# Analysis of Demand for Sweet Potato in North Sumatra

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## Abstract

Sweet potato has good prospects as a leading agricultural commodity. North Sumatra sweet potato is exported in fresh form and the rest is to meet domestic needs. This study aims to analyze the factors that influence the demand for sweet potatoes in North Sumatra, estimate the demand system model for sweet potatoes in North Sumatra using the demand system and determine the elasticity of demand for sweet potatoes in North Sumatra. This study uses the analysis of the Almost Ideal Demand System (AIDS). The results of the analysis show that the factors that influence the demand for sweet potatoes in North Sumatra significantly are the price of sweet potatoes from the commodity of corn, the price of sweet potatoes from the commodity of rice, the price of sweet potatoes from the commodity of cassava and the price of sweet potatoes from the commodity of sweet potatoes. The sweet potato demand system model explained by the AIDS model is consistent with the demand theory. The resulting coefficient of determination is between 62.14 per cent and 93.05 per cent. Testing the parameters of the three restrictions, namely adding up, homogeneity, and slutsky symmetry, succeeded in fulfilling the demand theory model. The price elasticity value itself shows that the elasticity value of sweet potato is elastic, while the elasticity value of cassava is inelastic. The value of cross-price elasticity is known that in general, all commodities have varying elasticity, some are positive and some are negative. The value of the elasticity of spending for the commodity of corn is included in the group of inferior goods/staple goods, the commodity of rice is included in the group of normal goods while the commodity of cassava and sweet potato is included in the group of superior/luxury goods.

**Keywords**: AIDS, Demand for Sweet Potatoes

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## Introduction:

The agricultural sector is a source of revenue and provisions the economy in Indonesia because agriculture forms a prodigious proportion. This makes the agricultural sector a potential market for domestic products for both production and consumption goods, especially products produced by the food crops sub-sector. Food can be defined as a basic human need so each person desires food adequacy. Food originates from biological and water resources, both processed and unprocessed, which are designated as food and drink for humans, including food additives, food raw materials and other materials. On the other hand, food security is a very important issue for almost every country in the world, including Indonesia. To overcome food insecurity, the government has launched a Food Security Improvement Program (BKP), based on Law No. 7 of 1996 concerning food. Then the government issued Presidential Regulation No. 68 of 2002 concerning Food Security, namely the development of diversification of food consumption which is based on the diversity of food resources, institutions and local culture. To meet carbohydrate sources, Indonesia is increasingly dependent on rice and wheat (Bantacut, 2014). The main problem with national food availability is Indonesia's very large population. In 2010 the population of Indonesia according to the census conducted by BPS showed more than 237 million people. It is estimated that in 2023 this figure will reach 274 million people. If population growth is calculated linearly at 1.6% per year, then a large enough food supply is needed. The largest food requirement referred to here is carbohydrate-sourced food, which is about half (> 50%) of the energy requirement per person per day (Gardjito, 2013).

One of the important food crop commodities taking a role in the development of the agricultural sector is the sweet potato commodity. Sweet potato is a substitution material for rice and corn. For Indonesia, sweet potato is a staple food after rice and corn. Sweet potato has a high nutritional content and can be used as a substitute for staple foods because it is an efficient source of calories. In addition, sweet potatoes also contain sufficient amounts of vitamin A such as ascorbic acid, *tianin*, riboflavin, niacin, phosphorus, iron and calcium. Sweet potatoes are very suitable for supporting food diversification programs towards food self-sufficiency and in the short term sweet potatoes can overcome rice shortages. Sweet potato is the main carbohydrate source commodity after rice, corn and cassava which has an important role in the supply of food, industrial raw materials and animal feed. Sweet potato can be one of many alternative food crops to accompany rice towards food security. This is based on the consideration that sweet potato is (1) the fourth source of carbohydrates after rice, corn and cassava; (2) has high productivity compared to corn and cassava; (3) has quite diverse potentials; (4) has potential market demand both local, regional and export which must increase; (5) and has quite a variety of nutritional content and is not owned by other food plants (Defri, 2011a, b).

Sweet potato is one of the commodities from food crops that can contribute to the economic aspect as a source of trade foreign exchange for both import and export, providing jobs and supplying staple food as well as raw materials for the food and beverage industry. The fluctuating sweet potato was due to fluctuations in the production and area of sweet potato land in North Sumatra.

**Table 1: Land Area, Production, Average North Sumatra Sweet Potato Production**[2]

| YEAR | Land area (hectare) | Production (tons) | Average Production (kw/ha) |
|---|---|---|---|
| 2016 | 6378,6 | 91531,4 | 143,5 |
| 2017 | 5884,2 | 92380,3 | 157 |
| 2018 | 4969,5 | 92554,55 | 186,25 |
| 2019 | 5511 | 97989,4 | 177,8 |
| 2020 | 4339 | 78071 | 179,92 |

Table 1 shows the production of sweet potatoes produced in North Sumatra from 2016 to 2020 fluctuated. The highest sweet potato production occurred in 2019, namely 97989.4 tons. The same thing happened to the development of sweet potato land area which fluctuated from 2016 to 2020. The fluctuations that occurred in sweet potato production and the land area had an impact on product development, where its development has increased from year to year. The increase was due to a balance between the area of land and the amount of production. The abundant production of sweet potatoes has not been utilized optimally in the local market, this can be seen from the not many uses of sweet potatoes as a food ingredient that is consumed by many people. Sweet potato in North Sumatra is still widely consumed only as a side dish, its use has not been maximized.

Prices of agricultural products, one of which is food commodity products, always fluctuate depending on changes that occur in the short term, namely per month, per week or even per day. This situation makes it difficult for farmers to carry out production planning, and traders also find it difficult to estimate demand. Because seen the nature and usefulness of this sweet potato commodity are easily damaged/rotted (not durable) so it needs to be marketed directly so that farmers do not experience big losses and limited trade networks. Farmers are forced to sell sweet potatoes at prices demanded by collectors/middlemen at relatively minimal prices, the price of sweet potatoes has increased due to the nature of the commodity so farmers are forced to sell them at relatively low prices. Price fluctuation is one of the most important market risks for producers. Fluctuating prices may be higher or lower so that the gain or loss is only theoretical, that is, it is associated with a lost opportunity. It can be seen from the following picture:

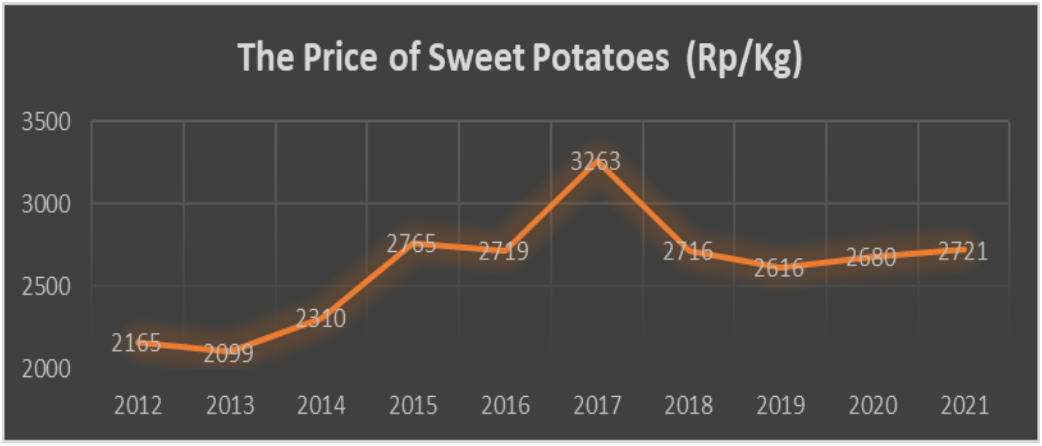


**Figure 1: Prices of Sweet Potatoes in North Sumatra Province** (BPS, 2021)

[2] Source: BPS North Sumatra, 2021

Figure 1 shows the price of sweet potato in 10 years has experienced price fluctuations. Every year or every three years there are fluctuations in the price of sweet potatoes in North Sumatra Province. From 2012 to 2013 the price of sweet potatoes fell. From 2013 to 2015 the price of sweet potatoes increased. From 2015 to 2016, sweet potato prices fell again. From 2016 to 2017 the price of sweet potatoes rose again, from 2017 to 2019 the price of sweet potatoes fell again and from 2019 to 2021 the price of sweet potatoes began to rise again.

One of the important problems of sweet potato consumption is the very low contribution of sweet potato consumption and the dependence on rice (rice) consumption in daily life. Viewed from the consumption aspect, the level of consumption of sweet potatoes in North Sumatra is still quite low. In fact, in terms of the availability of sweet potatoes in North Sumatra, production is quite large. This indicates that the available sweet potatoes were not immediately absorbed properly by the community.

Research on demand has been carried out quite a lot but in a large and non-specific scope. Previous studies only analyzed food demand in aggregate (Deaton, 1990). Based on the research results, it is known that the magnitude of elasticity for the analyzed food commodities has a different magnitude. The difference in results is possible due to differences in sociodemographic factors in the study area. What needs to be considered is the growth in demand which is dynamic and can change due to the price itself and the level of income. Prices can cause changes in the demand for sweet potatoes. Changes in prices and income cause changes in consumer consumption in terms of quantity.

Of the 4 commodities on the market, namely corn, rice, cassava and sweet potato, are commodities that are familiar for consumption. It is reasonable to suspect that the four commodities have a substitution function and influence each other. To prove this conjecture, mathematically and economically, a demand function model is needed that can explain the interrelationships between commodities in an integrated system. The Almost Ideal Demand System (AIDS) model has the advantage of producing simultaneous equations that can explain the interrelationships between commodities so that the two-way relations between commodities can be properly analyzed. The AIDS model is also capable of estimating the response of market demand to changes in the price of a commodity, estimating the demand function and calculating the elasticity value of a commodity.

North Sumatra Province needs information about consumption patterns of food commodities. This information is useful for estimating demand for food commodities such as corn, rice, cassava, and sweet potatoes. One effort that can be done is to estimate the demand system model with several food commodities.

## Research Methodology:

**Location Selection Method:** This research was conducted in North Sumatra Province. The determination of this area was carried out purposively, with the consideration that the province of North Sumatra is one of the provinces with the best producers of sweet potato commodities in Indonesia.

**Data Determination Method:** The data used in this study uses panel data. Panel data is a combination of time series data and cross-section data. Time series data is data from one object with several specific periods, while cross-section data is data obtained from one or more research objects in the same period. This study uses time series data for 20 years (t = 20), namely from

2001 to 2021, while the cross-section data in this study are 4 commodities (n = 4) so the total data used in this study is 20 x 4 = 80 data.

**Data Collection Method:** Based on data collection is secondary data, secondary data is data obtained by recording and quoting directly from government agencies or institutions related to research.

**Table 2: Types and Sources of Research Data Collection**[3]

| No. | Type of Data | Data Source |
|---|---|---|
| 1. | Quantity of Corn, Rice, Cassava and Sweet Potatoes in North Sumatra | BPS Sumatera Utara |
| 2. | Expenditure Value of Corn, Rice, Cassava and Sweet Potatoes in North Sumatra | BPS Sumatera Utara |
| 3. | Prices of Corn, Rice, Cassava and Sweet Potatoes in North Sumatra | BPS Sumatera Utara |

**Data Analysis Method:** The method to be used in this study is in the form of qualitative and quantitative analysis. Qualitative analysis (descriptive) is used to explain the data obtained from the analysis carried out using quantitative methods. The mathematical model used is a linear approximation of the AIDS model, which is as follows:

$$\mathbf{w_i} = \boldsymbol{\alpha_i} + \sum_{j=1}^{n} \boldsymbol{y_{ij}}\ \boldsymbol{lnp_j} + \boldsymbol{\beta_i}\ \mathbf{ln}\left(\frac{x}{a(p)}\right) + \boldsymbol{u_i}$$

**Descriptions:**

i, j = Type of Goods
$w_i$ = budget share allocated for goods *i*
$p_j$ = price of goods *j*
x = spending on goods in the system
*a(P)* = price index
$\alpha_i$ , $\gamma_{ij}$ , $\beta_i$ = estimation parameters
$u_i$ = standard error

**Model Specifications:** The Almost Ideal Demand System (AIDS) model uses SAS On-Demand software as a tool for processing sweet potato demand data in North Sumatra. In the Almost Ideal Demand System (AIDS) model in researching the demand for sweet potatoes, four commodities will be described in detail as follows:

i. Corn: $W_1 = a_1 + Y_{11}\, lnp_1 + Y_{12}\, lnp_2 + Y_{13}\, lnp_3 + Y_{14}\, lnp_4 + \beta_1 ln\left(\frac{x}{a(p)}\right) + u_1$

ii. Rice: $W_2 = a_2 + Y_{21}\, lnp_1 + Y_{22}\, lnp_2 + Y_{23}\, lnp_3 + Y_{24}\, lnp_4 + \beta_2 ln\left(\frac{x}{a(p)}\right) + u_2$

iii. Cassava: $W_3 = a_3 + Y_{31}\, lnp_1 + Y_{32}\, lnp_2 + Y_{33}\, lnp_3 + Y_{34}\, lnp_4 + \beta_3 ln\left(\frac{x}{a(p)}\right) + u_3$

iv. Sweet Potatoes: $W_4 = a_4 + Y_{41}\, lnp_1 + Y_{42}\, lnp_2 + Y_{43}\, lnp_3 + Y_{44}\, lnp_4 + \beta_4 ln\left(\frac{x}{a(p)}\right) + u_4$

[3] Source: processed data

**Descriptions:**

$a\ \gamma\ \beta$ = Regression parameter/Estimation coefficient
$w_1$ = Budget Share Corn
$w_2$ = Budget Share Rice
$w_3$ = Budget Share Cassava
$w_4$ = Budget Share Sweet Potatoes
$p_1$ = Corn Prices
$p_2$ = Rice Prices
$p_3$ = Cassava Prices
$p_4$ = Sweet Potatoes Prices
x = Total Expenditure Demand for Sweet Potatoes
$a(p)$ = Price index
$u_1,u_2,u_3,u_4$ = Standard Error

**Demand Estimation:** Theoretically, the Almost Ideal Demand System (AIDS) model has several limitations stemming from the assumption of the demand function. Three restrictions must be included in the model to maximize the level of customer satisfaction, as follows:

1. Adding up

$\sum_i a_i = 1$ , $\sum_i C_{ij} = 0$ , $\sum_i b_i = 0$

This adding up condition can be written as follows:

$\alpha_4=1- \alpha_1- \alpha_2- \alpha_3$
$Y_{4\,1}= Y_{1\,1}- Y_{2\,1}- Y_{3\,1}$
$Y_{4\,2}= Y_{1\,2}- Y_{2\,2}- Y_{3\,2}$
$Y_{4\,3}= Y_{1\,3}- Y_{2\,3}- Y_{3\,3}$
$Y_{4\,4}= Y_{1\,4}- Y_{2\,4}- Y_{3\,4}$
$\beta_4=- \beta_1- \beta_2- \beta_3$

2. Homogeneity

$\sum_j \gamma i\ j = 0$

The homogeneity condition can be written

$\gamma_{11}+ \gamma_{12}+ \gamma_{13}+ \gamma_{14} = 0$
$\gamma_{21}+ \gamma_{22}+ \gamma_{23}+ \gamma_{24} = 0$
$\gamma_{31}+ \gamma_{32}+ \gamma_{33}+ \gamma_{34} = 0$

3.Slutsky symmetry

$\gamma_{i\,j}=\gamma_{j\,i}$

Slutsky symmetry conditions can be written as follows:

$\gamma_{2\,1}=\gamma_{1\,2}$ $\gamma_{3\,1}=\gamma_{1\,3}$ $\gamma_{3\,2}=\gamma_{2\,3}$

Homogeneity and Symmetry restrictions can be included in the model and tested empirically while adding up restrictions have been fulfilled automatically in the conjecture model (Deaton and Muelbauer, 1980). This is because the budget share always increases to one (Chang and Nguyen, 2002).

**Analysis of Elasticity of Demand:** The estimated parameter coefficients of the AIDS model can be used as information to calculate price and expenditure elasticity (Mizobuchi and Tanizaki, 2013). The calculation of the elasticity value is as follows:

1. **Expenditure Elasticity:** $e_{iy} = 1 + \frac{\beta_i}{w_i}$

If: $\delta_{iy}$ Positive, then the item is a luxury item
$\delta_{iy}$ Negative, then the goods are inferior
$\delta_{iy}$ Zero, then the goods are normal

2. **Cross Elasticity:** $e_{ij} = \frac{\gamma_{ij}}{w_i}$ for $i \neq j$

If: $\delta_{ii}$ Positive, then the relationship between the two goods is a substitute
$\delta_{ii}$ Negative, then the relationship between the two goods is complementary goods
$\delta_{ii}$ Zero, then the relationship between the two goods is neutral goods

3. **Self-Price Elasticity:** $e_{ii} = -1 + \frac{\gamma_{ij}}{w_i} - \beta_i\left(\frac{wj}{wi}\right)$

If: $\delta_{ii} > 1$ then the price elasticity of demand is elastic
$\delta_{ii} < 1$ then the price elasticity of demand is inelastic
$\delta_{ii} = 1$ then the price elasticity of demand remains elastic

**Results and Discussion:**

**Location and Area of North Sumatra Province:** North Sumatra Province is a province in Indonesia which is located in the northern part of the island of Sumatra. This province has thousands of cities in Medan City, with an area of 72,981.23 km2 which is divided into 25 Regencies, 8 Cities, 325 Districts and 5,456 Sub-districts or villages. North Sumatra province is located at 1o - 4o north latitude and 98o - 100o east longitude. Its territory is bordered to the north by the provinces of Aceh and the Sumatra Strait, to the west by the provinces of West Sumatra and Riau, and to the east by the Sumatra Strait. North Sumatra can be divided into:

i. East Coast
ii. Bukit Barisan Mountains
iii. West Coast
iv. Nias Islands

The east coast is the region within the province that has the most rapid development due to relatively more complete infrastructure requirements than other regions. The east coast region is also a relatively densely populated area compared to other areas. During the colonial period of the Dutch East Indies, this area included the residency of Sumatra's Oostkust together with the province of Riau. In the central region of the province line the Bukit Barisan Mountains. In these mountains, several areas are pockets of population concentration. The area around Lake Toba and Samosir Island is a densely populated area that depends on this lake for its livelihood. The west coast is a fairly narrow area, with a population composition consisting of Batak, Minangkabau and Acehnese people. But culturally and ethnolinguistically, this area is included in Minangkabau culture and language.

**Climate conditions in North Sumatra:** The climate in North Sumatra includes a tropical climate which is influenced by the Passat winds and Monsoon winds. The average humidity is 78% - 91%, rainfall is 800 - 4000 mm/year and sunshine is 43%. North Sumatra Province has a dry season and a rainy season. The rainy season usually occurs from November to March, and the dry season usually occurs from June to September. The two rainy and dry seasons are interspersed with transition seasons.

**Sweet Potato Production in North Sumatra Province:** One of the results of the Food subsector is Sweet Potatoes. Sweet Potato Production in North Sumatra can be seen in Table 3:

**Table 3: Sweet Potato Production in North Sumatra Province**[4]

| Year | Sweet Potatoes Production (ton) |
|---|---|
| 2016 | 91531 |
| 2017 | 92380 |
| 2018 | 92555 |
| 2019 | 97989 |
| 2020 | 78071 |
| 2021 | 80144 |

Table 3 shows Sweet Potato Production increased in 2019 by 97,989 tons, in 2020 Sweet Potato Production decreased by 78,071 tons, and in 2021 Sweet Potato Production again increased by 80,144 tons. With the increase in the amount of sweet potato production, the availability to meet the demand for sweet potatoes will be fulfilled.

Ideal Demand System (AIDS) analysis: This study analyzed the demand for sweet potatoes in North Sumatra, which consisted of 4 groups, namely Corn, Rice, Cassava, and Sweet Potatoes. This study uses an analysis tool model of the AIDS demand system which is used to analyze cross-sectional data or cross sections.

Table 4 below shows that food consumption, namely the demand for sweet potatoes, consists of corn, rice, cassava and sweet potatoes in the 2001-2021 period. Rice consumption is the largest consumption of the population of North Sumatra with an average of 7.5 kg per year, followed by consumption of cassava, corn and sweet potatoes. Of the four types of food commodities, the price of rice is the highest with an average of IDR 110,251.21. The second highest price is sweet potato, followed by cassava and corn. The largest expenditure value can be seen from the expenditure of rice with an average nominal value of Rp. 827,056. The value of each budget share from the highest is rice at 98 %, followed by cassava at 8%, sweet potato at 3% and the lowest corn at 2%.

[4] Source: North Sumatra in Figures, 2021

**Table 4: Summary of Sweet Potato Demand Statistics in North Sumatra**[5]

| Variable | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|
| **Consumption of Corn (kg)** | 0,223 | 0,09 | 0,12 | 0,36 |
| **Rice Consumption (kg)** | 7,502 | 0,22 | 7,18 | 7,9 |
| **Cassava Consumption (kg)** | 0,380 | 0,50 | 0,15 | 2,52 |
| **Sweet Potatoes Consumption (kg)** | 0,077 | 0,03 | 0,043 | 0,16 |
| **Corn Prices (Rp)** | 7099,714 | 4082,87 | 700 | 15000 |
| **Rice Prices (Rp)** | 110251,210 | 15530,40 | 81601,60 | 129775,89 |
| **Cassava Prices (Rp)** | 24163,626 | 8264,50 | 1747,62 | 37000 |
| **Sweet Potatoes Prices (Rp)** | 39414,122 | 11489,14 | 22720 | 59466,67 |
| **Corn Production (Rp)** | 1547,429 | 33118,48 | 204 | 2904 |
| **Rice Production (Rp)** | 827056,571 | 33250,99 | 610380 | 955836 |
| **Cassava Production (Rp)** | 7219,429 | 33373,24 | 3600 | 15540 |
| **Sweet Potatoes Production (Rp)** | 3180,571 | 33482,73 | 1680 | 7056 |
| **Budget Share Corn** | 0,002006 | 0,001503 | 0,004366 | 0,000227 |
| **Budget Share Rice** | 0,986044 | 0,004991 | 0,975183 | 0,991716 |
| **Budget Share Cassava** | 0,008296 | 0,003935 | 0,00413 | 0,01622 |
| **Budget Share Sweet Potatoes** | 0,003654 | 0,00179 | 0,00179 | 0,00737 |

**Factors Affecting Demand for Sweet Potatoes in North Sumatra:** Several factors affect the demand for a commodity. In this research, the factors that are considered are the price of the commodity itself, the prices of other commodities and expenditure/income. The estimation of the sweet potato demand model was carried out using the SUR (Seemingly Unrelated Regression) method which consists of four expenditure share equations, namely corn, rice, cassava and sweet potato. The expenditure share referred to shows the percentage of commodity-type expenditure to total expenditure.

**Corn:** Table 5 is the result of the model estimation showing corn commodity and other variables. Based on the results of the AIDS model estimation of the corn commodity, the R-Square is 0.9305 per cent. This value means that the diversity of share proportions can be explained by the independent variable of 0.9305 per cent and the rest is explained by the independent variable.

The statistical p-value obtained from the estimation results for the corn commodity AIDS model shows good results. Where the p-value obtained is smaller than the 5 per cent significance level, it can be said to be significant (0.000 <0.05). This value means that the independent variable (free) together can explain the dependent (bound) variable, namely the variable share of corn commodity in the price of corn. Furthermore, the variables that influence the share of demand for corn commodities are explained as follows.

[5] Source: North Sumatra BPS data, data processed

**Table 5: Commodity Coefficient of Corn**[6]

| Independent Variable | Corn | | |
|---|---|---|---|
| | Coefficient | t-value | p-value |
| Constant | 0,0531 | 5,19 | 0,001 |
| | 0,0102 | | |
| Corn Price | 0,0010 | 6,55 | 0,001 |
| | 0,0001 | | |
| Rice Price | -0,0017 | -5,61 | 0,001 |
| | 0,0003 | | |
| Cassava Price | 0,0003 | 1,59 | 0,13 |
| | 0,0002 | | |
| Sweet Potatoes Price | -0,0003 | -6,35 | 0,001 |
| | 0,0004 | | |
| Total Expenditure Value | -0,0076 | -1,75 | 0,10 |
| | 0,0044 | | |

i. **Corn Prices:** Based on the estimation results of the model, the corn price variable has a positive relationship to the share of demand for corn commodities as indicated by a coefficient value of 6.55, which can be interpreted that if the price of corn rises 1 per cent, it will increase the share of corn commodities by 6.55 per cent. This indicates that when there is an increase in the price of corn, corn will still benefit where the share of the corn commodity from the price of corn will continue to increase. The corn price variable has a significant effect, where the corn price variable has a p-value of 0.001 <0.05. Thus, the variable price of corn can be said to have a significant effect on the share of corn commodities at a significant level of 5 per cent.

ii. **Rice Price:** The estimation results of the model show that the independent variable rice price is also related to the share of demand for corn as indicated by the coefficient value of -5.61. The coefficient value of -5.61 is suspected because the prices of rice and corn commodities have a complementary relationship, so that when the price of one commodity increases, it will decrease the share or share of other demand, this variable has a significant effect on the share of demand for corn. The rice price variable has a p-value of 0.001 so the rice price variable has a significant effect at the 5 per cent significance level (0.05) on the share of demand for corn commodity.

iii. **Price of Cassava:** Same with the price of corn and rice, the results of the estimation show that the independent variable cassava price is also positively related to the share of demand for the commodity of corn as indicated by a positive coefficient value of 1.59. The positive coefficient value is suspected because the prices of cassava and corn commodities have a substitution relationship, so that when the price of one commodity increases, it will increase the share or share of other demand, this variable has no significant effect on the share of demand for corn commodity. The cassava price variable has a p-value of 0.13 so the cassava variable has no significant effect at the 5 per cent significance level (0.05) on the share of demand for corn commodities.

[6] Primary data source, 2023 (processed)

iv. **Sweet Potato Prices:** From the estimation of the independent variable, the price of sweet potato has a p-value of 0.001. The p-value is smaller than the 5 per cent significance level (0.05). Thus, the sweet potato price variable has a significant effect on the corn commodity share at the 5 per cent significance level. The coefficient value obtained is -6.35, which means that when there is an increase in the price of sweet potato by 1 per cent, it will decrease the share of corn commodity by 0.05 per cent, ceteris paribus. This shows that there is a negative correlation between the price of cassava and corn commodities. It can also be assumed that the two have a complementary relationship so that when there is an increase in the price of sweet potatoes, it will also reduce the share of corn commodities.

v. **Corn Expenditure Value:** The variable total expenditure value has a negative coefficient value of -1.75% meaning that when the total expenditure value increases, it will increase the market share of the corn commodity but this variable is not significant with a p-value of 0.10>0.05.

**Rice:** Table 6 is the result of an estimation model showing Vietnamese coffee prices and competitors in the US market. Based on the estimation results of the AIDS model of Vietnamese coffee in the United States market, the R-Square value is 0.6214. This value means that the diversity of rice commodity share proportions can be explained by the independent variable (free) of 0.6214 and the rest is explained by the independent variables.

The statistical p-value obtained from the estimation of the rice commodity AIDS model shows good results, where the p-value obtained is less than 0.05 or it can be said to be significant at the 5 per cent significance level (0.000 <0.05). This value means that the independent (independent) variables together can explain the dependent (bound) variable, namely the variable share of the rice commodity. Furthermore, the variables that influence the share of rice demand are explained as follows:

**Table 6: Coefficient of rice commodity**[7]

| Independent Variable | Rice | | |
|---|---|---|---|
| | Coefficient | t-value | p-value |
| Constant | 1,1252 | 16,80 | 0,001 |
| | 0,0670 | | |
| Corn Price | -0,0017 | -5,61 | 0,001 |
| | 0,0003 | | |
| Rice Price | 0,0038 | 1,52 | 0,148 |
| | 0,0025 | | |
| Cassava Price | -0,0024 | -1,82 | 0,087 |
| | 0,0013 | | |
| Sweet Potatoes Price | -0,0115 | -3,97 | 0,001 |
| | 0,0029 | | |
| Total Expenditure Value | -0,0112 | -0,36 | 0,721 |
| | 0,0308 | | |

[7] Primary data source, 2023 (processed)

i. **Corn Prices:** Based on the estimation results of the model, the independent variable of Indonesian coffee has a positive correlation with the share of demand for coffee imports from Vietnam in the United States market as indicated by a coefficient value of -5.61, and the p-value obtained is 0.001 so that the p-value is significant at the 5 per cent level of significance. Thus, the variable price of corn can be said to have a significant effect on the share of rice commodity.

ii. **Rice Price:** The price of rice shows a positive relationship to the share of demand for rice commodities as indicated by a coefficient value of 0.0003. This value shows that when there is an increase in the price of rice, it will be profitable because the demand share continues to increase. Even so, the rice price variable has no significant effect, where the p-value obtained is 0.148> 0.05, so the rice price variable has no significant effect on the share of demand for rice.

iii. **Price of Cassava:** The cassava price variable obtained from the model estimation results has a negative relationship to the share of demand for the rice commodity with a negative coefficient value of -1.82. The sign of the coefficient obtained indicates that the price of cassava has a negative relationship to the share of the rice commodity, so that when there is an increase in the price of cassava it will reduce the share of the rice commodity. The negative coefficient results suggest that there is a complementary relationship between cassava prices and rice commodities, but this variable has no significant effect because the p-value obtained is 0.087 > 0.05.

iv. **Sweet Potato Prices:** The sweet potato price variable has a negative correlation with the share of rice commodity demand with a coefficient value of -0.0115, the sweet potato price variable has a significant effect on the rice commodity demand share. This is because the p-value of the sweet potato price variable is smaller than the 5 per cent significance level (0.001 <0.05). Thus it can be said that the price of sweet potatoes has a significant effect on the share of demand for rice commodities. The negative sign on the coefficient value also indicates that the prices of sweet potatoes and rice have a complementary relationship so the prices of sweet potatoes and rice have a negative correlation.

v. **Expenditure Value:** The variable total expenditure value has a negative coefficient value of -0.0112%, meaning that when the total value of expenditure increases, it will reduce the market share of the rice commodity and this variable is not significant because it has a p-value of 0.721 greater than 0.01 which means this variable has no effect real.

**Cassava:** Table 7 is the result of an estimation model showing the prices of competitors' maize and cassava commodities. The estimation results on the AIDS model of Brazilian coffee in the United States market obtained an R-Square value of 0.67 per cent. This value means that the variation in the proportion of demand for cassava commodities can be explained by the independent (independent) variable of 0.67 per cent and the rest is explained by other (independent) independent variables outside the model.

The statistical p-value obtained from the estimation of the AIDS model for the cassava commodity also showed good results, where the p-value obtained was greater than 0.001 or it can be said to be significant at the 5 percent significance level (0.001>0.05). This value means that the independent (independent) variables together can explain the dependent (bound)

variable, namely the cassava commodity share variable. Furthermore, the variables that influence the share of cassava commodities are explained as follows.

**Table 7: Cassava Commodity Coefficient**[8]

| Independent Variable | Cassava | | |
|---|---|---|---|
| | Coefficient | t-Value | p-value |
| Constant | -0,0998<br>0,0481 | -2,07 | 0,055 |
| Corn Price | 0,0003<br>0,0002 | 1,59 | 0,131 |
| Rice Price | -0,0024<br>0,0013 | -1,82 | 0,087 |
| Cassava Price | 0,0015<br>0,0010 | 1,58 | 0,133 |
| Sweet Potatoes Price | 0,0103<br>0,0021 | 5,04 | 0,0001 |
| Total Expenditure Value | 0,0046<br>0,0226 | 0,21 | 0,840 |

i. **Corn Prices:** The corn variable shows a positive relationship to the share of demand for the cassava commodity, but this variable has no significant effect on the share of the demand for the cassava commodity. The p-value obtained is 0.131> 0.05 so the corn price variable has no significant effect at the 5 per cent significance level on the share of demand for cassava commodities

ii. **Rice Price:** The rice price variable in the model estimation results has a p-value of 0.087, this value is greater than the 5 percent significance level, so rice has no significant effect on the share of demand for cassava commodities. Meanwhile, rice and the share of wood commodities show a negative relationship as indicated by a positive coefficient value of -0.0024.

iii. **Price of Cassava:** The independent variable price of cassava shows a positive relationship to the share of demand for cassava commodities indicated by a p-value of 0.133. This value shows that when there is an increase in cassava prices, it will be profitable because the share of demand continues to increase. Even so, the cassava price variable has no significant effect, so the cassava price variable has no significant effect on the share of demand for cassava commodities.

iv. **Sweet Potato Prices:** Based on the results of the estimation, the independent variable price of sweet potato shows a positive relationship to the share of demand for cassava commodities as indicated by a coefficient value of 0.0103, which means that when there is an increase in the price of sweet potato by 1 per cent, it will also increase the share of demand for cassava commodities. of 0.0103, with other factors considered constant. The positive relationship between sweet potato and cassava prices also indicates that the two have a substitution relationship. The positive p-value is 0.001. This value indicates when the price of sweet potato increases; it can increase the share of demand for cassava commodities. However, sweet potato prices have a significant effect on cassava commodities.

[8] Primary data source, 2023 (processed)

v. **Expenditure Value:** The total expenditure value variable has a positive coefficient value of 0.0046%, meaning that when the total expenditure value increases, it will reduce the market share of demand for cassava commodities and this variable is not significant because it has a p-value of 0.840 greater than 0.05.

**Sweet potato:** Table 8 is the result of model estimation which shows that the sweet potato commodity competes with other variables. Based on the estimation results of the sweet potato commodity AIDS model, the R-Square value is 0.6714 per cent. This value means that the variation in the proportion of sweet potato commodity share can be explained by the independent variable (free) of 0.6714 per cent and the rest is explained by the independent variable

The statistical p-value obtained from the estimation of the AIDS model for the sweet potato commodity also showed good results, where the p-value obtained was less than 0.05 or it could be said to be significant at the 5 per cent significance level (0.000<0.05). This value means that the independent (independent) variables together can explain the dependent (bound) variable, namely the sweet potato commodity share variable. Furthermore, the variables that influence the share of demand for sweet potato commodities are explained as follows.

**Table 8: Coefficient of Sweet Potato Commodity**[9]

| Independent Variable | Cassava | | |
|---|---|---|---|
| | Coefficient | t-Value | p-value |
| Constant | -0,0785 | -2,71 | 0,015 |
| | 0,0289 | | |
| Corn Price | 0,0005 | 2,00 | 0,063 |
| | 0,0002 | | |
| Rice Price | 0,0004 | 0,20 | 0,843 |
| | 0,0019 | | |
| Cassava Price | 0,0006 | 1,18 | 0,254 |
| | 0,0005 | | |
| Sweet Potatoes Price | 0,0037 | 2,83 | 0,012 |
| | 0,0013 | | |
| Total Expenditure Value | 0,0142 | 1,24 | 0,233 |
| | 0,0114 | | |

i. **Corn Prices:** The estimation results of this model show that the independent variable corn price is also positively related to the share of demand for sweet potato commodities as indicated by a coefficient value of 0.0005, presumably because corn and sweet potatoes have a substitution relationship, so that when the price of one commodity from another increase, it will increase the share or share of demand for other commodities, but these variables do not have a significant effect on the share of demand for sweet potatoes.

ii. **Price of Rice:** The rice price variable has a positive correlation to the share of demand for sweet potato commodities, with a coefficient value of 0.0004, but this variable has no significant effect on the share of demand for sweet potato commodities. This is because the p-value of the rice price variable is greater than the 5 per cent significance level (0.843>0.05). Thus it can be said that the price of

[9] Primary data source, 2023 (processed)

rice has no significant effect on the share of demand for sweet potato commodities at the 5 per cent significance level.

iii. **Price of Cassava:** The cassava price variable shows a positive relationship to the share of demand for sweet potato commodities, but this variable is not significant to the share of demand for sweet potato commodities. Where the p-value obtained is 0.254> 0.05, the cassava price variable has no significant effect at the 5 per cent significance level on the share of demand for sweet potato commodities.

iv. **Sweet Potato Prices:** With the estimation results of the model, the sweet potato price variable shows a positive relationship to the demand share for the sweet potato commodity as indicated by the p-value of 0.012. This value shows that when there is an increase in sweet potato prices, it will be profitable because the share of demand continues to increase. Even so, the sweet potato price variable has a significant effect, where the p-value obtained is 0.012 <0.05, so the sweet potato price variable has a significant effect on the share of demand for sweet potato commodities.

v. **Expenditure Value of Sweet Potatoes:** Total variable Expenditure value has a positive coefficient value, which means that when the total value of expenditure increases, it will increase the share of sweet potato commodities by 0.142% and this variable is not significant because it has a p-value of 0.233 greater than 0.01 which means this variable has no effect significant effect on sweet potato commodity.

**Estimation Results of the Almost Ideal Demand System Model:**

The results of the estimation of the AIDS model without restrictions are estimates made without taking into account several properties that must be fulfilled by the demand function, namely adding up restrictions, symmetry restrictions and homogeneity restrictions. The value of the coefficient of determination (R2) is explained by the independent variable for each demand equation for food commodities without restrictions ranging from 62.14 per cent to 93.05 per cent. This value indicates the ability of the model to explain the actual situation.

**Table 9: AIDS Model Estimation of North Sumatra Sweet Potato Demand**[10]

| Independent Variable | Corn | Rice | Cassava | Sweet Potatoes | $R^2$ |
|---|---|---|---|---|---|
| Constant | 0,0531 | 1,1252 | -0,0998 | -0,0785 | |
| | ( 0,0102) | (0,0670) | (0,0481) | (0,0289) | |
| Corn Price | 0,0010 | -0,0017 | 0,0003 | 0,0005 | 0.9305 |
| | (0,0001) | (0,0003) | (0,0002) | (0,0002) | |
| Rice Price | -0,0017 | 0,0038 | -0,0024 | 0,0004 | 0.6214 |
| | (0,0003) | (0,0025) | (0,0013) | (0,0019) | |
| Cassava Price | 0,0003 | -0,0024 | 0,0015 | 0,0006 | 0.67 |
| | (0,0002) | (0,0013) | (0,0010) | (0,0005) | |
| Sweet Potatoes | -0,0003 | -0,0115 | 0,0103 | 0,0037 | 0,6714 |
| | (0,0004) | (0,0029) | (0,0021) | (0,0013) | |
| Total Expenditure Value | -0,0076 | -0,0112 | 0,0046 | 0,0142 | |

[10] Source: primary data, 2022 (processed)

| | | | | | |
|---|---|---|---|---|---|
| | (0,0044) | (0,0308) | (0,0226) | (0,0114) | |

The resulting equations that can be obtained from the results of data processing based on the Almost Ideal Demand System model, then a new equation for the commodity is obtained which will be described as follows:

The expenditure share referred to shows the %age of commodity-type expenditure to total expenditure.

$w_1 = 0{,}0531 + 0{,}0010\text{lln } p_1 - 0{,}0017\ln p_2 + 0{,}0003\ln p_3 - 0{,}0003\ln p_4 - 0{,}0076\ln \left(\frac{x}{a(p)}\right) + e_1$

$w_2 = 1{,}1252 - 0{,}0017\ln p_1 + 0{,}0038\ln p_2 - 0{,}0024\ln p_3 - 0{,}0115\ln p_4 - 0{,}0112\ln \left(\frac{x}{a(p)}\right) + e_2$

$w_3 = -0{,}0998 + 0{,}0003\ln p_1 - 0{,}0024\ln p_2 + 0{,}0015\ln p_3 + 0{,}0103\ln p_4 + 0{,}0046\ln \left(\frac{x}{a(p)}\right) + e_3$

$w_4 = -0{,}0785 + 0{,}0005\ln p_1 + 0{,}0004\ln p_2 + 0{,}0006\ln p_3 + 0{,}0037\ln p_4 + 0{,}0142\ln \left(\frac{x}{a(p)}\right) + e_4$

The above equation can produce an estimation of the sweet potato demand system which uses three restrictions, namely adding up, homogeneity and Slutsky symmetry. The sweet potato demand equation is estimated using the using up the restriction. By using homogeneity restrictions, namely the corn price coefficient, rice price coefficient, cassava price coefficient, and sweet potato price coefficient in the corn demand equation, if the sum is equal, the result is zero. Likewise the coefficients in the equation of demand for other commodities the result is equal to zero. While the Slutsky symmetry, namely: the estimated parameter of rice prices in the corn equation is the same as the estimated price of corn in the rice equation; the cassava price estimation parameter in the corn equation is the same as the corn price estimation in the cassava equation; The parameter for estimating the price of rice in the cassava equation is the same as the parameter for estimating the price of cassava in the rice equation.

**Demand Elasticity:** The Almost Ideal Demand System model in this study is a demand function that can describe the level of demand for various commodities. The results of the Almost Ideal Demand System analysis can be seen in the elasticity value of each commodity. Elasticity analysis is a parameter in the Almost Ideal Demand System (AIDS) method. These elasticities include own-price elasticity, cross-price elasticity and expenditure elasticity which form part of the demand analysis and are used to formulate a food policy. The value of elasticity can be used as information for economic actors, both producers, consumers and the government in making decisions and policies. It also supports optimizing the profits of a commodity.

The price elasticity value itself and the expenditure elasticity value describe the level of demand for the commodity itself. And the value of cross-price elasticity describes the level of competitiveness among other commodities. The demand function is obtained by looking at the effect of changes in economic conditions (price and income) on the quantity demanded, but in practice, this information is not enough to know whether income is increasing or decreasing. The measurement of elasticity needs to be reviewed to determine the sensitivity of the quantity to various factors in the study. The table and description of each elasticity value below will explain the elasticity of demand for sweet potatoes to changes in prices and income.

i. **Self-Price Elasticity:** Based on the estimation results from the Almost Ideal Demand System model, it can be seen that the own price elasticity value. The value of price elasticity itself is generally negative which describes the negative

slope of the demand curve which indicates that if there is an increase in the price of a commodity, demand will decrease. The elasticity value also explains that in general, the price elasticity value itself is negative (Norton et al, 2010)

**Table 10: Self-Price Elasticity**[11]

| Commodity | Price Elasticity | Elasticity Properties |
|---|---|---|
| **Corn** | **-3,75258** | **Elastic** |
| **Rice** | **-0,98483** | **Inelastic** |
| **Cassava** | **0** | **Inelastic** |
| **Sweet Potatoes** | **-3,76237** | **Elastic** |

Table 10 shows that self-price elasticity is negative according to demand theory except for positive cassava price. Rice and cassava are inelastic to changes in their prices, it can be seen from their elasticity values of less than one, namely 0.98483 and 0 respectively, which means that rice and cassava are commodities not affected by price changes. While corn and sweet potato have a self-price elasticity value of more than one each of 3.75258 and 3.76237 which are classified as elastic goods, meaning that corn and sweet potato are commodities that are responsive/influenced by price changes.

ii. **Cross Price Elasticity:** Cross-price elasticity measures the relationship between the quantities demanded of one good and the change in the quantity of another good demanded. This cross elasticity also measures the impact of changes in prices, income and prices of other goods, hereinafter referred to as substitute goods or complementary goods which can be seen from the effect of changes in the value of elasticity. The cross elasticity value is positive indicating that the commodity is a substitute for other commodities. While the negative sign indicates that the commodity is complementary to other commodities.

**Table 11: Cross Price Elasticity Signed Positive**[12]

| **Price** | **Commodity** | | | |
|---|---|---|---|---|
| | Corn | Rice | Cassava | Sweet Potatoes |
| Corn | - | 3,26084 | 4,38170 | 2,83006 |
| Rice | 0,00960 | - | 0,00891 | |
| Cassava | | | - | 0,65859 |
| Sweet Potatoes | 0,03020 | | | - |

Table 11 shows the cross elasticity values between the prices of corn and the commodities of rice, cassava and sweet potato which are positive, each of 3.26084; 4.38170; 2.83006 which shows that the three commodities are substitutes, which means that the price of

[11] Source: primary data 2023 (processed)
[12] Source: primary data 2023 (processed)

corn increases, the amount of corn demanded decreases while the demand for rice, cassava and sweet potatoes will increase.

The relationship between the cross-elasticity values between the prices of rice and the commodities of corn and cassava is positive, respectively 0.00960 and 0.00891 which indicates that the two commodities are substitutes, meaning that if the price of rice rises, the demand for rice decreases while the demand for corn and cassava will go up. The cross-elasticity condition between cassava prices and sweet potato commodities is positive, which is equal to 0.65859, indicating that the sweet potato commodity is a substitute, meaning that if cassava prices increase, the cassava demanded decreases while the demand for sweet potatoes will increase.

The condition of the cross-price elasticity between the prices of sweet potatoes and corn commodities is positive, which is equal to 0.03020 which indicates that the corn commodity is a substitute, meaning that if the price of sweet potatoes increases, the demand for sweet potatoes will decrease while the demand for corn will increase.

The cross-elasticity value which has a positive sign indicates that there is a competitive relationship between the commodity and other commodities or can be referred to as a substitute commodity (commodities replace one another).

**Table 12: Cross Price Elasticity Signed Negative**[13]

| Commodity | Elasticity Values | Nature of Properties |
|---|---|---|
| Corn | -3,22385 | Inferior |
| Rice | 0,98864 | Normal |
| Cassava | 1,54025 | Deluxe |
| Sweet Potatoes | 4,72452 | Deluxe |

Expenditure elasticity can describe a particular commodity whether it belongs to the food group which is a basic need (inferior) or a luxury. A commodity is said to be a basic need (inferior) if the expenditure elasticity value is less than one (E < 1), luxury if it is more than one (E > 1) and normal goods if the elasticity value is greater than zero and less than one (0 < E > 1)

Table 13 shows that the corn commodity has an expenditure elasticity value of less than one, which is equal to -3.22385. It can be seen that corn is included in the category of inferior goods, that is, if there is an increase in income, the demand for it tends to decrease.

The rice commodity has an expenditure elasticity value greater than zero and less than one, namely 0.98864. With an increase in income of 10 per cent, the amount of rice demanded will increase by 9.88 per cent. it can be seen that rice is included in the category of normal goods, that is, if income increases with a smaller increase in demand than the increase in income.

Cassava and sweet potato have respective elasticity values of 1.540 and 4.725, with an increase in income of 10 per cent, the amount of cassava and the amount of sweet potato demanded will increase by 15.40 per cent and 47.25 per cent. It can be seen that the increase in the number of commodities demanded is greater than the increase in income which indicates that cassava and sweet potato tend to be elastic to changes in income. Cassava and sweet potato indicate that both commodities are included in the category of luxury goods. This can be seen from the high prices of these two commodities. The high price of cassava and sweet potato causes these commodities to tend to have a higher prestige value than corn and rice so an

[13] Source: primary data 2023 (processed)

increase in income will cause an increase in demand for these commodities to be greater than an increase in income.

Economic theory states that if a certain basic need is needed in large quantities, then the item is inelastic compared to non-basic needs. The low elastic value of expenditure for corn commodities indicates that corn consumption is sufficient for basic needs, so it is not responsive to price changes. This will only cause a slight increase in demand for the corn commodity, but will divert expenditure to other commodities with lower consumption.

**Conclusion:**

The conclusions obtained from the Analysis of Demand for Sweet Potatoes in North Sumatra conducted in this study include:

i. The results of the analysis show that the factors that significantly influence sweet potatoes in North Sumatra are sweet potato prices from the corn commodity, sweet potato prices from the rice commodity, sweet potato prices from the cassava commodity and sweet potato prices from the sweet potato commodity.
ii. The sweet potato demand system model explained by the AIDS model is consistent with the demand theory. The resulting coefficient of determination is between 62.14 per cent and 93.05 per cent. Testing the parameters of the three restrictions, namely adding up, homogeneity, and Slutsky symmetry, succeeded in fulfilling the demand theory model.
iii. The price elasticity value itself shows that the elasticity value of sweet potato is elastic, while the elasticity value of cassava is inelastic. The value of cross-price elasticity is known that in general, all commodities have varying elasticity, some are positive and some are negative. The value of the elasticity of spending for the commodity of corn is included in the group of inferior goods/staple goods, the commodity of rice is included in the group of normal goods while the commodities of cassava and sweet potato are included in the group of superior/luxury goods.

**Suggestions:**

Suggestions that can be given by researchers in this study are as follows:

i. It is necessary to carry out further research by expanding the scope of the commodity under study. To avoid a zero value in calculating the proportion of expenditure, it is better to use commodity grouping.
ii. It is necessary to modify the model by adding social and demographic variables. With the addition of these variables, it is hoped that the study of consumption patterns can be analyzed from many perspectives.

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