Agricultural Socio-Economics Journal
Volume 23, Number 2 (2023): 239-248

P-ISSN: 1421-1425
E-ISSN: 2252-6757

ANALYZING HOUSEHOLD DEMAND FOR ANIMAL FOOD AS A SOURCE OF PROTEIN: THE CASE OF RURAL GORONTALO PROVINCE, INDONESIA

Nikmatul Khoiriyah[1*], Hadi Apriliawan[1], David Forgenie[2]

[1]Department of Agribusiness, Faculty of Agriculture, University of Islam Malang, Indonesia
[2]Department of Agricultural Economics and Extension, Faculty of Food and Agriculture, The University of the West Indies, Trinidad

*corresponding author: nikmatul@unisma.ac.id

Abstract Animal foods are a major source of protein for households. Gorontalo Province has a lot of potential for marine fishery development, despite being one of the provinces where families consume less protein than the national protein sufficiency rate. This article investigates the household elasticity of demand for animal food in the context of increasing prices and incomes. The Quadratic Almost Ideal Demand System is used in to estimate the share equations from which reliable price and income elasticities can be derived. The article utilizes secondary data from the National Socio-Economic Survey for March 2021, which includes consumption and household expenditure information on all animal protein-containing meals, 4,811 households make up the study's sample. All animal foods, except for eggs, were found to be highly price elastic. The most elastic food is beef, which has a demand elasticity of 3.829%, followed by chicken meat (3.13%), fish (2.345%), milk (1.311%), and eggs (0.846 percent). Eggs were discovered to be price inelastic. Except for eggs, all animal products are considered luxury goods as indicated by income elasticity estimates. Beef has the highest income elasticity (3.181%), followed by chicken (2.957%), fish (1.674%), and milk (1.574 percent). Eggs are normal items because their income elasticity is the lowest at 0.589 percent. This finding confirms that for households in rural Gorontalo, price policy is more effective than income policy.

Keywords: *food demand system, elasticity, rural, QUAIDS, Gorontalo*

http://dx.doi.org/10.21776/ub.agrise.2023.023.2.13

Received 7 Match 2023
Accepted 20 April 2023
Available online 30 April 2023

INTRODUCTION

One measure of a country's household wellbeing is food sufficiency. The elimination of hunger and poverty, are two of the core mandates of the Sustainable Development Goals (SDGs) which can be achieved by household food sufficiency (Agarwal, 2018; Andrianarison, 2022; Chaudhary & Hanif, 2022; Khanal et al., 2021). Food includes common foods like food as a source of carbohydrates, food as a source of protein, food as a source of fat, and other foods. According to data from the Central Statistics Agency for the years 2015 to 2021, household income has a direct correlation with the proportion of money spent on protein, fruit and vegetable foods, and ready-to-drink food, whereas grain food expenditures are on the decline (Khoiriyah et al., 2020, Anindita et al., 2020). On the other hand, when household income is lower, grains make up the highest portion of expenditures.

Over the past five years, both globally and in Indonesia, there has been a growth in the demand for

CITATION: Khoiriyah, N., Apriliawan, H., Forgenie, D., (2023) ANALYZING HOUSEHOLD DEMAND FOR ANIMAL FOOD AS A SOURCE OF PROTEIN: THE CASE OF RURAL GORONTALO PROVINCE, INDONESIA, Agricultural Socio-Economics Journal, 23(2), 239-248 DOI: http://dx.doi.org/10.21776/ub.agrise.2023.023.2.13

foods and drinks that are ready to eat. According to statistics from the Indonesian Agricultural Socio-Economic Survey (SUSENAS), the Central Bureau of Statistics (BPS), the share of household expenditure on prepared meals and beverages is second only to cereals. In 2016, the share of household spending on food and beverages was close to around 20%, while the share of spending on grains was 21.6% (Nikmatul et al., 2020). According to the most recent BPS statistics, households in Indonesia would spend 31.7% of their household income on food and beverages in 2021, with urban areas spending 35.6% and rural areas 25.5%. While this was happening, Indonesia's share of grain spending fell to 11.2%, urban families' share to 9.6%, and rural households' share to 13.9% (BPS, 2022).

In 2021, household consumption of fish, shrimp, squid, and scallops is expected to be consistent, where the proportion of income is around 9.0% in urban areas, 8.7% in rural areas, and 8.3% in Indonesia. The fact that the share of food and beverage spending has climbed significantly, particularly in Indonesian urban households, to reach 35.6%, is a highly fascinating development. When looking specifically at animal food sources, it can be noted that in Indonesia the monthly average consumption per capita of fresh fish and shrimp, beef, broiler/local chicken meat, tofu, and tempeh between March 2017-2021, the source of protein food for households in Indonesia is dominated by fresh fish and shrimp and continues to suggest upward trend in consumption in the future. Consumption of animal protein is greater than that of vegetable protein, namely tofu and tempeh. The second source of protein is tofu, tempeh, purebred/village chicken and the last is beef. In 2017 to 2020, the consumption of tofu and tempeh tends to decrease but increases in 2021. In 2021 this is a special year due to the Covid 19 Pandemic. A quite interesting phenomenon is the consumption of purebred/village chicken meat, which tends to increase in 2017- 2020 but decreased in the year of the Covid 19 Pandemic. From this data it can be temporarily concluded that during the Covid 19 period there was a substitution of consumption from purebred/village chicken meat to the consumption of tofu or tempeh. This can be explained that during the Covid-19 pandemic there was an increase in the price of chicken which resulted in the household's purchasing power falling and in the end the household replaced the consumption of chicken meat with tofu or tempeh as shown in Figure 2 that there was a decrease in the group of broiler/village chicken meat from 0.557 in 2020 to 0.538 in 2021, while tofu and tempeh have increased. In tofu, household consumption is 0.654 in 2020 and increases to 0.675 in 2021. In tempeh protein food, there is also an increase in consumption, from 0.559 in 2020 to 0.624 in 2021. In Indonesia, the most expensive protein food is beef, then chicken, and eggs. Vegetable protein food prices are much cheaper than animal protein. Likewise, the price of tofu and tempeh is much cheaper than chicken. So, it can be concluded that during the Covid 19 pandemic, households in Indonesia consumed animal protein decreased and were replaced by consuming tofu and tempeh. Thus, the COVID-19 pandemic has reduced household purchasing power for beef or chicken.

In Indonesia, tofu and tempeh as a source of vegetable protein have a higher consumption participation rate than food sources of animal protein such as meat or fish. The participation rate of consumption of tempeh is 76.3% and tofu is 74.9%, while chicken meat is 52.5% and tuna/tuna is 22.5%. Meanwhile, the consumption participation rate for other commodities such as vegetables is relatively high, namely kale (50.1%) and spinach (46.9%), for fruits, namely oranges/grapefruit (30.7%) and papaya (22.4%). These vegetables and fruits are widely consumed by households because they are widely available in the local market and at affordable prices (BPS, 2022).

Consumption is the reduction or expenditure of goods and services in order to meet daily necessities. Consumption is defined by (Dosi et al., 2022; Efendioğku, 2022; Husain et al., 2022; Yildirim, 2022) as the use of products and services to satisfy human needs (the use of goods and services in the satisfaction of human wants). There are both durable and non-durable goods among the goods. Non-durable items include food and clothing, while durable products include automobiles and equipment. Services include intangible things such as haircuts and health care. Education expenditures are also included as consumption of services (Bachmann et al., 2022; Parker et al., 2022; Scheier & Kittner, 2022; Wang & Cheng, 2022). According to (Hayat et al., 2022) there are three approaches to represent the level of consumption: (1) based on the type and quantity of goods and services used by families, (2) based on the grouping of commodity use, and (3) based on the value of commodities consumed.

There are two categories of food-related household expenditures: food and non-food. Among conditions of limited income, food demands are

prioritized, so that in low-income groups it is seen that most of their income is spent to buy food. Along with a rise in income, there will be a change in spending patterns, specifically a drop in the proportion of income spent on food and an increase in the proportion of money spent on non-food items (BKP, 2010). The proportion of food expenditures is one indication of food security; as the proportion of food expenditures increases, food security declines. Less of a region's expenditures are allocated to food, the more prosperous its inhabitants (Deaton & Muellbauer, 1986). Engle's law asserts that if tastes do not alter, the proportion of income spent on food will drop as income rises (Sulaiman et al., 2019; Wu et al., 1995). This generalization connects the proportion of food expenses to income. This problem is caused by the fact that food is a fundamental requirement that grows more slowly than income. Achieving food security is one aspect of the framework for sustainable development goals (SDGs) in addition to reducing hunger and supporting sustainable agriculture. The government considers food security as a national development through adopting legislation and regulations to support the 2030 goals.

In accordance with Presidential Regulation Number 59 of 2017 on the Implementation of the Sustainable Development Goals and Government Regulation Number 17 of 2015 on Food Security and Nutrition, the average monthly consumption expenditure per capita is 1,264,950 rupiah. In comparison to this number, fifteen provinces have average expenditures that exceed the national average. DKI Jakarta had the greatest expenditures at 2,336,429 rupiah, while East Nusa Tenggara Province had the lowest at 840,357 rupiah (BPS, 2021). Food accounts for 49.3% of the average monthly expenditures per capita, while non-food expenses account for 50.75 percent. This immediately means that the food expenditure share at the national level is 49.3%. The fact that the share of food expenditures is less than 50% suggests that the share of non-food expenditures for the Indonesian population is slightly greater than the share of food expenditures. Rural areas with a 56.2% of food expenditures tend to have less food security than urban areas with a 43.8% percent share of food expenditures. Papua is the province with the highest proportion of food expenditures, at 57.9%, while DKI Jakarta Province has the lowest proportion, at 39.5%. In addition to Riau Islands, Banten, West Java, Central Java, DI Yogyakarta, Bali, East Kalimantan, North Kalimantan, Central Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, Maluku, North Maluku, and West Papua Provinces, which have a share of food expenditure below 50 percent, DKI Jakarta Province is the province with the highest level of food security in Indonesia (BPS, 2021).

The percentage of food expenditures is the ratio of food expenditures to the total monthly expenditures of a population. Gorontalo Province has the lowest share of food expenditures on the island of Sulawesi, at 46.2%, while West Sulawesi Province has the greatest share, at 50.8%. In the easternmost region of Indonesia, which includes the Maluku and Papua islands, Maluku Province has the lowest proportion of food expenditures at 48.2%, while Papua Province has the largest proportion at 57.9%.

Average Monthly Expenditure per Capita by Commodity Group and Residential Area (rupiahs), March 2021 in Indonesia for the fish/shrimp/squid/shells category, the number is 54,559 in urban regions, 47,505 in rural areas, and 51,514 at the national level. For the meat group (Meat), the urban population is 34,129, the rural population is 23,499, and the national population is 29,539. The Eggs and milk category has a population of 42,111 in urban areas, 26,200 in rural areas, and 35,241 nationally.

Fish/shrimp/common squid/shells is the primary source of protein for households, particularly in rural Gorontalo, with a consumption and expenditure of 78,326 in urban areas, 66,656 in rural regions, and 71,763 in provinces. For the meat category (meat), the urban rate is 16,839, the rural rate is 11,236 and the provincial rate is 13,688, whereas the urban rate for eggs and milk is 37,595, the rural rate is 20,318 and the provincial rate is 27,879.

Numerous countries have conducted research on the food demand system utilizing the AIDS or QUAIDS methodology, including Nigeria (Elijah Obayelu et al., 2009), Saudi Arabia (Al-Shuaibi, 2011), China (Asadoorian et al., 2008; Bai et al., 2020; Wu et al., 1995), Malaysia (Bharumshah & Mohamed, 1993; Norimah et al., 2008), as well as in Indonesia (Nendissa et al., 2021, 2021; Nikmatul et al., 2020; Sa'diyah et al., 2019). It can be established that price and income have an effect on protein consumption. This study seeks to determine the consumption pattern of protein-rich foods in rural Gorontalo, given that the province is a rich source of marine resources. Is fish sufficient to supply the protein demands of rural Gorontalo households? The model strategy employs QUAIDS. The research data utilize BPS-collected SUSENAS March 2021

data. In order for households to consume protein in accordance with the national protein adequacy rate, it is anticipated that the research results will be useful in formulating price and income regulations.

1. Methods: Quadratic Almost Ideal Demand System (QUAIDS) Approach

In the past two decades, the AIDS model has been the most used technique for demand analysis (Dosi et al., 2022; Efendioğku, 2022; Husain et al., 2022; Yildirim, 2022). Among the demand features of the AIDS model are checking for symmetry and homogeneity using restrictions imposed on the parameters during estimation. Banks et al., (1997) expanded the AIDS model by demonstrating that, unlike the linear form in the original AIDS, the correct form for some consumer preferences is quadratic. In addition, the QUAIDS model keeps the demand characteristics and theoretical consistency of the AIDS model. Formally, the share equations of the QUAIDS model Banks et al., (1997) are as follows:

$$\boldsymbol{w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} ln p_j + \beta_1 ln\left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{ln\left[\frac{m}{a(p)}\right]\right\}^2 + \varepsilon_i} \quad (1)$$

Where $\boldsymbol{w_i}$ represents a household's expenditure share on good i, and is defined as follows:

$$\boldsymbol{w_i \equiv \frac{p_i q_i}{m} and \sum_{i=1}^{n} w_i = 1} \quad (2)$$

On the other hand, the demand theory requires the following restrictions:

- Adding-up: $\boldsymbol{\sum_{i=1}^{n} \alpha_1 = 1, \sum_{i=1}^{n} \beta_1 = 0, \sum_{i=1}^{n} y_{ij} = 0, \sum_{i=1}^{n} \lambda_i = 0,}$ (3)
- Homogeneity: $\boldsymbol{\sum_{i=1}^{n} y_{ji} = 0}$ (4)
- Slutsky symmetry: $\boldsymbol{\gamma_{ji} = \gamma_{ij}}$ (5)

Using the QUAIDS model, the socio-demographic (z) impacts on the demand for animal products were analyzed in this study (Alboghdady & Alashry, 2010) (Tefera et al., 2018) found that demographic factors can influence how households behave in terms of demand and how they distribute their funds among various items. In this study, demographic scaling was employed as a way of consideration. In this study, demographic scaling was employed as a way of consideration. It relates to Poi, (2012). This strategy restricts the effects of a change in demographics to those of a change in the cost of animal foods.

In the simplest situation, considering z as a vector of S household attributes, z is a scalar indicating the household size. Let $\boldsymbol{e^R(p,u)}$ reflect the expenditure pattern of a reference home with only adults. Ray's method applies a function of household variable expenditures to each family without adjusting for changes in consumption behavior. The second term regulates differences in the consumption of current products and relative price changes.

Following the QUAIDS parameterized $\boldsymbol{\overline{m_o}(z)}$ as

$$\boldsymbol{\overline{m_o}(z) = 1 + \rho z} \quad (6)$$

Where ρ is a vector containing the parameters to estimate. Following is the form of the spending share expenditure equation:

$$\boldsymbol{w_i = \alpha_i + \sum_{j=1}^{K} \gamma_{ij} ln p_j + (\beta_i + \acute{\eta}_i z) ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\} + \frac{\lambda_i}{b(p)c(p,z)}\left[ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]^2} \quad (7)$$

Where $\boldsymbol{c(p,z) = \prod_{j=1}^{K} \rho_j^{n_{iz}}}$ (8)

The condition for adding-up is $\boldsymbol{\sum_{j=1}^{K} \eta_{rj} = 0}$ for $\boldsymbol{r = 1, \dots, s}$. (9)

Two demographic variables were included in this study: area (urban and rural) and household size (HH size). The uncompensated (Marshallian) price elasticity for the animal product group $\boldsymbol{i}$ with respect to variations for animal product group good $\boldsymbol{j}$ is:

$$\boldsymbol{\varepsilon_{ij} = -\delta_{ij} + \frac{1}{w_i}\left(\gamma_{ij}\left[\beta_i + \acute{\eta}_i z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right] * \left(\alpha_j + \sum_1 \gamma_{ij} ln p_j\right) - \frac{(\beta_i + \acute{\eta}_i z)\lambda_i}{b(p)c(p,z)}\left[ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]^2\right)} \quad (10)$$

The expenditure (income) elasticity for the animal product group $\boldsymbol{i}$ is:

The expenditures (income) elasticity for the animal protein group i is:

$$\boldsymbol{\mu_i = 1 + \frac{1}{w_i}\left[\beta_i + \acute{\eta}_i z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]} \quad (11)$$

The compensated (Hicksian) price elasticity is derived from the Slutsky equation:

$$\boldsymbol{\varepsilon_{ij}^c = \varepsilon_{ij} + \mu_i w_j} \quad (12)$$

Stata's 'NLSUR' command is utilized to estimate the parameters employing iterated feasible

generalized non-linier least squares, which are analogous to the normally distributed maximum likelihood estimator for this type of problem (Poi, 2012).

1.1. Data and data source

This study employed secondary Susenas (National Socioeconomic Survey) data (March 2021). The subjects of the analysis were the sociodemographic data (household housing status, total number of household members (HHsize), household consumption and expenditure, and total spending). Animal foods observed were eggs (chicken eggs, local chicken eggs, and duck eggs), chicken (local chicken meat), beef, fish (fresh fish and shrimp comprising fish, shrimp, and shellfish), and milk (milk powder and infant milk). The sample for this study consists of 4,811 households.

2. Results and Discussion

2.1. Determinants of the demand for animal food

The Iterated non-linear Seemingly Unrelated Regression (ITNLSUR) method is utilized to estimate constant parameters ($\boldsymbol{\alpha}$), income (β), eggs price (γ_1), chicken price (γ_2), beef price (γ_3), fish price (γ_4), and milk price (γ_5). This parameter is used to determine both the own-price and cross-price Marshallian elasticities. In addition, it is utilized to determine Hicksian price elasticity, own-Price and cross-price elasticity. This parameter must also satisfy the three restrictions of the demand system. All parameters have satisfied the three requirements of the demand system, namely adding-up, homogeneity, and symmetry, as shown by the results of the analysis. The study of data on parameters revealed that the income parameter was significant for the chicken, beef, fish, and milk groups, but not for the egg group. For the price parameter, all the parameters are significant, as indicated by the numbers in brackets for all price parameters that are less than 0.05. This indicates that the demand for eggs, chicken meat, beef, fish, and milk is affected by all price variables. All income square characteristics are highly important for all animal feeds, as indicated by the income square parameter. A significance value of less than 0.01 indicates this. This indicates that the square of income has a significant influence on the demand for eggs, chicken meat, beef, fish, and milk.

The demographic component of the animal food QUAIDS model is represented by the number of household members and the rural or urban status of residence. The characteristic of household size has a considerable impact on the demand for animal food. The number of household members has a significant impact on the demand for eggs, chicken meat, beef, fish, and milk. The household residence status parameter was highly significant for all animal foods, as demonstrated by a p-value less than 0.01. In other words, residency status has a substantial impact on the demand for eggs, chicken meat, beef, fish, and milk. In general, it can be argued that the demand for animal food is affected by nearly all criteria. Or the demand for animal food is affected by the price of animal food, household income, household income squared, the number of household members, and the residential status of the household. The outcomes of this parameter estimation investigation concur with those of Bopape and Myers (2007). Table 1 summarizes the findings of the data analysis on parameter estimates. This parameter estimate is utilized to determine the price elasticity and income for all animal foods.

Table 1. Parameter Estimates for the QUAIDS Model for Animal Food

Parameter	Animal Food Share Equation				
	Eggs	Chicken	Beef	Fish	Milk
Constant	-0,0693	0.6313	0.1952**	0.1261**	0.1172**
α	(0,085)	(0.067)	(0.037)	(0.023)	(0.0401)
Eggs Price	0.2255**	-0.1841**	-0.0102*	0.0239**	-0.0550**
γ_1	(0.0448)	(0.0367)	(0.0122)	(0.0071)	(0.0116)
Chicken Price	-0.1841**	0.1267**	0.0048*	0.0069*	0.0456**
γ_2	(0.0367)	(0.0339)	(0.0114)	(0.0066)	(0.0114)
Beef Price	-0.0102***	0.0048*	-0.0272**	-0.0092*	0.0417**
γ_3	(0.0132)	(0.0114)	(0.0135)	(0.0057)	(0.0084)
Fish Price	0.0239***	0.0069*	-0.0092*	-0.0151*	0.0051*
γ_4	(0.0081)	(0.0066)	(0.0057)	(-0.0067)	(0.0055)
Milk Price	-0.0550**	0.0456**	0.0417**	0.0071*	-0.0267**
γ_5	(0.0116)	(0.0114)	(0.0084)	(0.0055)	(0.0131)
Income	0.2486	-0.0545**	-0.0398*	-0.0062*	-0.2579*

β	(0.0642)	(0.0464)	(0.0127)	(0.0065)	(0.0151)
Quadratic Income	0.0127*	-0.0032*	-0.0017*	-0.0004*	-0.0079*
λ	(0.0007)	(0.0011)	(0.0005)	(0.0003)	(0.0007)
Demography	-0.0020*	0.0018*	0.0004*	0.00001*	-0.0002*
η_hhsize_tot	(0.0006)	(0.0004)	(0.0002)	(0.0001)	(0.0004)
Demography	0.00006*	0.00006*	0.00006*	0.00006*	0.00006*
Urban_rural	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)

Source: March 2021 Susenas. standard errors in parentheses (* p<0.01. ** p<0.05)

2.2. Marshallian (uncompensated) own and cross-price elasticities

Elasticity measures the percentage change in quantity demanded in response to a percentage change in price. Animal food is elastic if the elasticity is greater than 1, inelastic if it is less than 1, and unitary elastic if the elasticity of animal food is equal to 1. All Marshallian own-price elasticities are negative according to a study of the data (Table 2). This indicates that an increase in prices reduces demand for animal food. According to classical economic theory, there is a negative relationship between price and quantity demanded, hence, the own-price elasticity is expected to yield a negative sign. Beef is the most elastic animal food (3.829%), followed by chicken (3.103%), fish (2.345%), milk (1.311%), and eggs (0.846%). Apart from eggs, all animal foods are price elastic or highly responsive to changes in price. A 1% increase in beef prices is expected to decrease the quantity demanded for beef by around 3.829% on average. In rural Gorontalo, chicken is also a very elastic food source for households as it was found that a 1% rise in the price of chicken meat resulted in a 3.103% decrease in the quantity of chicken meat demanded. Similarly, the quantity fish demanded decreased by 2.345% as a result of a 1% increase in prices. Only the egg group is inelastic, meaning that an increase in egg prices by 1% reduces the quantity of eggs purchased by households by less than 1%. Through the Marshallian price elasticity, it is possible to conclude that a price increase reduces animal food demand more than the price increase itself which then affects household food security.

Table 2. Marshallian Price Elasticities for Animal Food in Rural Gorontalo

Animal Food Group	Eggs	Chicken	Beef	Fish	Milk
	-0.846	0.162	0.004	0.049	0.042
Eggs	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)
	-0.427	-3.103	0.145	0.219	0.210
Chicken	(0.026)	(0.032)	(0.012)	(0.012)	(0.018)
	-1.440	0.842	-3.829	1.114	0.131
Beef	(0.086)	(0.089)	(0.095)	(0.059)	(0.079)
	-0.195	0.553	0.307	-2.345	0.006
Fish	(0.022)	(0.022)	(0.014)	(0.019)	(0.019)
	-0.344	0.094	0.016	-0.029	-1.311
Milk	(0.009)	(0.010)	(0.006)	(0.005)	(0.010)

Source: March 2021 Susenas. Standard errors of means in parentheses.

Cross-price elasticity is defined as the percentage change in animal food demand caused by a percentage change in the price of other animal food groups (Ahn et al.. 2020; Elijah Obayelu et al.. 2009). For example, what is the percentage change in the demand for chicken as a result of a 1% percentage change in the price of beef? Positive cross-elasticities indicates that animal foods are substitutes, hence, an increase in the price of beef boosts the demand for chicken. On the other hand, if the cross-elasticity is negative, then the two items are complimentary, meaning that an increase in beef prices decreases demand for chicken meat. Table 2 displays the findings of the Marshallian or uncompensated cross-price elasticity for animal foods. Except for the egg group, almost all of the uncompensated Marshallian cross-price elasticity are positive. This indicates that beef, chicken, fish, and milk all share varying levels of substitution relationships. A 1% increase in beef prices boosts the demand for eggs by 0.162%, chicken meat by 0.145%, fish by 0.307%, and milk by 0.015% on average. This suggests that if the price of beef increases, rural households in Gorontalo substitute fish, eggs, poultry, or milk for beef in their diets. When the price of cattle increases, the fish group is

the first to be substituted. This is consistent with Gorontalo's vast potential for marine fish species. The sea waters of the Gorontalo province have a variety of possible marine fish species, including skipjack (*Katsuwonus pelamis*), tuna (*Thunnus sp*), kite (*Decapterus russeli*), tuna (*Eutynnus sp*), anchovy (*Stolephorus sp*), and Nike (*Awaous melanocephalus*) which are all commonly consumed by households.

Data from the Central Bureau of Statistics (BPS) of Gorontalo states that Gorontalo Province has quite a large fishery and marine potential. The water area of Gorontalo reaches 9.438.44 km^2 and the coastline is 903.7 km. covering the northern coast (Sulawesi Sea) of 331.2 km and the southern coast (Tomini Bay) of 572.5 km. With this potential, the Regional Secretary of Gorontalo Province, Darda Daraba hopes that Gorontalo can become a fish barn. The province of Gorontalo also has a large potential for capture fisheries resources and is divided based on the Management and Utilization Area (WPP), namely the Tomini Bay WPP to the Seram Sea the potential reaches 595.630 tons/year and the Sulawesi Sea WPP to the Pacific Ocean has a potential of 630.470 tons/year, this potential including the potential in the Exclusive Economic Zone (specifically the EEZ has a potential of 487.600 tons/year). The potential for aquaculture includes marine aquaculture. brackish fishery and freshwater fishery. the potential is 339.268 tons/year. Thus, this marine potential supports the 'blue economy' which can support the adequacy of protein consumption for households in Gorontalo Province.

2.3. Hicksian elasticities of own and cross-price

Hicksian price elasticity (compensated) is the percentage change in animal food demand due to a percentage change in the price of animal food. In absolute terms. Marshallian price elasticity is greater than Hicksian price elasticity because Marshallian elasticity includes both price and income effects, but Hicksian price elasticity includes only price effect. Table 3 displays Hicksian elasticity of households in rural Gorontalo. All Hicksian own-price elasticity coefficients are negative as expected, indicating that an increase in the price of animal food reduces demand or consumption. This outcome is also consistent with economic theory. Beef, as per Hicksian elasticity, is the most elastic animal food. Eggs are inelastic, whereas chicken and fish are highly elastic. The quantity of beef demanded is expected to fall by around 3.795% if prices increases by1%. Similarly, a 1% increase in the price of chicken and fish is expected to decrease chicken meat demand by 2.887% and fish meat demand by 2.271% on average. For milk, a 1% increase prices is expected to bring about on average a 1.070% decrease in quantity demanded. However, the egg group is a regarded as inelastic as a 1% increase in price is expected to only decrease quantity demanded by around 0.426% on average. Eggs is the least responsive to price changes in rural Gorontalo.

Table 3. Hicksian Price Elasticities for Animal Food in Rural Gorontalo

Animal Food Group	Eggs	Chicken	Beef	Fish	Milk
Eggs	-0.426 (0.003)	0.208 (0.003)	0.011 (0.001)	0.075 (0.001)	0.132 (0.002)
Chicken	1.683 (0.028)	-2.873 (0.032)	0.177 (0.012)	0.349 (0.012)	0.663 (0.018)
Beef	0.832 (0.087)	1.089 (0.089)	-3.795 (0.095)	1.254 (0.059)	0.619 (0.078)
Fish	1.000 (0.021)	0.683 (0.023)	0.325 (0.014)	-2.271 (0.019)	0.263 (0.019)
Milk	0.780 (0.009)	0.216 (0.010)	0.033 (0.006)	0.041 (0.005)	-1.070 (0.010)

Source: March 2021 Susenas. Standard errors of means in parentheses.

Hicksian cross-price elasticities is also shown in Table 3. All of the price elasticity of the Hicksian cross is positive, which suggest that there are mainly substation relationships among various animal food sources in rural Gorontalo. In other words, a rise in the price of one animal food increases the demand for another animal food as households substitute that animal food source with a relatively cheaper source. The results indicated that chicken was the second-most elastic animal food after beef. The 1% increase in the price of chicken meat increased demand for milk by 0.216%, fish by 0.683%, and eggs by 0.208%. If the price of chicken meat increases by 1%, rural households in Gorontalo substitute chicken meat for milk, fish, or eggs. In the fish group, a 1% increase in fish prices decreases the demand for chicken, eggs, and milk by 0.349%, 0.075%, and 0.049%, respectively. A 1% increase in

milk prices decreased the demand for chicken meat by 0.663%, fish by 0.263%, and eggs by 0.133% on average.

2.4. Expenditure elasticity (income elasticity)

Income elasticity is the percentage change in animal food demand in response to a percentage change in income. If the income elasticity of animal food is more than one, then animal food is a luxury good; otherwise, animal food is a normal good if positive and inferior if negative. The findings of the computation of the elasticity of household income in rural Gorontalo are displayed in Table 4. The income elasticity of chicken, beef, fish, and milk is greater than one, indicating that these four groups of animal foods are luxuries. The beef income elasticity is the highest at 3.181%. followed by chicken meat (2.957%), fish (1.674%), and milk (1.574%). The income elasticity of eggs is the smallest, at 0.589%, hence it may be argued that eggs are normal goods which are not very responsive to changes in income compared to the other animal food groups.

Table 4. Expenditure Elasticities

Animal Food Group	Eggs	Chicken	Beef	Fish	Milk
Gorontalo	0.563	2.278	3.928	1.752	1.456
	(0.001)	(0.007)	(0.032)	(0.008)	(0.002)
Urban	0.524	1.801	5.516	1.884	1.368
	(0.013)	(0.005)	(0.038)	(0.011)	(0.002)
Rural	0.589	2.957	3.181	1.674	1.574
	(0.001)	(0.011)	(0.029)	(0.008)	(0.003)
<=2 people	0.618	2.893	9.249	1.605	1.803
	(0.005)	(0.012)	(0.114)	(0.007)	(0.004)
3-4 people	0.562	2.048	3.163	1.879	1.488
	(0.012)	(0.006)	(0.021)	(0.014)	(0.002)
>=5 people	0.545	2.372	4.324	1.722	1.391
	(0.006)	(0.008)	(0.035)	(0.008)	(0.002)

Source: March 2021 Susenas. Standard errors of means in parentheses.

Gorontalo rural households have the lowest income elasticity for beef animal food at 3.181%, compared to 5.516% for urban households and 3.928% for the province as a whole. Rural households are both consumers and producers of beef, whereas the majority of households in urban regions are only consumers; hence. beef is most elastic in urban areas. The same occurred with the fish groupings. In contrast. the elasticity of income for the animal food group. which includes chicken meat, milk, and eggs, is greater in rural households. In rural areas. the income elasticity of chicken meat is 2.957%, while in urban areas it is 1.807%. Regarding milk and eggs, the income elasticity in rural areas is 1.574% and 0.589%, while it is 1.368% and 0.529% in urban areas. This study confirms that households in Gorontalo urban regions are more elastic when animal food is more luxurious, whereas households in Gorontalo rural areas are more inelastic when animal food is closer to normal goods.

As shown by the analysis of the estimated parameters in Table 1, the number of household members has a substantial impact on the demand for animal feed in rural households in Gorontalo. Table 4 presents three kinds of households based on the number of members: 1-2 people. 3-4 people. and more than 5 people. All animal foods are most elastic in small homes. consisting of no more than two persons. When demographic parameters are considered. the results indicate that beef is the most elastic animal meal. with a 9.249% elasticity. This suggests that households in Gorontalo prioritize purchasing animal foods such as beef if their income increases. followed by chicken (2.893%), milk (1.803%), fish (1.605%), and eggs (0.618%). The most elastic animal food in households with 3 to 4 members is beef, at 3.163%, followed by chicken meat (2.048%), fish (1.879%), milk (1.488%), and eggs (0.562%). Beef has the highest income elasticity in large households, with a value of 4.324%. followed by chicken (2.372%), fish (1.722%), milk (1.394%), and eggs (0.545%). This finding demonstrates that tiny households are most receptive to beef when their income increases. Beef, chicken, fish, milk, and eggs are the most commonly consumed animal foods in Gorontalo if the population's income increases. Eggs are the primary source of animal protein for rural and urban households in the province of Gorontalo. Given that price elasticity is greater than income elasticity,

particularly in rural Gorontalo, price intervention is significantly more successful than income policy.

CONCLUSION

This article analyzes the impact of price and income on the consumption and demand patterns of rural Gorontalo households. The research data is comprised of secondary data in the form of BPS consumption and expenditure data obtained in 2021 via Susenas. The model strategy employs QUAIDS. With a demand elasticity of 3.829%, beef was the most elastic animal food followed by chicken meat (3.103%), fish (2.345%), milk (1.311%), and eggs (0.846%). Eggs are a rigid animal food source. Except for eggs, all animal meals are luxury items. Beef has the highest income elasticity, at 3.181%. followed by chicken (2.957%), fish (1.674%), and milk (1.574%). Eggs have the lowest income elasticity, at 0.589%. Small households respond to an increase in income the greatest to beef demand. In other words. the household consumes more beef if its members are few. It can be stated that the price strategy is more effective than the income policy for rural households in Gorontalo.

ACKNOWLEDGMENT

Acknowledgment is submitted to the Universitas Islam Malang regarding the Institutional Funding for research (Hi-ma is Hibah Institusi UNISMA) for 2021 with the Contract Number: 022/6164/U.LPPM/K/B07?II?2022. Also acknowledged is BPS for completing the data purchase so speedily. We also appreciate how quickly the data tabulation and analysis team worked so that the outcomes of the data analysis could be instantly interpreted.

REFERENCES

Agarwal, B. (2018). Gender equality, food security and the sustainable development goals. *Current Opinion in Environmental Sustainability*, *34*, 26–32.

Ahn, Y., Lee, B. C., & Lee, S. K. (2020). Analysis of Korean millennials' travel expenditure patterns: An almost ideal demand system approach. *Asia Pacific Journal of Tourism Research*, *25*(1), 3–14.

Alboghdady, M. A., & Alashry, M. K. (2010). The demand for meat in Egypt: An almost ideal estimation. *African Journal of Agricultural and Resource Economics*, *4*(1), 70–81.

Al-Shuaibi, A. M. (2011). An Economic Study of the Demand for Red meat in the Kingdom of Saudi Arabia using almost Ideal demand system. *Trends in Agricultural Economics*, *4*(1), 30–40.

Andrianarison, F. (2022). Unravelling the Linkage between Food Security, Poverty Reduction, and Education for Sustainable Development. *The Journal of Development Studies*, 1–22.

Anindita, R., Sadiyah, A. A., Khoiriyah, N., & Nendyssa, D. R. (2020). The demand for beef in Indonesian urban. *IOP Conference Series: Earth and Environmental Science*, *411*(1), 012057.

Asadoorian, M. O., Eckaus, R. S., & Schlosser, C. A. (2008). Modeling climate feedbacks to electricity demand: The case of China. *Energy Economics*, *30*(4), 1577–1602.

Bachmann, C. J., Beecham, J., O'Connor, T. G., Briskman, J., & Scott, S. (2022). A good investment: Longer-term cost savings of sensitive parenting in childhood. *Journal of Child Psychology and Psychiatry*, *63*(1), 78–87.

Bai, J., Seale Jr, J. L., & Wahl, T. I. (2020). Meat demand in China: To include or not to include meat away from home? *Australian Journal of Agricultural and Resource Economics*, *64*(1), 150–170.

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel curves and consumer demand. *Review of Economics and Statistics*, *79*(4), 527–539.

Bharumshah, A. Z., & Mohamed, Z. A. (1993). Demand for Meat in Malaysia: An Application of the Almost Ideal Demand System Analysis. *Pertanika Journal of Social Sciences & Humanities*, *1*, 91–99.

Bopape, L., & Myers, R. (2007). Analysis of household demand for food in South Africa: Model selection, expenditure endogeneity, and the influence of socio-demographic effects. *African Econometrics Society Annual Conference", Cape Town, South Africa*.

Chaudhary, A. R., & Hanif, U. (2022). Climate Change and Food Security: Steps towards Sustainable Development Goals. *IRASD Journal of Economics*, *4*(2), 310–328.

Deaton, A., & Muellbauer, J. (1980). An almost ideal demand system. *The American Economic Review*, *70*(3), 312–326.

Deaton, A. S., & Muellbauer, J. (1986). On measuring child costs: With applications to poor countries. *Journal of Political Economy*, *94*(4), 720–744.

Dosi, G., Pereira, M. C., Roventini, A., & Virgillito, M. E. (2022). Technological paradigms, labour creation and destruction in a multi-sector agent-based model. *Research Policy*, *51*(10), 104565.

Efendioğku, İ. H. (2022). The impact of conspicuous consumption in social media on purchasing intentions. *ArXiv Preprint ArXiv:2205.12026*.

Elijah Obayelu, A., Okoruwa, V. O., & Ajani, O. I. Y. (2009). Cross-sectional analysis of food demand in the North Central, Nigeria: The quadratic almost ideal demand system (QUAIDS) approach. *China Agricultural Economic Review*, *1*(2), 173–193.

Hayat, N., Mustafa, G., Alotaibi, B. A., & Traore, A. (2022). Nutritional Demand and Consumption Pattern: A Case Study of Pakistan. *Sustainability*, *14*(12), 7068.

Husain, R., Ahmad, A., & Khan, B. M. (2022). The role of status consumption and brand equity: A comparative study of the marketing of Indian luxury brands by traditional and social-media. *Global Business and Organizational Excellence*, *41*(4), 48–67.

Khanal, U., Wilson, C., Rahman, S., Lee, B. L., & Hoang, V.-N. (2021). Smallholder farmers' adaptation to climate change and its potential contribution to UN's sustainable development goals of zero hunger and no poverty. *Journal of Cleaner Production*, *281*, 124999.

Khoiriyah, N., Anindita, R., Hanani, N., & Muhaimin, A. W. (2020). Animal Food Demand in Indonesia: A Quadratic Almost Ideal Demand System Approach. *AGRIS On-Line Papers in Economics and Informatics*, *12*(665-2020–1237), 85–97.

Nendissa, D. R., Anindita, R., Khoiriyah, N., & Sa'diyah, A. A. (2021). *Consumption and Beef Price Changes on Demand in East Nusa Tenggara, Indonesia*.

Nikmatul, K., Ratya, A., Nuhfil, H., & Wahib, M. A. (2020). The analysis demand for animal source food in Indonesia: Using Quadratic Almost Ideal Demand System. *Business: Theory and Practice*, *21*(1), 427–439.

Norimah, J. A., Safiah, M., Jamal, K., Haslinda, S., Zuhaida, H., Rohida, S., Fatimah, S., Norazlin, S., Poh, B. K., & Kandiah, M. (2008). Food Consumption Patterns: Findings from the Malaysian Adult Nutrition Survey (MANS). *Malaysian Journal of Nutrition*, *14*(1), 25–39.

Parker, J. A., Schild, J., Erhard, L., & Johnson, D. (2022). *Household spending responses to the economic impact payments of 2020: Evidence from the consumer expenditure survey*. National Bureau of Economic Research.

Poi, B. P. (2012). Easy demand-system estimation with quaids. *Stata Journal*, *12*(3), 433.

Sa'diyah, A. A., Anindita, R., Hanani, N., & Muhaimin, A. W. (2019). The strategic food demand for non poor rural households in Indonesia. *EurAsian Journal of BioSciences*, *13*(2), 2197–2202.

Scheier, E., & Kittner, N. (2022). A measurement strategy to address disparities across household energy burdens. *Nature Communications*, *13*(1), 1–11.

Sulaiman, A. A., Sulaeman, Y., Mustikasari, N., Nursyamsi, D., & Syakir, A. M. (2019). Increasing sugar production in Indonesia through land suitability analysis and sugar mill restructuring. *Land*, *8*(4), 61.

Tefera, N. U., Desta, M. D., & Rashid, S. (2018). A Dynamic analysis of food demand patterns and habit effects: Panel evidence from rural households in Ethiopia. *J Agr Econ Open Access*, *1*(1), 1–13.

Wang, H., & Cheng, Z. (2022). Kids eat free: School feeding and family spending on education. *Journal of Economic Behavior & Organization*, *193*, 196–212.

Wu, Y., Li, E., & Samuel, S. N. (1995). Food consumption in urban China: An empirical analysis. *Applied Economics*, *27*(6), 509–515.

Yildirim, S. (2022). The consumer role for sustainable development: How consumers contribute sustainable development goals. In *Research Anthology on Measuring and Achieving Sustainable Development Goals* (pp. 872–888). IGI Global.