	-0.0141	-0.0492
	(0.1614)	**(0.134)**	(0.0237)	(0.0281)
Chevon	0.2472***	0.0991***	**-0.2759*** **	0.0027
	(0.0387)	(0.0237)	**(0.0248)**	(0.015)
Camel	0.3328**	-0.0925	0.008	**-0.1919*** **
	(0.1572)	(0.1145)	(0.058)	**(0.0741)**
Compensated Price Elasticity				
Beef	**-0.0526**	-0.0075	0.0430***	0.0171**
	(0.0371)	(0.0333)	(0.0087)	(0.0083)
Mutton	-0.0263	**-0.0224**	0.0743***	-0.0255
	(0.1403)	**(0.1346)**	(0.0214)	(0.0283)
Chevon	0.1986***	0.0876***	**-0.2862*** **	-3.12E-05
	(0.0402)	(0.0229)	**(0.0241)**	(0.015)
Camel	0.2954**	-0.1014	4.82E-05	**-0.1941*** **
	(0.1442)	(0.1164)	(0.0553)	**(0.0743)**
Expenditure Elasticity	1.3752***	0.6278***	-0.0731***	-0.0563
	(0.0239)	(0.0954)	(0.0165)	(0.0693)

***, ** significant (p<0.01) and (p<0.05) respectively, figures in parentheses are standard errors
Source: Computed from Field Data, 2022

Elasticities of Demand for Processed Beef Products

The results for the different elasticities estimated for *kilishi*, *tsire* and *balangu* are presented in Table 2. The Marshallian own price elasticity for all the processed beef products were negative as expected *a priori* and significant (p<0.01). The coefficient for *kilishi* (0.9755) was approximately unitary. This shows that a 1% increase in the price of *kilishi* will yield approximately 1% decrease in its quantity demand. The coefficient for *tsire* (2.6837) was more elastic than for *kilishi*. This results suggest that *tsire* is more responsive to its price change than *kilishi* is to *kilishi* price change. *Balangu* was most responsive to its price change among the processed beef products (3.8467). The low response of *kilishi* to its price change could be attributed to its longer shelf life. *Kilishi* can keep for a longer time at room temperature without losing its freshness unlike *tsire* and *kilishi* which cannot keep for more than a few hours without preservation facilities. Similarly, the shorter shelf life of *tsire* and *balangu* may be the reason why both are price elastic.

Coefficients for cross price elasticity were mostly significant (p<0.01). Cross price effects for *tsire* and *balangu* were not significant. Almost all the coefficients for all the three products were negative except for *kilishi* and *balangu* which were positive. This means that all the processed products were complements except for *kilishi* and *balangu* which were substitute. The complementarity among the processed products is not surprising given that all are products of beef. An increase in the price of beef would result to increase in prices of the processed products concurrently and a subsequent decrease in demand of the products. Similarly, a decrease in beef price will lead to increase in demand of the products. *Kilishi* demand was more responsive to the price of *balangu* than *tsire* (both significant p<0.01). A percentage increase in price of *tsire* will decrease the demand for *kilishi* by about 1.3% and a percentage price increase in *balangu* will increase *kilishi* demand by 2.8%. Consumption of *tsire* is responsive to *kilishi* price by about 1.2% decrease and *balangu* demand is responsive to *kilishi* price by about 0.7% increase.

Coefficients for Hicksian own price were also consistent with economic theory. Among the processed products, *kilishi* had the least coefficient (0.0866) making it highly inelastic. This showed without considering the income effect, decrease in demand for *kilishi* was very small with increase in its own price. *Tsire* and *balangu* had similar price elasticity with their uncompensated elasticities. Both have elasticities greater than unity making them elastic. The results suggest that with and

without the income effect the demand for these products are affected by changes in their prices.

Compensated cross price elasticity had similar signs with the uncompensated elasticity. *Balangu* and *kilishi* were substitutes while all the other products were complements. All the cross price effects were significant ($p<0.01$) except for *tsire* and *balangu* relationship. This showed that ignoring the income effect, demand for *tsire* and *balangu* were irresponsive to changes in price of each other. The highest price response was between *kilishi* demand and *balangu* price.

The results for expenditure elasticity presented in Table 2 showed all elasticity coefficients were positive as *a priori* expected. This shows that all the *suya* products are normal goods. Increase in income would lead to increased expenditure on the products. *Kilishi* and *balangu* had elasticity coefficients greater than one making them luxury goods while *tsire* had elasticity of less than one (0.9439) making it a necessary good. *Tsire* had the least expenditure coefficient among the products. This is not surprising since *tsire* is the most popular processed beef product; it is even synonymous with the name *suya*. Consumers' high regard for this product in the study area could make them buy it no matter their income level. The expenditure elasticity showed consumers in Maiduguri regard *tsire* as the most important when considering their expenditure or income among the processed beef products, followed by *kilishi* then *balangu*.

Table 2: Estimates of Own Price, Cross Price and Expenditure Elasticity of Processed Beef Products

Elasticity	*Kilishi*	*Tsire*	*Balangu*
Uncompensated price elasticity	**-0.9755*** **	-1.189***	0.7296***
	(0.2119)	(0.1506)	(0.1517)
	-1.2559***	**-2.6837*** **	-0.484
	(0.3209)	**(0.5456)**	(0.5294)
	2.8269***	-2.186	**-3.8467*** **
	(0.7472)	(1.253)	**(1.3444)**
Compensated price elasticity	**-0.0866**	-0.8056***	0.8922***
	(0.2147)	(0.1427)	(0.1525)
	-1.8406***	**-2.4315*** **	-0.5909
	(0.3266)	**(0.5425)**	(0.5245)
	4.8128***	-1.3294	**-3.4834*** **
	(0.8271)	(1.236)	**(1.3389)**
Expenditure Elasticity	1.4349***	0.9439***	3.2058***
	(0.0698)	(0.2274)	(0.2921)

***, ** significant ($p<0.01$) and ($p<0.05$) respectively, figures in parentheses are standard errors
Source: Computed from Field Data, 2022

CONCLUSION AND RECOMMENDATION

Beef was considered a luxury good in Maiduguri and taking Marshallian price elasticity, change in demand for beef was the same as its price change and it is complements with mutton, chevon and camel. Beef demand was unresponsive to its price change and had a complementary relationship with mutton and substitute with chevon and camel by taking the Hicksian elasticity. For the processed products, *kilishi* and *balangu* were luxuries and *tsire* was a necessity. *Kilishi* had the same response to its price change, *tsire* and *balangu* were more responsive to their price change were all complements except for *kilishi* and *balangu* under the Marshallian elasticity. Taking the Hicksian elasticity, *kilishi* was irresponsive to its price change while *tsire* and *balangu* were responsive to their price change and all were complements except for *kilishi* and *balangu* as well. The study recommends that since most of the products studied were luxury goods and have elastic demand, policy measures geared at ensuring increased incomes such as employment creation which would concurrently increase purchasing power of consumers should be exploited.

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Cite this Article: Ghide, AA; Jaafar-Furo, MR; Tahir, AD; Danladi, H; Bada, MM (2024). Analysis of Demand within the Beef Value Chain in Maiduguri, Borno State, Nigeria. *Greener Journal of Agricultural Sciences*, 14(1): 50-57**.**