Farming Households Food Demand in South Western Nigeria: An Application of Substitution Elasticity Demand System (SEDS)

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Abstract

Food constitutes a key component of a number of fundamental welfare dimensions, such as food security, nutrition and health. It makes up the largest share of total household expenditure in low-income countries, accounting on average for about 50% of the households' budgets. Most demand analyses use existing models, but this study applied a new model- SEDS to analyse food demand among farming households in Southwest Nigeria.

A multi-stage sampling technique was employed study to select 342 respondents. Primary data was collected through the use of a structured questionnaire. Data collected include information on the number of different food groups consumed by households, socioeconomic characteristics, demographic factors and income. The analytical techniques used were descriptive analysis and the Substitution Elasticity Demand System (SEDS).

The results showed that the majority were male farmers who were mostly married and the average household size was 7 persons. The average age was about 50 years, cultivating an average farm size of 1.8 ha with a mean income of ₦73,637 per annum. The result of SEDS shows that own-price elasticities were less than 1 except for root and tuber, and fat and oil. It was found that cereals, legumes, fruit and vegetables and animal protein were price inelastic, i.e. necessities, and roots and tubers and fats and oils were price elastic, i.e. luxury goods.

The substitution effects of price were relatively strong, therefore government policy interventions should be on price regulation to avert considerable price repercussions in the economy.

Keywords: Food, Demand systems, Household, Elasticity and Substitution

Introduction

Food is one of the most basic necessities of life. Every human being needs a minimum amount of it for existence and a balanced diet to maintain sound health. However, where there are availability issues there is a great deal of deprivation and ignorance among the rural and even urban masses about a balanced diet. Normally this leads to various health problems, which ultimately affect the economic growth and prosperity of a country (Begum *et al.,* 2010; Colen *et al.*, 2018). Food constitutes a key component of a number of fundamental welfare dimensions, such as food security, nutrition and health. It makes up the largest share of total

household expenditure in low-income countries, accounting on average for about 50% of the households' budgets (Murcott *et al.*, 2013; Oteh *et al.*, 2014).

Food consumption pattern and behaviour differ across nations and cultures. In Nigeria, food consumption patterns have undergone remarkable changes over the last few years, specifically, there has been an increase in the consumption of starchy foods like cassava, yams, maize and rice and some decreases in the consumption of protein-based food items such as fish and meats (Oloyede, 2005). However, the nature and patterns of food expenditure also reflect the socio-economic characteristics of households. A household's relative expenditure on food is a reliable indicator of vulnerability, it describes the household's capacity to cope with price increases, as well as its ability to remain productive by investing in health services, education, and other productive assets for its members. Furthermore, spending in excess of 65% of households' total expenditure on food is a clear indication of households' vulnerability, which, in turn, forced them to choose between meeting their food and non-food needs or reduce consumption of one or both below their needs (Thirumarpan, 2013). Households have varying degrees of spending capacity which influences their spending patterns. According to Engel's law of expenditure in 1857, the proportion of expenditure spent on food is inversely related to total income (Adeniyi *et al.*, 2012). Drescher and Roosen (2013) further opined that food is important in household expenditure because of the amount of income dedicated to food. They further submitted that, for most households, spending on food is the largest expense followed by housing (rent, mortgage payments, opportunity cost or implied rent). However, for richer households, it comes second after housing expenditure. Households with less income tend to spend higher percentages of income on food and this leaves less for education, housing and transportation. In Nigeria, food consumption among households could be said to be poor. This is evident as most households in Nigeria are not able to provide for their food consumption needs as it was estimated in 2004 that over 40% of Nigeria's population is food insecure (Fasoranti, 2011) and about 52% of people in Nigeria live below the poverty line (Ahmed, Eugene and Abah, 2015). In March 2017 the Food and Agriculture Organization (FAO) declared that about 7.1 million people in Nigeria are facing acute food insecurity and in need of urgent life-saving and livelihood protection (Food and Agriculture Organization, 2017). Despite various policies, strategies and programmes on fine-tuning the food consumption pattern, the living standard is still below its potential (Ogundari *et al.*, 2015).

Whatever is consumed, which in turn provides energy and nourishes the human body for healthy living, is termed as food (Olorunfemi, 2013). The goal of food for meeting the needs

of man has two dimensions. These are food supply and food demand. The general consumer behaviour theory depicts demand functions are derived by assuming that the consumer maximizes his/her utility subject to a budget constraint. Study of demand in economics is aimed at describing the behaviour of consumers. This was actualized by Alfred Marshall in the 1930s and is still in use as a starting point for economic theory today (Marshall, 1948).

Effective food demand is equal to food consumption. Food consumption is a component of the food system at which people's nutritional needs are met at the individual or household level. Familiarity with modern consumption research requires understanding three fundamental models: Keynes' Absolute Income Hypothesis (AIH), Friedman's Permanent Income Hypothesis (PIH), and Modigliani's Life-Cycle Hypothesis (LCH). Although these were developed in the context of aggregate rather than microeconomic analysis, this study looked at the microeconomic analysis of the demand theory. Modern consumption research is however based on varying degrees on at least one of these approaches.

The concept of consumer demand refers to the variations in the quantities of a commodity that a consumer is expected to buy at specified (different) prices and time period, assuming that his income, prices of other (substitute) commodities, tastes and preferences, and all other factors remain constant. In mathematical form, according to Bektas *et al.* (2011),

$$Q_d = f\left(P^o, y, P^1, b, t, P\ , z\right) \quad \text{.....(1)}$$

Where,

$Q_d = quantity\ of\ com\,\text{mod}\,ity\ demand$

$P^o = price\ of\ the\ com\,\text{mod}\,ity$

$y = consumer's\ income$

$P^1 = prices\ of\ related\ com\,\text{mod}\,ities\ (substitute\ or\ complement)$

$b = tastes\ and\ preference$

$t = time\ period$

$P = population$

$z = other\ \ factors$

Demand theory suggests an inverse (negative) relationship between the quantities demanded of that product and its (own) price. The relationship is called a direct price effect, meaning that as the price of the commodity falls, the quantity demanded increases and as price increases, the quantity demanded will decrease with other factors remaining constant. Hence, equation (1) can be expressed, ceteris paribus, as

$$Q_d = f(p) \quad \text{.....(2)}$$

Relationships between the quantity demanded of one commodity and the prices of other commodities may be positive, negative or zero. This is called the cross-price effect. Relationships are expected to be positive for substitute products. For complementary products, the relationship is likely to be negative. That is an increase in the price of one commodity may lead to a decrease in demand for the other. The relationship is expected to be zero for independent products, meaning that the price of one product does not affect the demand for others. Also, predicted by economic theory is a direct relationship between the consumer's income and the quantity demanded of a product at any given price [q = f (y)]. That is, as consumer's income increases (y), demand (q) is expected to increase.

Many different factors may affect a product's elasticity of demand, but generally, it is true to say that essential goods have inelastic demand, while luxury goods have elastic demand. Since food is regarded as an essential good, human beings need food in order to live. Once we have enough food to satisfy our needs, we do not generally buy more food. So, consumers demand for food is income-elastic (Akinleye, 2007).

As consumers' incomes increase, the household spends their money on luxuries (such as holidays, manufactured goods etc.). The producers of these products, in turn, receive higher incomes. One other noticeable economic theory suggests that as the output, or supply of a product increases, its price falls. As the price of a product falls, normally consumers demand more of it. But the demand for food is price inelastic. No matter how far price falls, if we already have enough food, we are unlikely to buy more, but consumers will possibly substitute better quality food for inferior products as real income will have increased. In fact, any fall in the price of food effectively increases consumers' real disposable income, and they are likely to spend that money on more luxuries.

Methodological Review on Tools used in Analysing Demand

Demand for food and food-related products analysis is dominated by the econometric estimation of demand systems based on aggregate market data. The argument here is that the conceptualization of mainstream demand analysis has contributed to the fact that some important issues have been widely ignored in food demand analysis, but is crucial for understanding recent consumption trends (Herman and Roeder, 1998). The main methodological approaches used to analyse food demand are the use of simple Engel curves and the use of a demand system. Mathematical methods are used in the empirical measurement of demand. These methods involve the estimation of functional forms which is the most straight forward and convenient way in demand estimation. Most demand analyses

use existing models such as the Almost Ideal Demand System (AIDS) of Deaton and Muelbauer (1980), Translog Demand System (TDS), Transcendental Logarithmic Utility Function of Christensen *et. al.,* (1975), Generalized Leontief Demand System (GLDS), Linear Expenditure System (LES) proposed by Stone, Quadratic Expenditure System (QUES), Quadratic Almost Ideal Demand System (QU AIDS) of Banks *et. al.,* (1997) and more recently the Substitution Elasticity Demand System (SEDS) by Coloma, (2007). The rank of these demand systems is defined as the dimension of the space spanned by their Engel curves. Demand system ranking has many implications for aggregation, separability, empirical modelling and welfare analysis (Lewbel, 2004).

The substitution elasticity demand system (SEDS) was employed in this study to assess and analyze the food consumption behaviour of farming households in southwest Nigeria.

The concept of Elasticity of Substitution

The concept of elasticity of substitution, created by Allen (1938), measures the relative change in the ratio between the quantities of two goods consumed by a certain individual as a response to a relative change in the ratio of the prices of those goods. It is defined for a given level of the individual's utility, that is, for a situation where that individual is located at a certain indifference curve.

For two arbitrary goods i and j, consumed at quantities *Qi* and *Qj* and bought at prices *Pi* and *Pj* respectively, the elasticity of substitution between those goods (σ_{ij}) are defined following Allen (1938), as:

$$\sigma_{ij} = -\frac{d(Q_i / Q_j)/(Q_i / Q_j)}{d(P_i / P_j)/(P_i / P_j)} \quad \text{.....(3)}$$

As one of the basic implications of consumer theory, which holds for differentiable utility functions, is that price ratio is equated to marginal utility ratios, it is possible to write (3) in the following alternative form:

$$\sigma_{ij} = -\frac{d(Q_i / Q_j)/(Q_i / Q_j)}{d(U_i / U_j)/(U_i / U_j)} \quad \text{.....(4)}$$

where *Ui* and *Uj* are the marginal utilities of goods i and j evaluated at *Qi* and *Qj*. If the corresponding utility function is homogeneous, moreover, this equation can be transformed into the following expression:

$$\sigma_{ij} = -\frac{U_i \cdot U_j}{U \cdot U_{ij}} = -\frac{U_i \cdot U_j}{U \cdot U_{ji}} = \sigma_{ji} \quad \text{.....(5)}$$

Where *Uij = Uji* is the symmetric second derivative of the utility function with respect to *Qi* and *Qj*, *U* is the utility derived from substituting Q_i for Q_j or vice versa. As we can see in (5), the elasticity of substitution is asymmetric concept, which is the same whether we are measuring the substitution of good i for good j or the substitution of good j for good i.

The elasticity of substitution between goods i and j can also be related to the cross elasticities of demand for those goods. Consider, for example, the Hicksian demand elasticity of good i with respect to good j (ε_{ij}), which is defined for a given level of utility. It can be shown that:

$$\varepsilon_{ij} = \frac{\partial Q_i}{\partial P_j} \cdot \frac{P_j}{Q_i} = \sigma_{ij} \cdot s_j \quad \text{.....(6)}$$

where *sj* is the share of good j in consumer's total expenditure. But as the Hicksian demand elasticity and the ordinary, or Marshallian, demand elasticity (η_{ij}) are related in the following way by the "Slutsky equation":

$$\eta_{ij} = \varepsilon_{ij} - \eta_{iY} \cdot s_j \quad \text{.....(7)}$$

where η_{iY} is the income elasticity of good i, then we can combine (6) and (7) to obtain the following alternative expression:

$$\eta_{ij} = s_j \cdot (\sigma_{ij} - \eta_{iY}) \quad \text{..... (8)}$$

As we will see, this formula will be useful to estimate a particular class of demand systems, where elasticities of substitution will be related among them.

The Substitution Elasticity Demand System

Defining a system of N demands, each of which has the following form:

$$\ln(Q_i) = \alpha_i + \eta_{ij} \cdot \ln(P_i) + \sum_{j \neq i} \eta_{ij} \cdot \ln(P_j) + \eta_{iY} \cdot \ln(Y) \quad \text{.....(9)}$$

where *Y* is the consumer's income. Due to the logarithmic nature of the model, its coefficients are Marshallian demand elasticities.

Substituting (7) into (9), we obtain:

$$\ln(Q_i) = \alpha_i + \eta_{ii} \cdot \ln(P_i) + \sum_{j \neq i} \sigma_{ij} \cdot s_j \cdot \ln(P_j) + \eta_{iY} \cdot \left[\ln(Y) - \sum_{j \neq i} s_j \cdot \ln(P_j) \right] \quad \text{.....(10)}$$

Recall that Marshallian demands are homogeneous of degree zero in prices and income, and write the corresponding restriction in elasticity form:

$$\eta_{iY} = -\eta_{ii} - \sum_{j \neq i} \eta_{ij} \quad \text{..... (11)}$$

Substituting (7) into (10), this implies:

$$\eta_{iY} = \frac{-\eta_{ii} - \sum_{j \neq i} s_j \cdot \sigma_{ij}}{s_j} \quad \text{..... (12)}$$

which, replaced into (9), generates "substitution elasticity demand system" (SEDS).

The system of N equations defined in SEDS is a linear system whose coefficients are the own-price Marshallian demand elasticities and the elasticities of substitution between goods.

Research methodology

Study Area

Southwestern Nigeria represents an agricultural zone spreading between Lat. 5^{o} and 9^{o} N and has a land area of 114,271 km^{2} representing 12% of the country's landmass. The agricultural Southwestern Nigeria zone comprises of 8 States namely Delta, Edo, Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo States (State Agricultural Zones) (Agricultural Research Council of Nigeria (www.arcnigeria.org); Research Extension Farmers Input Linkage System Workshop Report, 2016). It has a total population of about 27,581,992 (NPC, 2006). The zone is characterized by a typical equatorial climate with distinct dry and wet seasons. The main growing season lasts up to 9 months with two peaks of rainfall in July and September. Rainfall ranges between 1200mm in the northern areas of Ondo, Oyo and Osun States to nearly 2600mm in the coastal areas of Lagos and Ogun States. Average zonal rainfall is 1480mm with a monthly temperature range of 18^{o}-24^{o}C during the rainy season and 30^{o}-35^{o}C during the dry season.

Source of Data Collection

Primary data were used for this study. They were collected through the use of a structured questionnaire. Data collected include households' expenditure on selected food items, socioeconomic characteristics, demographic factors and income of crop farmers. The major foods items consumed in Nigeria include maize, rice, beans, cassava, yam, plantain, vegetable/oil and meat/fish. However, information on the number of different food groups consumed was gathered rather than the number of different foods. Knowing that households consume, for example, an average of four different food groups implies that their diets offer some diversity in both macro- and micronutrients. This is a more meaningful indicator than knowing that households consume four different foods, which might all be cereals. The U.N.

Food and Agriculture Organization (FAO) classification as adapted by Obayelu (2008), Hadijah *et al.,* (2016) and the modified classification was used in the study (Table 1).

Table 1: Components of each of the Selected Food Group

Food group	Composition
Tuber and root crops	Cassava tuber and other products (cassava flour, chips and Gari), yam tuber and other products (flour and chips), sweet potato, Irish potato, cocoyam
Cereal	Fresh maize, dry maize grain, maize flour, sorghum, rice, wheat grain and flour
Legume	Beans, soybean, groundnut
Fruit and vegetable	Banana, plantain, orange, mango, pawpaw, pineapple, apple, coconut, guava, chochorous, bitter leaf, pepper, onion, okra, tomato and eggplant
Animal protein	Beef, mutton, goat meat, pork, bush meat, chicken, fish (dry, fresh), crayfish, turkey and snail
Fats and oil	Palm oil and groundnut oil.

Source: Adapted from Obayelu (2008), Hadijah *et al.,* (2016). Modified by Egbetokun (2018).

Sample Size and Sampling Procedure

The total sample size of respondents interviewed is given by Bowley's (1977) proportion sample formula:

$$S_{total} = \frac{N}{1 + N(e^2)} \quad \text{..... (13)}$$

Where:

S_{total} = Total sample size of all respondents

N = Total population of farming household in the Southwest Agricultural Zone.

e = Level of significance (Confidence Interval that is 95%)

The total farming household in Southwestern Nigeria is estimated as 1,788,384 (REFILS Workshop Report, 2016). Assuming a 95% confidence interval, equation (13) gives a total sample size of 400 for the study that is

$$\overline{1+1,788,384(0.05)^2} = 400 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

The sample size in each of the States is however determined by probability proportional to size given by

$$S_{state} = \frac{P_i}{P_t} n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(15)$$

Where:

S_{State} = Sample size for a State *i*

P_i = Population of farming households in State *i*

P_t = Total population of farming households in the selected States

n = the total sample size for the Study obtained above.

In view of the objectives of the study, household-level data were collected from a survey of Southwestern agricultural zones of Nigeria. A multi-stage sampling technique was employed in the study. The first stage was the simple random sampling of three States in southwestern Nigeria. Here, Edo, Ondo and Oyo States were selected. The second stage was a random sampling of six Local Government Areas (LGAs) that are agricultural from the selected states. Third and the last stage was proportionate to size sampling of households in the selected LGA. In all, a total number of 400 households were selected and questionnaires were administered, however, due to inadequate information given by the respondents 342 were found useful for analysis. Households were sampled from selected households using probability proportionate to the size of the population.

Substitution Elasticity Demand System (SEDS) Model

Substitution Elasticity Demand System (SEDS) is a system whose coefficients are the own-price Marshallian demand elasticities and the elasticities of substitution between goods. The functional form of the model is given as:

$$\ln Q_i = \alpha_i + \eta_{ii} \cdot \left[\ln P_i - \frac{\ln Y - \sum_{j \neq i} S_j . \ln P_j}{S_i} \right] + \sum_{j \neq i} \sigma_{ij} . S_j \cdot \left[\ln P_j - \frac{\ln Y - \sum_{j \neq i} S_j . \ln P_j}{S_i} \right] \ldots\ldots\ldots (16)$$

Where:

$Q_i = quantiy\ of\ demand\ of\ good\ i$

$Y = income\ of\ respondents$

$P_j = price\ of\ good\ j$

$S_j = market\ share\ of\ commodity\ j$

$\eta_{ii} = income\ elasticity\ of\ commodity\ i$

$S_i = market\ share\ of\ commodity\ i$

$\sigma_{ij} = elasticity\ of\ substitution$

Since the price elasticities of substitution are symmetric (that is $\sigma_{ij} = \sigma_{ji}$), this model displays the symmetry property, together with the homogeneity property. The homogeneity property is given by

$$\eta_{iY} = -\eta_{ii} - \sum_{j \neq i} \eta_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

$Where$

$\eta_{iY} = income\ elasticity$

$\eta_{ii} = income\ elasticityofcommod\ i\ tyi$

$\eta_{ij} = incomeelasticityofcommod\ i\ tyj$

The inclusion of the homogeneity and symmetry restrictions in the model reduces the number of elasticity coefficients from N (N+1) to N + N (N-1)/2. Adding-up restriction of consumer theory is also incorporated into the model. In order to do this, restrictions are written in a way that relates Marshallian own-price elasticities and cross-price elasticities. The main advantage of SEDS over other models of demand system such as the ranked- three demand model QUAIDS proposed by Banks *et al.* (1997); and ranked-two demand model AIDS of Deaton and Muellbauer (1980), is the fact that the main coefficients are direct estimates of different elasticity concepts (own-price and substitution elasticities). This allows for straight forward interpretation of its results, which does not occur when using other models.

Results and Discussion

Socio-economic characteristics of the respondents

Appendix 1 shows that a larger percentage of the head of farming households was male (78.95%). This shows male farmers are still dominating the production activities on the farm. The mean age was 50.8±16.8 years and 69.01% of the respondents fell within the age bracket of 41-50 years. This shows that the majority of farmers are at the peak of their productive years. The result also reveals that 88.89% of the respondents were married. The average

household size in the study area was 7.0±2.78 while larger proportion (76.6%) of the respondents has a household size of between 4 and 9 members. This implies that more members of the household could serve as family labour as household size increases. In line with the result of this study, Cazzuffi *et al.,* (2010) found out in their study that 89% of the agrarian household has a large household size.

Moreover, many (38.3%) of the respondents had primary school education while 31.29% had secondary school education. The average farm size in the study area is 1.8±1.72 ha. This shows that food production in Nigeria is still in the hands of small-scale farmers. The farmers in the area cultivate small farm sizes as 56.43% of the respondents have farm size between 0.5 and 1.4 hectares which represents the highest followed by farm sizes between 1.5 and 2.4 hectares. Farmers who are members of the farmers' group or association make up 54.5% of the farming population, while a significant proportion of the respondents (75.7%) has access to extension services. This implies that extension workers have a significant impact on improving expenditure on the food of farming households through the dissemination of best consumption pattern. The total income per annum is ₦73, 637.13±14.6, which indicates that returns per annum are low. This, in turn, implies if farmers do not engage in off-farm work, what they get in a cropping season is not an adequate income. The distance to the nearest market is 7.7±9.1. This means that farmers would need to cover a long distance which implies an additional cost to food bought for consumption in the market.

Analysis and Description of Substitution among Food Groups in the Study Area

Substitution elasticity demand system (SEDS) whose coefficients are own-price Marshallian elasticities and elasticities of substitution between goods was used in this study. The model satisfies the homogeneity, symmetry and adding-up restrictions implied by consumer theory.

Food Demand Elasticities among Farming Households in Southwest Nigeria

The Marshallian elasticities of food groups obtained in this study have the correct signs and are consistent with past studies (Wang and Zivkovic, 2018; Coloma, 2007). All own price elasticities were less than 1 except root and tuber, and fat and oil as shown in Table 3. This indicated that all foods were price inelastic (necessity) except root and tuber and, fat and oil.

Table 3: SEDS Estimation Results

Food groups	**Coefficient**	**Std. error**	**t-statistic**	**Probability**
Own-price elasticities				
Root and tuber (η_{rt})	-1.3613***	0.1493	-9.11	0.000

Cereals (η_c)	-0.7135***	0.1207	-5.91	0.000
Legumes (η_l)	-0.6616***	0.1653	-4.00	0.000
Fruits and vegetables (η_f)	-0.5390***	0.0597	-9.03	0.000
Animal protein (η_{ap})	-0.4712***	0.0661	-7.13	0.000
Fats and oil (η_{fat})	-1.2406***	0.3643	-3.41	0.003
Substitution elasticities				
R&tuber/cereals($\sigma_{rt/c}$)	0.1742***	0.0459	3.79	0.000
R&tuber/legumes($\sigma_{rt/l}$)	0.0531	0.0643	0.78	0.434
R&tuber/fruits($\sigma_{rt/f}$)	0.4338***	0.0505	8.58	0.000
R&tuber/animal protein($\sigma_{rt/ap}$)	0.3340***	0.0589	5.67	0.000
R&tuber/fats($\sigma_{rt/fat}$)	-0.2097***	0.0567	-3.69	0.000
Cereals/r&tuber($\sigma_{c/rt}$)	0.3234***	0.8531	3.79	0.000
Cereals/legumes($\sigma_{c/l}$)	-0.0568	0.8844	-0.064	0.052
Cereals/fruits($\sigma_{c/f}$)	0.3379***	0.0745	4.53	0.000
Cereals/animal protein($\sigma_{c/ap}$)	0.4721***	0.0814	5.80	0.000
Cereals/fats($\sigma_{c/fat}$)	-0.2295***	0.0774	-2.96	0.003
Legumes/r&tuber($\sigma_{l/rt}$)	0.0522	0.6681	0.78	0.434
Legumes/cereals($\sigma_{l/c}$)	-0.0318	0.0494	-0.64	0.520
Legumes/fruits($\sigma_{l/f}$)	0.1652***	0.0567	2.91	0.004
Legumes/animal protein($\sigma_{l/ap}$)	0.2650***	0.0612	4.32	0.000
Legumes/fats($\sigma_{l/fat}$)	-0.4134***	0.0522	7.91	0.000
Fruits/r&tuber($\sigma_{f/rt}$)	0.5725***	0.0667	8.58	0.000
Fruits/cereals($\sigma_{f/c}$)	0.2403***	0.0530	4.53	0.000
Fruits/legumes($\sigma_{f/l}$)	0.2099***	0.0721	2.91	0.004
Fruits/animal protein($\sigma_{f/ap}$)	-0.0141	0.0715	-0.20	0.843
Fruits/fats($\sigma_{f/fat}$)	0.2812***	0.0630	4.46	0.000
Animal Protein/r&tuber($\sigma_{p/rt}$)	0.3597***	0.0635	5.67	0.000
Animal Protein/cereals($\sigma_{ap/c}$)	0.2740***	0.0472	5.80	0.000
Animal	0.2748***	0.0635	4.32	0.000

Protein/legumes($\sigma_{ap/l}$)				
Animal Protein/fruits($\sigma_{ap/f}$)	-0.0115	0.0583	-0.20	0.843
Animal Protein/fats($\sigma_{ap/fat}$)	0.3169***	0.0554	5.72	0.000
Fats/r&tuber($\sigma_{fat/rt}$)	-0.2811***	0.0760	-3.69	0.000
Fats/cereals($\sigma_{fat/c}$)	-0.1658***	0.0559	-2.96	0.003
Fats/legumes($\sigma_{fat/l}$)	0.5336***	0.0675	7.91	0.000
Fats/fruit($\sigma_{fat/fr}$)	0.2857***	0.0640	4.46	0.000
Fats/animal protein($\sigma_{fats/ap}$)	0.3944***	0.0690	5.72	0.000

*** Significant at 1% level.
Source: Data analysis, 2018

The result was slightly different from the findings of Obayelu (2008) whereby the own price of only root and tuber were elastic. The own-price elasticity of animal protein was the smallest in absolute terms, indicating that animal protein was the least sensitive to changes in its own price. This is due to the fact that animal protein is not always consumed by households in the study area. On the other hand, an increase in household's total expenditure would be accompanied by an increase in expenditure on root and tuber, and fat and oil with a higher than proportionate increase in total expenditure. This implies that an increase in average total household expenditure would lead to an increase in demand for root and tuber, and fat and oil by a higher extent.

Table 3 further revealed that root and tuber only complement fat and oil (-0.21) but substituted for cereals (0.17), fruits/vegetables (0.43) and animal protein (0.33). This implies that the demand for cereals, fruit/vegetables and animal protein are low in the study area. The reason could be the high prices of cereals and animal protein and seasonality in the production of fruit/vegetables. The result slightly differs from the findings of Maluleke, (2018), who reported high demand in carbohydrate and animal protein while other food groups are less in demand in South Africa. Cereals complemented with fat and oil (-0.23) but substituted for fruits/vegetables (0.34) and animal protein (0.47). This result is in line with the findings of Ulubasoglu *et al.,* (2015) on food demand elasticities for Australia. Legume complemented with cereals (-0.03) and fat and oil (-0.41) but substituted for fruit and vegetable (0.17) and animal protein (0.27). It is also revealed that fruit and vegetable

substituted for root and tuber (0.57), cereals (0.24), legume (0.21) and fat and oil (0.28). Also, animal protein substituted for root and tuber (0.36), cereals (0.27), legumes (0.27) and fat and oil (0.32). In addition, fat and oil complemented with root and tuber (-0.28) and cereals (-0.17) but substituted for legumes (0.53), fruit and vegetable (0.29) and animal protein (0.39).

Generally, fruit/vegetables and animal protein are in low demand in the study area. This is because the prices of the two food groups are high and many of the farming households could not afford it. In addition, the seasonality of fruit/vegetable production could be a limiting factor to its substitute nature. The result is in line with the findings of Abeshu, Lelisa and Geleta (2016) in a study conducted on complementary feeding in Ethiopia.

Conclusion

Estimated results of the households' food demand and substitution in the study area using SEDS model shows that cereals (-0.71), legume (-0.66), fruit and vegetables (-0.54), animal protein (-0.47) were price inelastic and root and tuber (-1.36), fat and oil (-1.24) were price elastic. Own-price elasticities show that all food items are price inelastic except root and tuber and, fat and oil. In the study, cereals, legume, fruit and vegetables, animal protein were price inelastic indicating that they are all necessity while on the contrary root and tuber, and fat and oil were price elastic for which they could be considered as a luxury.

The food sector production policy should, therefore, be based on the demand-supply balance in the market. The substitution effects of price were quite strong therefore, government policy interventions should be on price regulation to avert considerable price repercussions in the economy.

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Appendix: Socio-economic characteristics of the respondents

Variables		**Frequency**	**Percentage**
Gender	Male	270	78.95
	Female	72	21.05
Age	< 30	7	2.05
	31-40	45	13.15
	41-50	236	69.01
	51-60	47	13.74
	61 and above	7	2.05
	Mean (50.8 ± 16.8**)**		
Household size	1-3 members	17	4.98
	4-6 members	152	44.44
	7-9 members	110	32.16
	10-12 members	49	14.33
	12 and above	14	4.09
	Mean (7 ± 2.78)		
Level of education	No formal edu.	49	14.33
	Pri. sch.	131	38.30
	Sec. sch.	107	31.29
	Tertiary	55	16.08

Source: Data analysis, 2018

Appendix cont'd: Socio-economic characteristics of the respondents

Marital status	single	8	2.34
	married	304	88.89
	widow	22	6.43
	Divorced/sep.	8	2.34
Farm size	0.5-1.4	193	56.43
	1.5-2.4	77	22.51
	2.5-3.4	45	13.16
	Above 3.5	27	7.89
	Mean (1.8 ± 1.72)		
Membership of farmers' group	Yes	184	54.45
	No	154	45.55
Access to extension service	Yes	259	75.73
	No	83	24.27
Total income			
	<30000	82	24.0
	31000 - 60000	136	39.8
	61000 – 90000	27	7.9
	91000 and above	97	28.4
	Mean (73637.13 ± 14.57)		
Distance to market	<2	122	35.7
	2.1 – 4	71	20.8
	4.1 – 6	76	22.2
	6.1 and above	73	21.3
	Mean (7.68 ± 6.63)		

Source: Data analysis, 2018

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