Modeling the Future of Indonesian Food Consumption:
Final Report

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Executive Summary

Modeling the Future of Indonesian Food Consumption

The growing food consumption demand in Indonesia has provided serious challenges for food policy which will have an impact in the years to come. Existing policies to increase the production of staple foods such as rice, maize and soybeans (*Upsus Pajale*) may not be adequate to meet increasing food demand. A growing population and middle class in Indonesia, and a high rate of urbanization have led to changes in the dietary patterns and food demand of the future. Higher incomes and better knowledge tend to make consumers demand healthier and more diversified food.

This study aims to develop a model of the future of Indonesia's food demand up to 2045, using a baseline of food consumption in 2017 and projections to 2025 as milestones, and to draw policy relevance on food and related issues including the Medium-Term Development Planning (RPJM) of 2020-2024 by Bappenas. Food commodities include rice, maize, soybeans, sugar, beef, poultry, and fruit such as oranges, apples, bananas, mangoes and snake fruit, and vegetables such as shallots, garlic, red chilies, hot chilies, spinach and kangkung (swamp cabbage). The projected demand of Indonesian food consumption for 2025 and 2045 is built based on the functional relationship between income and food consumption at the baseline using three different scenarios of economic growth: baseline, moderate and optimistic. The food projections are built on some assumptions of population projections, composition of rural-urban population, income per capita and food affordability per capita. Almost Ideal Demand System was implemented to estimate estimated changes of food consumption with regard the changes of it's ownr price, other food price and income. Susenas data from 2017 is used as the baseline of food demand model, including income elsticities estimation. Impact of own price, cross elasticities and income elacticities were predicted using the almost ideal demand system (AIDS) model. Susenas data from 1990-2016 is used to analyze selected food consumption trends and examine the relationship between food consumption, price trends, and income in all 33 provinces of Indonesia.

The results show that future food demand in Indonesia is determined by existing demand, income, price and its composition, and various other factors that affect the behavior and trends of consumption. Average rice consumption in 2017 was recorded at 97.6 kilograms per capita per year, which was significantly lower than the official rice consumption on 114 kilograms per capita. Average consumption of beef, as a protein source, is extremely high in the highest income group. Average beef and poultry consumption in Quintile 5 is 6 and 14.7 kilograms per capita per year respectively, which is higher than the national average of 2.5 and 7.5 kilograms per capita per year. A contrasting figure is found in maize consumption for humans, which averages 2 kilograms per capita per year, but this figure declines as income increases.

The per capita rice consumption projection at the baseline gradually increases by 1.5 percent to 99.08 kilograms per capita per year in 2025 and increases by 2 percent to 99.55 kilograms per capita in 2045. The projection of the demand for rice, after referring the correction factors at Food Balance Sheet (NBM) for the domestic uses of food for non-food purposes, such as industrial use for non-food, feed, seed, food loss, also increases to 102.73 kilograms per capita per year in 2025 and 103.22 kilograms per capita per year in 2045. The demand for rice is also projected to increase to 127.09 kilograms per capita in 2025 and 127.70 kilograms per capita 2045, after considering food loss and waste in line with the FAO (2011). Rice consumption has different characteristics among different income groups and in rural and urban areas. Only in the highest income group has Indonesia experienced declining rice consumption, which is somewhat different from other Asian countries, where rice consumption declines are also found in medium and lower level income groups.

The poultry consumption projection shows the highest increase compared to other animal products, which is 22.1 percent in 2025 to 9.13 kilograms per capita per year, and 29.3 percent in 2045 to 9.66 kilograms per capita per year. The beef consumption projection increases by 10.3 percent to 2.79 kilograms per capita per year in 2025, and 20.4 percent to 3.04 kilograms per capita per year in 2045. The fish consumption projection increases by 11 percent to 29.09 kilograms per capita per year in 2025 and 14.6 percent to 30.04 kilograms per capita per year in 2045. Beef is consumed by higher income groups in urban areas. Poultry is consumed by all income groups, including the lowest quintiles. Fish is consumed by both the urban and rural population.

In the category of fruit and vegetables, the highest food consumption demand projection per capita relates to apples, with an increase of 55 percent in 2025 to 1.49 kilograms per capita per year, and 73.5 percent in 2045 to 1.66 kilograms per capita per year. Consumers of apples are mostly part of the urban population in high and medium income groups. The projected demand for local fruit such as oranges, bananas, snake fruit and mangoes in 2025 and 2045 is not as high as apples, and this demand is dominated by imported apples.

The projected demand for sugar is 8.98 and 9.12 kilograms per capita in 2025 and 2045 respectively. The increase in sugar consumption is not very significant, compared to other food commodity groups. The total consumption of sugar is projected to reach 25.6 million tons in 2025 and 29.1 million tons in 2045. The projection estimates of sugar consumption do not include indirect consumption of sugar in the form of cakes, drinks and other food products that use refined sugar and its derivatives, so the figure may be higher.

As rice remains a staple food, even in 2045, the policy relevance is that elements of food consumption could determine the level of food accessibility, and therefore food security in the country. Ensuring access to rice, especially for low and middle-income groups, is as important as the stability of the retail price of rice. The policy of food assistance targeting the poorest group of rice consumers remains relevant to maintain food and nutrition adequacy. As the government is planning to transform in-kind food assistance to non-cash subsidies, the implementation of such targeted subsidies could be adjusted in line with the latest development of infrastructure, data technology and preparedness of the stakeholders in the overall food system.

As the income elasticity of beef, poultry and fish remains high, the policy relevance is based on infrastructure improvements of the marketplace, including both modern retail markets and traditional markets which could shape the performance of value chains of these sources of animal protein. The value chain policies not only directly affect food accessibility among all income groups, but also affect many value chain players, such as retailers, processors, wholesalers, and collector traders that directly connect rural areas to farmers or producers of protein sources. These players could also help convey the messages of urban consumers to farmers and other actors along the value chains, including product specifications, food safety, health and hygienic requirements, and halal and other quality standards that have shaped the characteristics of the value chains of these protein sources.

For perishable fruit and vegetable products, the policy relevance is that actors in fruits and vegetable value chains need access to cold-storage facilities, including medium scale controlled atmosphere systems (CAS) which could improve the efficiency of horticulture products. The policy should also focus on the balance between demand-side management and supply-side or productivity improvement, as the majority of horticulture production centers are located in Java. As the majority of horticulture products are marketed through cooperation with the wholesale markets (*pasar induk*), large and medium cities should implement spatial planning and zoning policies for end-to-end waste management in these traditional horticulture markets. The policy relevance is that there is a need to

support farmers who could meet rising quality and safety standards set by retail markets, or by consumers, through modern retail markets and supermarkets.

The food demand modeling exercise in Indonesia in this study is mostly aimed at strengthening national level policy analysis. Specific models for regional or sub-national levels might follow similar procedures, but extra care should be given to the structure and availability of Susenas data as the baseline. The government will play an important role in the response to the results of this study, and in anticipating various changes in demand for selected important foods in Indonesia.

Foreword

The Final Report of the study "Modeling the Future of Indonesian Food Consumption" is complete. This study was conducted to fulfill the request by the National Development Planning Agency (Bappenas), the World Food Programme (WFP) and Food and Agricultural Organization of the United Nations (FAO), through support from the Australian Government. The results of this study could serve as an important reference for the formulation of Medium-Term Development Planning (RPJM = Rencana Pembangunan Jangka Menengah) for 2020-2024, which is an important mandate of Bappenas.

The study involves extensive work including literature reviews, data gathering and analysis from a series of National Surveys of Social and Economics (Susenas) in the last 17 years from 1990-2016, and a detailed data processing, data cleaning and modeling exercise based on the baseline of Susenas data from 2017. The projected demand of Indonesian food consumption for 2025 and 2045 is built based on the functional relationship between income and food consumption at the baseline using three different scenarios of economic growth: baseline, moderate and optimistic. The food projections are built on some assumptions of population projections, composition of rural-urban population, income per capita and food affordability per capita.

We would like to express our sincerest thanks and appreciation to Minister Bambang P. Brodjonegoro of Bappenas, WFP Country Director, Anthea Webb, and Mark Smulders, FAO Representative in Indonesia, for providing the opportunity to conduct this study. Special thanks should also go to officers in Bappenas including: Director of Food and Agriculture, Anang Noegroho, and his predecessor, Sri Yanti JS, who were very helpful in providing insights and direction for the study, and Jarot Indarto, who was very helpful in providing access to a complete set of Susenas data and other logistical issues. Special thanks and appreciation should also go to Katarina Kohutova who was very helpful with the development of the Terms of Reference (TOR). We would like to thank Saidamon Bodamaev of WFP, who provided comments on the draft of the report. We would also like to thank independent reviewers of the FAO, the Australian Embassy, DFAT and workshop participants who provided us with useful comments and stimulating discussion.

We also welcome more comments and feedback on this Final Report, with a view to improving food policy in Indonesia.

Jakarta, May 25, 2018

Bustanul Arifin

Team Leader

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Chapter 1
Introduction

1.1 Background

This is the Final Report of the study "Modeling the Future of Indonesian Food Consumption", combining desk analysis, modeling exercises, results of technical and policy workshops attended by major stakeholders in the food and agriculture industry, meetings and consultations with the National Development Planning Agency (Bappenas) and several in-depth discussions among the team and the World Food Programme (WFP). This Draft Final Report also serves as an important reference for the formulation of the Medium-Term Development Planning (RPJM = Rencana Pembangunan Jangka Menengah) from 2020-2024 convened by Bappenas and respective long-term development planning. Therefore, in this report, the concerns are not only about the scope and focus of food commodities, but also about policy relevance for future development planning in the food industry sectors and economic development in general.

This report has drawn considerably on the useful comments and suggestions from external reviewers since the Inception Report and related Progress Report on initial analysis results of focused food commodities, and the trends in the last 17 years from 1990-2016 of 17 food commodities, based on the results of the National Social-Economic Survey (Susenas) and other relevance sources. Earlier works on food demand in Indonesia are also used as the basis of analysis in the current study, not only focused on modeling, but also on the determinants of food demand and policy scenarios for long-term demand in Indonesia. In this study, Indonesia is not treated as a closed country, but as an open country where export and import activities are part of the economic portfolio. Food prices in the domestic market are not sterile from the international market, and neither is the food demand for focused commodities.

The growing demand of food consumption in Indonesia has provided serious food policy challenges for the current government and these will continue in the years to come. Existing policies to increase the production of staple foods like rice, maize and soybeans (*Upsus Pajale*) might not be adequate to meet the increasing food demand. For the existing total population of 261 million, and the growth of 1.43 percent per year, coupled with increasing income growth of 5.01 percent per year especially among middle class, fulfilling the growing demand for food in Indonesia is not an easy task. Using the standard food-demand equation of Johnston-Mellor, the growth rate of food demand in Indonesia is estimated about 4.03 percent per year (using income elasticity for food is 0.52). When food production domestically is inadequate, food imports are necessary and economically justified, however, political considerations must also be taken into consideration, given Indonesia's adoption of food sovereignty Food Law 18/2012.

The United Nations Population Division (2015) projects that Indonesia's population will grow approximately 0.7 per cent annually to reach around 312 million in 2045. The real value of food production is projected to more than double in 2050 (Gunning-Trant et al., 2015). Indonesian policy does not seem to tolerate food import dependency, especially with regards to rice as a staple food, and the government has been under pressure to increase local food production, sometimes at a very high cost to the state budget. Large fluctuations in prices have meant large fluctuations in the purchasing power of both consumers and farmers, and it has been difficult for many to adapt to these frequent changes. Moreover, the world rice market has been unstable, much more so than other world grain markets, especially after the sharp price increases after the global food crisis in 2008-2009. On the whole, food security has improved in recent years but, as a result of climate

change, more frequent cases of extreme weather and environmental risks such as droughts, floods, and landslides in food-production centers in Indonesia have posed serious risks to farming practices and crop production.

In the meantime, estimates of food consumption in Indonesia are not easily verified directly in the field. For example, the level of rice consumption in Indonesia has declined significantly from nearly 140 kilograms in 2006 to only 124 kilograms per capita per year in 2015. Nevertheless, rice consumption in Indonesia is very high compared to other Asian countries, which have an average of less than 100 kilograms per capita per year. Such a high level of rice consumption could trigger more problems for the Indonesian economy, including political controversy surrounding rice imports, although problems of data accuracy have been used in the past as an excuse by various political factions. Indonesia issued Presidential Regulation 22/2009 on food diversification to reduce the pressures on rice consumption, although such a diversification movement in the last decade has been operational only on paper. This procedural movement should be combined with the development of food technology, using simple know-how that is modern in nature, which complements and is compatible with Indonesia's current food production systems.

Moreover, a growing middle class in Indonesia and a high rate of urbanization have led to changes in dietary patterns and food demand both now and in the future, from fulfilling the demand for cereals or the consumption of 2.100 kilocalories per capita, to diversifying diets towards more balanced nutrition. Obviously, food demand in Indonesia will increase in quantity and quality as population and income increases, and awareness of balanced nutrition also increases. Better income and knowledge tends to make consumers demand healthier and more diversified food. Demand for cereals may decrease while consumption of fruit, vegetables, meat, fish and dairy products is likely to increase. For example, in the period from 1990-2013, consumption of fruit and dairy products doubled, especially among middle and high income groups. In other words, changing socio-economic-demographics will transform food systems in the future. Envisioning that transformation is a pivotal part of understanding our future food systems. This study seeks to model food demand in Indonesia until 2045, as one of the prerequisites to develop better food policies.

1.2 Objective

The general objective of this study is to develop models of the future of Indonesia's food demand up to 2045 and to draw policy relevance on food and related issues in the future. As a first step, the demand projection covers Indonesian food demand from the baseline year of 2017 to 2025 as a milestone. The second step will develop models for the next 20 years from 2025 up to 2045 as a benchmark of 100 years following Indonesian independence.

The specific objectives of this study consist of the following sequential steps, namely:

1. Identify determinant factors of Indonesia's food consumption and demand
2. Develop models to estimate food demand in 2025 and 2045
3. Develop scenarios to forecast food demand
4. Elaborate on the current trends in food consumption
5. Formulate policy recommendations based on the findings of the above analysis
6. Disseminate the results of the model to government officials through workshops and training sessions to improve the knowledge of relevant officers in the National Development Planning Agency (Bappenas)

1.3 Expected Output

The expected output of this study is a comprehensive report, consisting of:

1. Models on the future of Indonesia's food demand until 2045
2. Specific consumption and demand for commodities or commodity groups
3. Policy relevance based on important trends and scenarios

Chapter 2

Scope of Analysis

2.1 Commodity Focus

The scope of the study covers a general projective analysis of the future of Indonesia's food consumption towards 2045. A more robust food demand projection can be developed up to 2025, using historical data and a baseline of 2017. From the projected demand for food in the medium term to 2025, a long-term demand projection will also be developed for 2045 or the centennial of Indonesian independence in 1945. As commonly conducted in studies of this kind, the current study also covers the following aspects related to food consumption: estimated demand of food for non-food consumption purposes, particularly for non-food industries, feed, seed, and estimated food lost.

Initial discussions among the research team and the World Food Programme (WFP) have come up with several important food commodities that have been analyzed comprehensively in the study. As mentioned previously, intensive consultations and discussions with the National Development Planning Agency (Bappenas) have so far agreed on the food commodities that have strategic dimensions to Indonesian economic development. The projected food demand is used as a basis of policy formulation in terms of food production, stocks, distribution and regional dimensions. Immediate objectives of this food projection will be used as important information and guidelines for formulating Medium-Term Development Planning (RPJM) from 2019-2024, that should commence in the middle of this year, or June-July 2018.

The food commodities covered under this study include the following:

- Rice, a major staple food.
- Maize, a secondary crop and important feedstock for the feed industry.
- Soybeans, an important source of protein, either consumed directly or processed as tofu, tempeh, and soy sauce.
- Sugar, usually projected as having an increasing rate of consumption as the food industry develops.
- Beef, an important source of protein. Beef imports are conducted to fulfill consumption.
- Poultry, a protein source for all levels of the population, as the price is relatively cheap.
- Fruit, a source of vitamins and fiber. Indonesia is known to have some of the lowest fruit consumption figures in Asia. Fruit consumption includes oranges, apples, bananas, mangoes, and snake fruit.
- Vegetables, important sources of vitamins and fiber, but generally less consumed in Indonesia. Important vegetable commodities in Indonesia include shallots, garlic, red chilies, hot chilies (cayenne), spinach and kangkung (swamp cabbage).
- Fish, a healthy source of protein, including shrimp, crustaceans, and salted fish.

2.2 Desk Study

The desk study and literature reviews in this research examine the determinant factors of Indonesia's food demand, covering the details of food availability, access to food and food nutrition. This study analyzes socio-economic factors such as: education levels, nutrition and health knowledge/awareness, income levels, income elasticity, changes in price and purchasing power, demographic factors (such as the population, population growth, urbanization, and shifts in labor composition from high energy to sedentary), and other relevant factors to determine the demand for food in Indonesia.

Literature reviews are conducted for similar or relevant studies in other countries, in order to obtain some general patterns on the trends of food consumption/demand in other developing countries with regards to socio-economic-demographic changes and determinants. The review also covers general food policy and specific policies on commodities or commodity groups in other countries, food and nutrition policies, socio-economic factors, demographics and public health/epidemiological transition situations.

2.3 Data

The following lists, although not exhaustive, include the data needed to estimate the projected demand for food consumption in Indonesia of 2045, namely:

a. Household Consumption based on Social-Economic Survey SUSENAS: 1990-2016.

b. Food Consumption Raw Data based on Social-Economic Survey SUSENAS 2017.

c. Population Growth and Number (BPS-Bappenas).

d. Economic and income growth (BPS-Bappenas).

e. Food availability, domestic uses: non-food industry, seed, feed and food loss from Food Balance Sheet data (BPS, MoA).

f. Other relevant data for verification on food loss and waste (FAO publication) and other uses.

Chapter 3

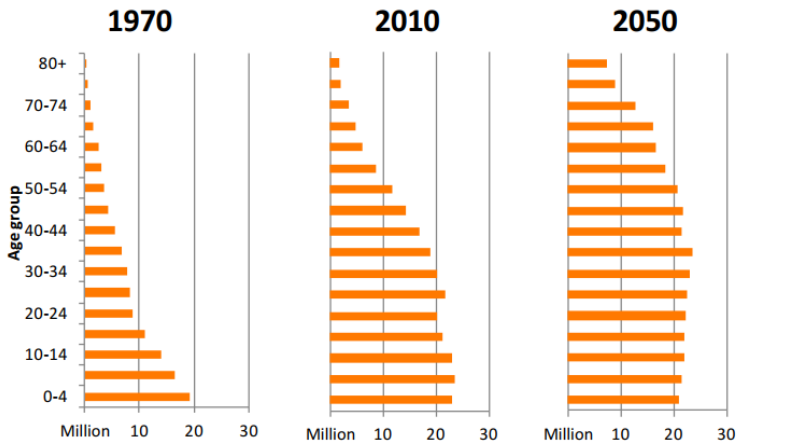
Determinants of Indonesia's Food Demand: Emprical Evidence

Food consumption has always been an imperative issue for any ruling Indonesian government. The highly-regulated staple foods market has a strategic role in the Indonesian economy. Socio-economic and demographic factors are also important for estimating future food consumption. Therefore, it is important to identify the determinants of Indonesia's food demand, in terms of the socio-economic and demographic background, as will be explained below (Appendix 1).

3.1 Food Demand Determinants

(a) Population

Population is one of the key determinants of food demand in a country. Growing populations are positively correlated to food demands, as well as to specific food products. Current population growth in Indonesia requires the production of more food. Within twenty-seven years (by 2045), the population of Indonesia will reach 318.6 million (Bappenas, 2017). Food consumption and the demand for food are not only determined by the population, but also by the population structure or population pyramids, which will represent the composition of population by age and sex (see Figure 1). The shifting of age composition determines type of food, preference, and the volume of food demand. The shifting composition of urban and rural populations also affects the patterns of food consumption. A rising urban population will change food preferences and the demand for food in general as urban residents generally have higher purchasing power (see Figure 4). Urban residents work mostly in the manufacturing and service sectors, thus changing the patterns of food consumption from food prepared at home to prepared food bought and consumed in the workplace. In short, shifting population composition of urban and rural and of youths and adults, shown by changing population pyramids, will lead to a higher average daily food requirement due to the increase of average RDAs (Recommended Dietary Allowances) of the population.



Source: 'World population prospects, the 2015 revision', United Nations Population Division (United Nations Population Division 2015)

Figure 1: Trend of population growth in Indonesia: From Pyramid to Bullet

In 2045, Indonesia will experience substantial population growth - an increase of 63.9 million or 25.05 percent (Figure 1). The working age population will continue to increase, but the share of younger groups (aged 15-29) will decline. The labor force is projected to grow over the next 30 years at an annual rate of 0.7 percent. By 2045, the labor force is projected to reach 172.1 million.

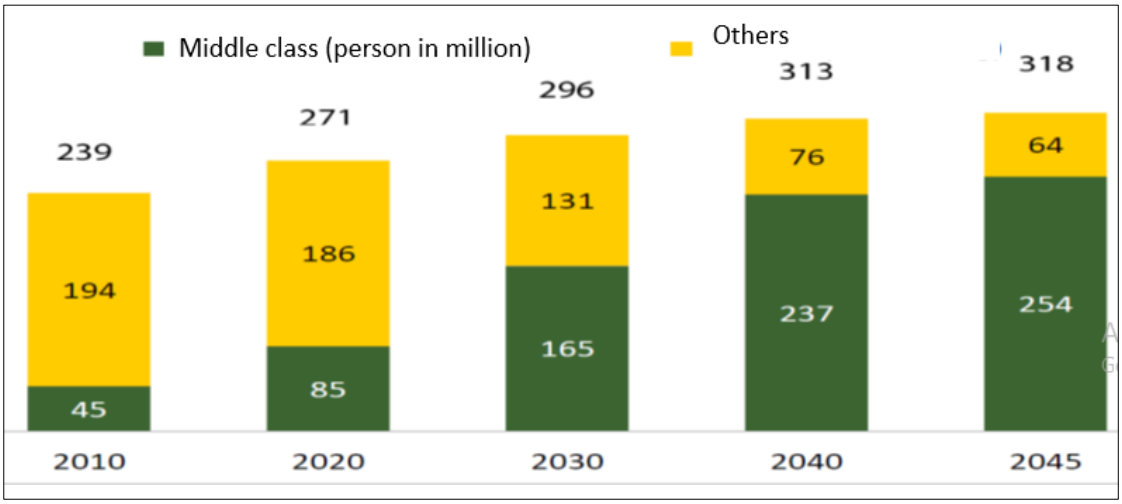
The consequences of population growth and labor force growth will include productivity improvement, and trading systems in the agriculture sector are essential.

(b) Income (GDP Per Capita)

The other of key determinant of demand is the level of income (GDP per capita) evident in the country. Indonesia has shown economic development that has resulted in increased purchasing power, causing not only a demand for more food, but also for other primary goods. Increasing income per capita is one of the economic development indicators. When income rises, so too will the quantity of demand. When income falls, so will demand. But if income doubles, the demand for goods and services will not always increase to twice as much the initial demand. Other things equal, the estimated demand is very much dependent on income and food preferences. The demand for each individual food commodity will have different responses to changing income. In other words, each food commodity has different income elasticity, although the final response is also determined by the functional relationship between food consumption and per capita income.

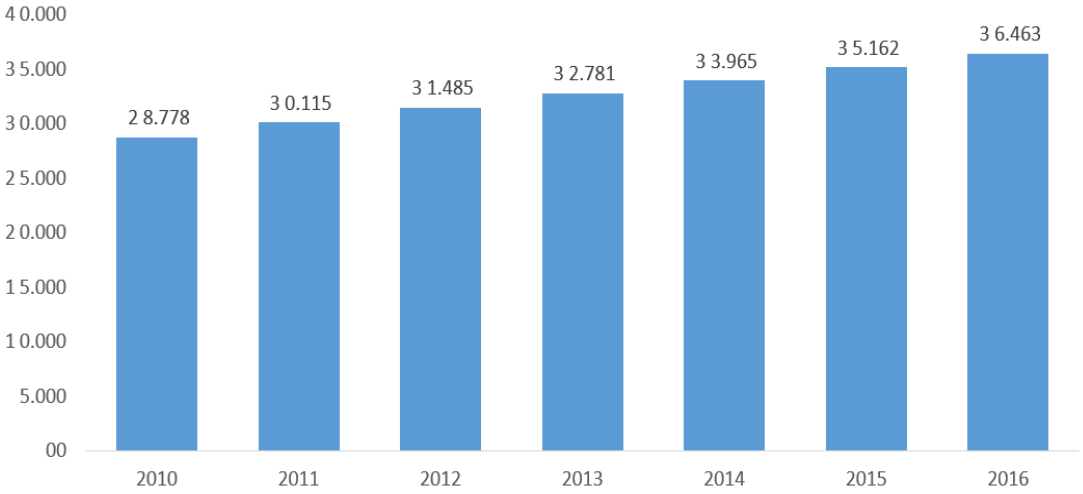
High and inclusive economic growth will lead to a rising middle income class in Indonesia (Figure 2). The Indonesian middle-class population in 2020 is estimated to reach 85 million people (31 percent of the population), and in 2030 up to 165 million people (56 percent of the population). In 2040, it is projected to rise to 237 million people (76 percent population), and in 2045 to 254 million people (80 percent of the population). The growth of the middle-income class in Indonesia has consequences for the increasing quality of food and nutrition. Stakeholders need to identify potential consumers' behavior and consumption patterns.

The GDP per capita in Indonesia was Rp36.46 million as of 2016 (Figure 3). Over the past 56 years, this indicator has fluctuated between Rp5.97 million in 1967 and Rp 36.46 million in 2016.



Source: Bappenas, 2017

Figure 2: Middle class income in Indonesia (2010-2045)



Source: BPS, 2018 (in 000 Rp)

Figure 3: GDP per capita at 2010 constant market prices

(c) Price

The law of demand states that when prices rise, the quantity of demand falls. That also means that when prices drop, demand will grow. People base their purchasing decisions on price if all other things are constant. If the quantity demanded responds significantly to price change, then it is known as elastic demand. If the volume does not change much, regardless of price, it is known as inelastic demand. Increases in food prices can lead to changes in purchasing behavior, but it depends on elasticity estimates. Table 1 shows commodities price trends from 2010 until 2017.

Table 1: Average retail price of important food commodities, 2010-2018 (in Rupiah)

No	Commodity	2010	2011	2012	2013	2014	2015	2016	2017
1	Rice	6,512	7,373	8,056	8,409	8,936	10,149	10,685	10,665
2	Dry shelled corn	4,206	4,880	5,260	5,736	6,204	6,465	7,122	7,139
3	Soybean (Local)	8,483	8,813	9,216	10,055	10,634	10,934	11,079	10,707
4	Soybean (Import)	8,096	8,326	8,797	9,818	11,152	11,086	10,793	10,669
5	Shallot	17,068	18,955	14,188	34,338	22,122	25,246	39,274	31,272
6	Garlic	n/a	n/a	n/a	20,621	16,047	21,073	35,866	34,853
7	Sugar (Local)	10,740	10,665	12,003	12,242	11,301	12,363	14,399	13,359
8	Sugar (Import)	10,301	10,552	11,864	12,422	n/a	n/a	n/a	n/a
9	Beef	66,329	69,733	76,910	90,402	99,398	105,345	113,555	115,932
10	Broiler Chicken	24,166	20,872	25,323	28,032	26,350	30,100	31,334	30,743
11	Local Chicken	42,067	45,503	48,906	48,934	59,029	61,656	62,360	64,034

Source: Ministry of Agriculture, 2018 (http://www.pertanian.go.id)

(d) Availability and Price of other Goods

Consumption of other goods is also influenced by the alternative options facing consumers in the market. The availability of other goods, and their prices, are important factors in determining the

elasticity of demand, both in the short term (static) sense and over time (long run). Complementary goods are the goods that complement each other, such as vegetables like garlic or coffee and sugar. The demand for complementary goods is positively correlated with the prices of the goods. If vegetable prices increase, the demand for the vegetable decreases, so in this example the demand for garlic decreases. Substitute goods are the goods that substitute each other, such as beef and poultry or rice and wheat. The demand for substitute goods is negatively correlated with the price of the goods. If beef prices increase, the demand for beef decreases, hence the demand for poultry increases.

(e) Taste and Preferences

The demand for goods is affected by collective and individual tastes and preferences. These patterns are partly shaped by culture and partly implanted by information and knowledge of products and services (including the influence of advertising). Various societies use food products differently because of these differences in taste and preferences. When the public's desires and preferences change in favor of a product, so does the quantity demanded. Likewise, when tastes turn against a product it depresses the amount demanded. Brand advertising tries to increase the desire for consumer goods.

1.2 Previous Studies on Indonesia's Food Demand

Studies of food demand in Indonesia have been conducted in conjunction with food security issues, which normally refer to main dimensions, namely: availability, accessibility and utilization. Food availability means that, on average, sufficient food supplies should be available to meet consumption needs. Food accessibility draws attention to the fact that, even with bountiful supplies, many people still go hungry because they do not have the resources to produce or purchase the food they need. Food utilization refers to many aspects of food safety and food quality to fulfill the degree of nutritious food absorbed by the human body. One should note, however, that very high food prices cause the majority of the population to be unable to purchase adequate food and food security can be a serious problem, even if food is plenty and available in the country. Stability refers to minimizing the probability that, in difficult years or seasons, food consumption might fall below requirements. Food security concerns the individual or family unit, and its main determinant is purchasing power at the income adjusted for the cost of living.

Food security issues in Indonesia are quite complex, not only because the scopes are cross-boundary at individual, household, national and global levels, but also because the dimensions are quite wide and include food availability, accessibility and price stability. At a global level, Indonesia ranks 69 among 113 countries in the Global Food Security Index (GFSI) published by the Economist Intelligence Unit in September 2017, far below the first and second rankings of the United States and Singapore. Indonesia is below its ASEAN peers such as Malaysia (41), Thailand (55) and Vietnam (64), mostly because food access in Indonesia is quite low. The poverty level in Indonesia is still very high by ASEAN standards, and the number of people under the poverty line in 2017 was over 26.6 million (10.1 percent). This group of people is very vulnerable to food price changes and production declines due to climate change and extreme weather such as droughts, floods, and natural disasters.

Food consumption in Indonesia determines the level of food accessibility, especially rice consumption as the staple food of the poor and their vulnerability to price changes and production declines. As mentioned previously, rice consumption in Indonesia has declined significantly, from nearly 140 kilograms in 2006 to only 124 kilograms per capita per year in 2015. Rice consumption

estimates in 2017 have declined significantly, according to the Susenas data, which includes direct consumption, rice being used for seed and rice consumption by the industry. Given that the production performance is somewhat dependent on environmental risks, and natural and economic volatility, high consumption levels of rice would correlate to the amount of rice traded in the world market. Problems usually arise when the world rice trade and distribution activities are not operated properly due to mismanagement at a bureaucratic level linked to rice price stabilization and consumption subsidies.

According to Peter Timmer, food security strategies in the Asia-Pacific region are in "almost total disarray" or sometimes known as 'food policy paradox'. Timmer (2013) describes the problems of a fundamental disconnect between "food security strategies" and the actual "food policies" pursued by most Asia and Pacific countries. The disconnect is most evident with rice policy, where high prices for rice farmers are implemented to 'reduce poverty', when in fact most of the poor and hungry in the region are net rice buyers (some regions in Vietnam and China might be exceptions) and thus suffer more hunger and poverty from high rice prices. The disconnect between politically expressed food security strategies and actual policies put in place to implement these extends well beyond rice price policies, especially as a result of low public spending for research and development on food policies and agricultural development in general.

A study on the long-run dynamics of rice consumption was conducted by Timmer et al. (2010), commissioned by the International Rice Research Institute (IRRI), by disaggregating rice consumption in 11 countries by income or household expenditure, by quintile and by rural and urban population. Rice consumption in China, India and Indonesia accounts for 60 percent of world consumption. Other major rice consumers in Asia are the Philippines, Bangladesh, Vietnam and Thailand, although Vietnam and Thailand are also rice exporters.

Some important findings of the study can be summarized as follows: Firstly, rice consumption experiences sharp differences according to income class for a given country or region at one point in time, especially if that income class is quite poor. Secondly, large differences between rural and urban rice consumption are common, but the differences change substantially over time and by income class. In most important rice-consuming areas, rural rice consumption is significantly higher than urban rice consumption. These patterns have sharp implications for future levels of rice consumption, when a larger share of the population will work in urban areas. Thirdly, the income elasticity of demand for rice from cross-section data depends on whether the household lives in a rural or urban area. Most income elasticities for urban households are now zero or negative, which confirms the behavior of Engel curves, which are flattening out during progressive time periods; they are also falling in absolute terms. Income elasticities are more positive in rural areas, because incomes in these locations are lower on average. Fourthly, there is a very dramatic convergence of rice consumption patterns across income classes in some Asian countries. This convergence is partly a result of flattening Engel curves across income classes as overall income levels rise, but it is also possible that tastes are changing in ways that make food consumption patterns more uniform across households, whatever their income levels and place of residence. Furthermore, tastes are changing to become more homogeneous, especially in urban areas. For example, in rural areas in China, the latitude of the capital city is a strong determinant of per capita rice consumption. But in urban areas, this relationship is breaking down and provincial production of rice has relatively little impact on urban consumption. As a result, tastes are becoming more homogeneous in urban areas, with traditional rice eaters reducing rice consumption and traditional wheat eaters increasing rice consumption.

Declining rice consumption is quite common in most rice producing countries in Asia, although the rate of decline in Indonesia is quite small. As such, the dynamic declines of rice consumption

are generally consistent with Bennett's Law, which originated in 1954 and argues for an inherent desire for dietary diversity as incomes rise. Reardon and Timmer (2012) suggest that rural consumers in Asia fulfill about 70 percent of their daily calories from rice, as Asia is the only region in the world where a single food so dominates consumption patterns. More open trade, global communications and economic growth in most Asian countries has contributed to declining rice consumption and even to the negative income elasticity of the demand for rice. In this case, rice might eventually be associated with the food of the poor, although high income consumers in Indonesia might shift their consumption to premium or high quality rice. As a result, the stability of the price of rice remains a relevant policy issue for Indonesia and other rice producing countries in Asia.

Increases in internal food prices, including rice, during the Food Crisis from 2007-2008 also raised poverty levels in Indonesia. The effect was significant, but not large and only temporary (Warr and Yusuf, 2014), as the weather was conducive to food production and the domestic food stock was sufficient to keep the increase in food prices manageable (Arifin, 2015). However, the percentage increase in poverty was larger in rural areas than urban areas, despite the fact that, for many of the rural poor, higher agricultural prices mean higher incomes. Their gain was outweighed by the losses incurred by a large number of the rural poor who are net buyers of food and the fact that, for these people, food represents a large share of their total budget, even larger on average than for the urban poor. Until recently, at the time of writing this report in May 2018, the food price has predominantly (73.4 percent) determined the poverty line in Indonesia, while the non-food price determines the remaining 26.6 percent. Among food commodities, the price of rice contributes to 24.5 percent of the poverty line in rural areas and 18.8 percent in urban areas. The price of cigarettes ranks as the second most important contribution to the poverty line in rural areas, followed by the price of beef, eggs, chicken, instant noodles and sugar. Therefore, food policy that addresses food-price stability might be one of the most important factors in maintaining food security policy in the country, and inform the political dimensions of food sovereignty strategies in Indonesia. The current government administration does not restrict rice imports explicitly, but stipulates that rice imports be conducted through Bulog, a state-owned enterprise that has a mandate to contribute to the price stabilization of 11 commodities of staple foods and other important foods. According to Presidential Regulation 48/2016, Bulog is assigned to stabilize the price of rice, maize, sugar, soybeans, cooking oil, wheat, shallots, chilies, beef, chicken and eggs.

Other recent studies of Indonesian long-term food demand projections for 2050 were also conducted by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), using the baseline of 2009 data (Gunning-Trant et al., 2015). The study suggests that the real value of food consumption in Indonesia is projected to increase more than four times between 2009 and 2050, assuming there are no major changes in agricultural policies. The consumption increase is characterized by a move towards more diverse diets, with a higher intake of meat, dairy products, fruit and vegetables. The real value of beef consumption is projected to rise more than 14 times, dairy tenfold, and fruit and vegetables to more than triple. To support this rise in demand, imports of many agri food commodities are projected to increase up to 2050, and these imports may come from industrialized countries. The upward trend in food demand is most pronounced among urban households, whose income growth is assumed to be more than double that of rural households. A declining rural population and relatively lower incomes will result in slower growth in food consumption compared with the urban population.

If consumers' behavior regarding food demand is projected accurately, then fulfilling the rising demand for such high-income elastic foods should be straightforward. Consumers tend to behave normally, and as their income increases, they tend to demand more diversified and healthy food.

This includes not only the basic carbohydrates and protein sources, as consumers also tend to buy food at higher prices. The behavioral dimensions of consumers' response to price spikes should be understood properly, especially regarding rice and other staple foods, such as during the Food Crisis from 2007-2008. The crisis has taught us some lessons that the fear or negative expectations of a food crisis could lead to panic buying by consumers, especially the panic buying of rice. The amount of rice being traded in the international market is quite small and at risk of disappearing, so panic buying behaviour could lead to even higher price spikes. Even the Philippines at the time of the Food Crisis, announced that it would import rice at any price as the National Food Authority (NFA) did not have adequate stocks and domestic political tensions were running high. Similar cases also occured in Haiti, Egypt and Syria, where the impacts were political and affected food policy and the power of ruling governments.

Food security in Indonesia might have to cope with similar behavioral dimensions as food prices are very sensitive and significantly affect poverty levels, causing further consequences. Timmer (2014) suggests that high volatile food prices (both sharp spikes and price collapses) are non-favorable for consumers and producers alike. Volatile staple grain prices have serious consequences for economic welfare, especially for the poor. The price of volatile food has contributed significantly to the rate of inflation, both during times of high inflation rates and low rates. Food becomes a political commodity if price stability becomes a recurrent issue, especially during specific months associated with religious festivities such as Ramadhan, Idul Fitri, Idul Adha and Christmas.

The government of Indonesia generally implements price stabilization policy by increasing the food supply at a certain market price and implementing special market operations such as subsidizing the food price for the poor households, manifested in the Rice for the Poor Program (Raskin or recently known as Rastra). The demand for rice as a staple food is very inelastic and remains high in rural areas and in lower income groups. The 15.5 million poor households across Indonesia could determine the level of price stability, and therefore food security in the country. Saifullah and Sulandari (2017) have compiled a thorough review of the Raskin program and the plan to transform the in-kind rice distribution into a card-based or non-cash rice assistance program to be effectively implemented in 2019. A delay in distributing rice to poor households could cause a rise in the retail price of rice, thus causing an additional 6,000 people to be classified as poor (Arifin, 2017). A full implementation of card-based food assistance in 2019 would require adequate supporting policies, such as improvements to the infrastructure of data communication, increasing the number of local shops to be equipped with electronic data capture (EDC) and other relevant hard and soft infrastructure developments, especially in remote areas.

Another important factor contributing to the future of food demand in Indonesia is the rapid growth of supermarkets, especially in the last decade, that have served the food needs of the urban population. The growth of supermarkets could be associated with Indonesia's economic growth of over 5 percent in the last decade, increasing household incomes, and urbanization and food systems transformation (Reardon and Timmer, 2014; Reardon et al., 2014, Reardon et al., 2015). Over the last two decades there has been substantial growth in the number of modern food retail outlets in Indonesia, as the number of supermarkets in Indonesia increased 67 percent from 1999 to 2009, while the number of hypermarkets increased by a factor of seven, and the number of mini-markets by a factor of 18. Furthermore, Indonesian households' spending on processed or packaged food made at supermarkets and hypermarkets grew from approximately 20 to 30 percent from 1998 to 2010 (Dyck et al, 2012). Reardon et al. (2014) suggests that in 2010, urban consumers in Indonesia spent 16 percent of their food budgets on rice, 15 percent on fruit and vegetables and 22 percent on animal proteins (meat, fish, eggs and dairy). Rural consumers spent 24 percent, 17 percent and

20 percent respectively. Yet these important diversification issues have received little coverage in the policy debates.

Unfortunately, the growing number of supermarkets has been closely associated with changing diets (Reardon and Timmer, 2014), and rates of obesity are increasing across all population groups and income levels (Roemling and Qaim, 2012; Umberger et al. 2015). Changing diets and nutritional levels associated with the existence of supermarkets also differ by income groups and between adults and children. Children have higher potential links between the use of supermarkets and the probability of being obese, especially those coming from high income households (Umberger et al., 2015). Furthermore, Umberger et al (2015) suggest that child nutrition may be relatively unaffected by the use of supermarkets among lower and middle income households because they don't have the disposable income to purchase convenience food and other processed foods that are high in sugar and fat. Adult consumers who have income constraints might purchase some expensive foods in supermarkets, albeit in a small quantity. However, adult consumers from high income groups might purchase processed food products which are less healthy, but will be consumed by the children in the household. In short, the combination of high income and a large amount of food purchased at supermarkets seems to be sufficient enough to change diets and result in a higher prevalence of overweight and obese children. The policy relevance of these studies is that nutrition information messages aiming to reduce the prevalence of overnutrition should focus on children in higher income households that obtain a large share of their food from supermarkets and other modern food retailers.

Meanwhile, consumers from middle and low-income groups get food products from a large number of traditional markets, including wet markets and modernized traditional dry markets. Traditional markets also refer to street vendors, peddlers or mobile vendors, small retail outlets (*warungs*) and wet and dry markets managed by companies owned by local governments. These traditional markets usually provide fresh food such as meat, chicken, eggs, fish, fruit, vegetables and grains such as rice, maize and even soybeans. Modern supermarkets and convenience stores are generally assumed to replace traditional markets, but studies by Suryadarma et al. (2010) suggest that traditional markets are able to compete against modern retailers, especially if local governments continually improve their infrastructures. Traditional markets need to improve the quality of their service, including proper hygiene, sufficient cleanliness, ample lighting and an overall comfortable environment. In the past, there might have been a very specific number of foods offered in traditional markets, while modern supermarkets and hypermarkets generally offer a variety of food products at competitive prices such as dairy, imported foods, and frozen products or products with certain quality attributes such as organic foods. They also traditionally sell foods for convenience such as packaged and ready-to-eat meals. Since the urban population of Indonesia have rapidly increased from 40 million in 1984 to 134 million in 2014 (Reardon and Timmer, 2014) or from 25 percent of the national population in the 1980s to 52 percent in 2017 (BPS, 2017), the roles of supermarkets are important in the future of food access in Indonesia. Generally, income levels of urban consumers are higher than rural consumers, so that the share of urban consumers in the overall food economy is significantly higher and could reach about 70 percent.

All studies on food demand being reviewed here are an important basis to develop the projected food demand for the future, which is the main focus of the present study. The study examines this in more detail using methods that have solid foundations in economic theory: namely modeling identification of the equation of the demand for food and the well-known almost ideal demand system (AIDS) model. The expected results of the present study will fill the gap in the literature of Indonesia's food demand that has not been examined in a great detail previously.

Chapter 4

Methods of Analysis

After reviewing the literature on the economics of Indonesian food demand, the study proposes two methods of food demand estimation, which are commonly conducted in other countries and other circumstances, namely: (a) Modeling Identification of the Demand Equation and the (b) Almost Ideal Demand System (AIDS) model. Moreover, a regression analysis using panel data from 33 provinces in recent years is also employed to verify the functional relationship between demand for selected foods and income per capita and price trends. A brief explanation of these methods is outlined as follows:

4.1 Modeling Identification of the Demand Equation

Modeling identification of the food demand model is conducted to determine the best model to describe the relationship between per capita income and consumption of a commodity. Income does not only affect the amount of goods consumed but also the quality of goods consumed. The consumer's income affects the size of the purchasing power of the goods needed. Households who receive a higher income are expected to purchase more commodities, although the price of the commodity remains unchanged.

The selection of the best model is done to identify the behavior of each commodity with its income. The model specifications being exercised in this study are linear, semi-log, double-log, exponential, and polynomial models (Table 2). The best model criteria chosen to represent the model used in this study is the one with the highest R-square (R^2).

Table 2: Model specification of the food demand

No	Model	Specification	Income Elasticity
1	Linear	$Q = \beta_0 + \beta_1 I + \varepsilon$	$e_I = \frac{\beta_1 I}{Q}$
2	Polynomial (degree-r)	$Q = \beta_0 + \sum_{r=1}^{R} \beta_r I^r + \varepsilon$	
3	Semi-Logarithmic	$Q = \beta_0 + \beta_1 \ln(I) + \varepsilon$	$e_I = \frac{\beta_1}{Q}$
4	Double-Logarithmic	$\ln(Q) = \beta_0 + \beta_1 \ln(I) + \varepsilon$	$e_I = \beta_1$
5	Exponential	$Q = \beta_0 e^{\beta_1 I}.\varepsilon$	$e_y = \beta_0 e^{\beta_1 I}$

Where Q is the quantity of consumption (kg/capita/year)
I is income per capita

Demand analysis generally uses income elasticity to measure the sensitivity of the quantity consumed as income changes, assuming other factors are constant. In this case, income elasticity is the percentage of change of the food consumed as a response to the percentage change of consumers' income. Income elasticity ranges from positive for normal goods to negative for inferior goods. For normal goods, consumption increases as income increases. For inferior goods,

consumption decreases as income increases. Finally, for income elasticity which is significant, such normal goods are known as luxury goods.

4.2 Almost Ideal Demand System (AIDS) Model

The Almost Ideal Demand System (AIDS) used in modeling and estimating the demand for food is used to present empirical evidence about food consumption behavior in Indonesia. AIDS can also answer questions about the demands of consumer preferences. The basic model of AIDS, developed by Deaton and Meulbeaur (1980), is derived from the preferences of cost function. The advantages of the AIDS model are: (i) an arbitrary first-order approximation of any system request, (ii) fulfills the axiom of choice exactly, (iii) has a form of function consistent with household expenditure, (iv) is easy to estimate because it avoids the function which is non-linear, and (v) can be used to test the restrictions of homogeneity, symmetry and adding up properties.

AIDS function is derived from the cost minimization process to maintain a fixed utility. From the result we can obtain the Hicksian demand function – where the quantity of goods is determined by the utility and price. By entering the Hicksian demand function into the expenditure, we will find the expenditure function – determined by the utility and price. By using Lemma Shepard we can obtain a basic model of AIDS in the form of the budget share. The system used here is:

$$\mathrm{w}_i = \alpha_i + \sum_j \gamma_{ij} \log \mathrm{p}_j + \beta_i \log(x/p^*) + \gamma_i \log(Z) + u_i$$

Where w_i is the budget share of food *i*, p_j are food prices *j*, x is food expenditure, and p^* is a stone index defined by:

$$logp^* = \sum_k w_k \log \mathrm{p}_k$$

For Indonesia, SUSENAS data is usually adequate to develop and estimate the demand function. The demand for specific foods is determined by the price of the individual foods, the total expenditure on food and other factors (for example: number of family members, education).

The methodology or procedure of analysis in the AIDS approach is summarized as follows:

1. Model Specifications
2. Determine the Elasticity

   Expenditure elasticity, own price elasticity of demand and the cross-price elasticity of demand can be calculated as follows:

   a. Expenditure elasticity

   $$\eta_i = 1 + (\beta_i + \mathrm{w}_i)$$

To calculate the income elasticity we need to apply the regression on the total expenditure of the commodity bundle against a total household income. The regression model used in this analysis is the double log model, as follows:

$$\ln x = a + b \ln Y$$

Where w is the total of food expenditure and Y is income of household. Thus, the income elasticity values are obtained using the following formula:

$$\eta t = b \times \eta_i$$

b. Own-Price Elasticity

$$\varepsilon_{ii} = \left(\frac{\gamma_{ii}}{w_i}\right) - 1$$

The value of own-price elasticity is a measurement to see how consumers react to changes in the price of the commodity itself.

c. Cross-Price Elasticity

$$\varepsilon_{ij} = \left(\frac{\gamma_{ij}}{w_i}\right)$$

The value of cross-price elasticity determines the relationship among the goods, whether the goods are complementary, substitutions, or neutral.

3. Analysis of the projected food demand in 2025 and 2045:

This projection analysis is conducted by applying information income elasticity, cross-price and own price. The elasticity is also used to determine the behavior of each commodity, whether the commodity is logarithmic, exponential or quadratic. Thus, this information is used to estimate food demand until 2045, with 2025 as a mid-term milestone.

Chapter 5

Long-Term Demand for Food and Policy Scenarios

5.1 Determinants of Long-Term Demand

This study will also examine the determinants of long-term demand for food, depending on the availability of the data that supports the analysis. The determinants of long-term demand will include projections for population and income growth and urbanization. The following dimensions might serve as entry points for further discussions and verification:

1. Baseline consumption levels will serve as the baseline forecasts.
2. Socio-economic and demographic trends to identify the potential consumer behavior and consumption patterns due to changes the number of population and urban-rural population ratio.
3. The changes in real prices, shifts in labor force composition (changing from high-energy to more sedentary occupations), and increasing health awareness (likely resulting in higher demand for nutritious food).
4. These trends and changes will be considered to articulate relevant policies and strategies responding to the anticipated developments in food consumption in Indonesia.
5. Policy alternatives or improvement of food policies will be formulated by providing a better design for medium-term measures, including assistance to vulnerable households.

5.2 Policy Scenarios for Commodity Group

The study will develop a set of policy scenarios, and each has consequences for each commodity (or commodity group) following possible socio-economic or demographic trends and plans in agricultural policy. The following scenarios will be included:

1. Slower and faster income growth
2. Slower and faster rates of urbanization
3. Changes in income distribution (i.e. equity effects on demand growth)
4. Growing health awareness or of public policies focused on healthy living
5. Trade policies and price changes of important food commodities

5.3 Assumption

The following assumptions are used as the basis to develop food demand projections in 2025 and in 2045. These cover the total population, population growth, changes in population compositions between rural and urban areas and economic growth or the growth of income per capita.

Population

The estimated population of Indonesia in 2017 was 261.9 million, which was based on the Population Census of 2000. The Agency of Central Statistics (BPS, 2013) has projected that the Indonesian population will be 284.8 million in 2025 and 318.7 million in 2045 (Table 3).

Table 3: Projected population of Indonesia in 2025 and 2045

No	Year	Number of Population (N_t)
1	2017	261,891,000.00
2	2025	284,829,000.00
3	2045	318,683,000.00

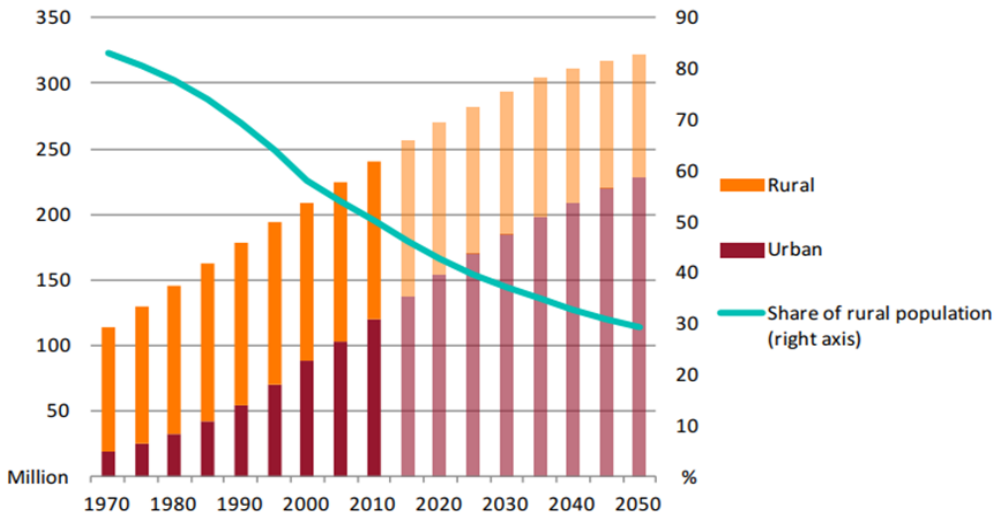
Source: Badan Pusat Statistik (2013)

The composition between rural and urban populations is obtained from the United Nations Population Divisions (2014), which projected that since 2010 the urban population is growing more rapidly than the rural population (Figure 4). This phenomenon is related to urbanization, changing diets and food consumption patterns. In 2017, the rural population was 47 percent, while the urban population was 53 percent.

Table 4: Composition of urban and rural population

Indicator	Year		
	2017	2025	2045
Percentage of urban population	0.53	0.58	0.64
Percentage of rural population	0.47	0.42	0.36

Source: United Nations Population Division (2014)



Source: 'World urbanisation prospects, the 2014 revision', United Nations Population Division (United Nations Population Division 2014)

Figure 4: Projected urban and rural population Ratio in Indonesia

This composition changes considerably in 2025 when the urban population is projected to grow significantly and reach 58 percent, while the rural population will reach 42 percent. Further changes will also occur in 2045 when the urban population will reach 64 percent and the rural population will decrease to only 36 percent (Table 4).

Income per Capita

The assumption of per capita income growth used in this study is based on Bappenas data (2015), which also uses the baseline, moderate, and optimistic scenarios. Economic growth at the baseline is assumed to reach 5.1 percent per year. In the moderate scenario it is assumed to reach 6.4 percent and in the optimistic scenario, the economic growth is assumed to reach 6,4 percent per year. In this case, population growth in each scenario is assumed at 0.71 percent per year (Table 5). The rate of inflation is assumed at 4 percent as announced by the Central Bank of Bank Indonesia to absorb some changes in each commodity. Growth of food affordablity per capita is used to estimate food demand in 2025 and 2045.

Table 5: Scenario of economic growth of Indonesia

Indicator	Scenario Economic Growth		
	Baseline	Moderate	Optimist
Average Economic Growth (% per year)	5.10	5.70	6.40
Average Population Growth (% per year)	0.71	0.71	0.71
Average GDP Growth per capita (% per year)	4.39	4.99	5.69
Average Food Inflation Rate (% per year)	4.00	4.00	4.00
Average Food Affordability per capita (% per year)	0.39	0.99	1.69

Source: Bappenas (2017)

The following Table 6 presents projected income per capita for 2025 and 2045 using the baseline of 2017 for baseline, moderate and optimistic scenarios.

Table 6: Projected Income per capita (Rp/month)

Year	GDP (Rp/month/cap)								
	Indonesia			Urban			Rural		
	A1	A2	A3	A1	A2	A3	A1	A2	A3
2017	1,018,929	1,018,930	1,018,930	1,249,231	1,249,231	1,249,231	843,599	843,599	843,599
2025	1,051,158 (3%)	1,102,481 (8%)	1,165,119 (14%)	1,288,743 (3%)	1,351,667 (8%)	1,428,462 (14%)	870,281 (3%)	912,773 (8%)	964,633 (14%)
2045	1,136,258 (12%)	1,342,575 (32%)	1,629,053 (60%)	1,393,078 (12%)	1,646,027 (32%)	1,997,255 (60%)	940,738 (12%)	1,111,554 (32%)	1,348,736 (60%)

A1: baseline scenario of GDP per capita0.39%
A2: baseline scenario of GDP per capita 0.99%
A3: baseline scenario of GDP per capita 1.69%
The number in brackets represents changes in income per capita of the baseline 2017

Source: Calculated from Bappenas (2015)

Chapter 6

Brief Overview of Selected Food Commodities

This chapter presents a brief overview of food commodities that will be analyzed further in this study. Data and information in this chapter is mostly collected from Statistics Indonesia (BPS), from annual statistics, from the National Social-Economic Survey (Susenas) and from previous studies and literature.

6.1 Focused Food Commodities

Rice is the staple food of the majority of Indonesia's population. Given the historical perspective and strategic position of the rice economy, it has considerable political significance. Currently, the demand for rice in Indonesia is estimated to reach about 30 million tons per year, using the rate of consumption of 124 kilograms per capita for the 261 million population. The official data of rice production is reported as 79 million tons of non-husked rice (GKG) harvested in 2016, which is equivalent to over 45 million tons of milled rice. Therefore, theoretically, Indonesia has a surplus of over 15 million tons of rice. Such a large rice surplus could be expected to significantly decrease the retail price of rice. However, the retail price of rice has steadily increased at 5 percent per year in the last three years, from Rp 11,522 in October 2014 to Rp 13,125 per kilogram in October 2017. In fact, since the end of 2017, the retail of price has increased steadily and reached over Rp 11,000 per kilogram. This is far higher than the maximum retail price (MRP) according to the Ministry of Trade Regulation Number 57/2017 of Rp 9,450 per kilogram for medium quality rice, which is commonly consumed by the average Indonesian.

Maize is directly consumed by a relatively small number of people and is a critical commodity for the feed industry. The availability and price of maize for feed affects consumption of beef, poultry and aquaculture – important sources of protein for much of the population. It is sometimes called a secondary food crop, although average maize consumption is only 2 kilograms per year. The demand issues for maize are similar to rice, and official data of maize production puts it at over 21 million tons per year. In the meantime, the existing demand for maize by the feed industries operated in Lampung and other places in Indonesia is 8-10 million tons annually.

Soybeans are consumed directly, or after being processed as tofu, tempeh, soy sauce, etc. Soybeans serve as an important source of protein, especially for middle and lower income groups as this source of protein is generally cheaper than animal-source protein. Soybean production in Indonesia is less than one million tons, so Indonesia has to depend heavily on imported soybeans, primarily from the United States of America.

Sugar is consumed by nearly all Indonesian people, although not in very significant amounts. The total sugar consumption is estimated to reach 6 million tons per year, with more than half of this fulfilled from sugar imports. The production capacity of the domestic sugar industry is declining steadily due to structural problems at farm level and factory level which both have issues with aging machinery systems and business processes and management in the industry. The demand for refined sugar by the food and beverage industries has been growing steadily; although the government has been struggling to manage the value chain systems of raw sugar imports which are then refined in domestic sugar factories. Policy issues arise when refined sugar cannot be distributed openly to domestic markets, but is directed to food and beverage industries, creating the possibility of leakage into domestic markets.

Beef is still considered a luxury item which is accessible only to the middle and upper classes. The demand for beef in Indonesia is less than 3 kilograms per capita per year and is not evenly distributed across the nation. The demand for beef is generally high in big cities and urban areas, especially among the middle class, and has grown rapidly in recent years as the national economy has grown over 5 percent per year. Indonesia sources about 30 percent of its beef from meat imports and/or live cattle imports, especially from Australia. Domestic beef production in 2016 was 524 thousand tons, while consumption is estimated at about 650 thousand tons. Beef consumption has been mentioned in public debates and political discussions as the government has been trying to reduce the retail price of beef down to Rp 80,000 (US$ 6) per kilogram, creating negative incentives for livestock farmers and cattle ranchers to increase the production and productivity of live cattle.

Chicken serves as an alternate source of protein, especially for lower and middle income groups. Chicken consumption per capita is about 8 kilograms, so total chicken consumption in Indonesia is about 2.65 million tons per year, implying a surplus of chicken. One should note that the demand for chicken is much higher than beef, as it costs Rp 30,000 to 35,000 per kilogram, which is far below the price of beef at Rp 110,000 to 120,000 per kilogram. Chicken is much more affordable than the beef even for the lowest quintile of consumers. Meanwhile, the poultry population has increased steadily in the last decade as poultry farms have developed rapidly all over the country. The official data shows that broiler meat production in 2017 was 2.2 million tons, a significant increase from 1.5 million tons in 2013. Added together with meat production from local chicken or free-range chicken, duck and layer chicken, poultry meat production in Indonesia is about 2.5 million tons.

Fruit has become part of the daily diet for all level of consumers in Indonesia, although lower income groups tend to consume less fruit, compared to middle and upper level consumers. The exception is probably rural people who have regular access to fruit (and vegetables) that are readily available for free and found in the local environment or home gardens. Consumption of fruit can be calculated based on the aggregated data from some kinds of fruit, mostly tropical fruit, such as bananas, mangoes, oranges, etc. Average fruit consumption in Indonesia is very low, at only 40.35 kilograms per capita per year, far below the standard fruit consumption set by the World Health Organization (WHO) of 91.25 kilograms per capita per year. In the near future, fruit consumption in Indonesia is projected to increase rapidly as the economy grows, income levels grow steadily and people's awareness of balanced diets increases.

Vegetables play an important role in Indonesian daily diets, although the consumption level is very low at only 35 kilograms per capita per year, which is less than half of WHO standards of 73 kilograms per capita per year. Although Indonesian farmers across the nation grow many kinds of tropical vegetables, not many people have adequate access to consume them. Some people in specific cultures across Indonesia are known for being raw vegetable eaters, especially in rural areas. However, many other groups of people, especially in big cities and urbanized areas, prioritize rice over protein and over vegetable purchases as the retail market price is considered high even for middle income groups.

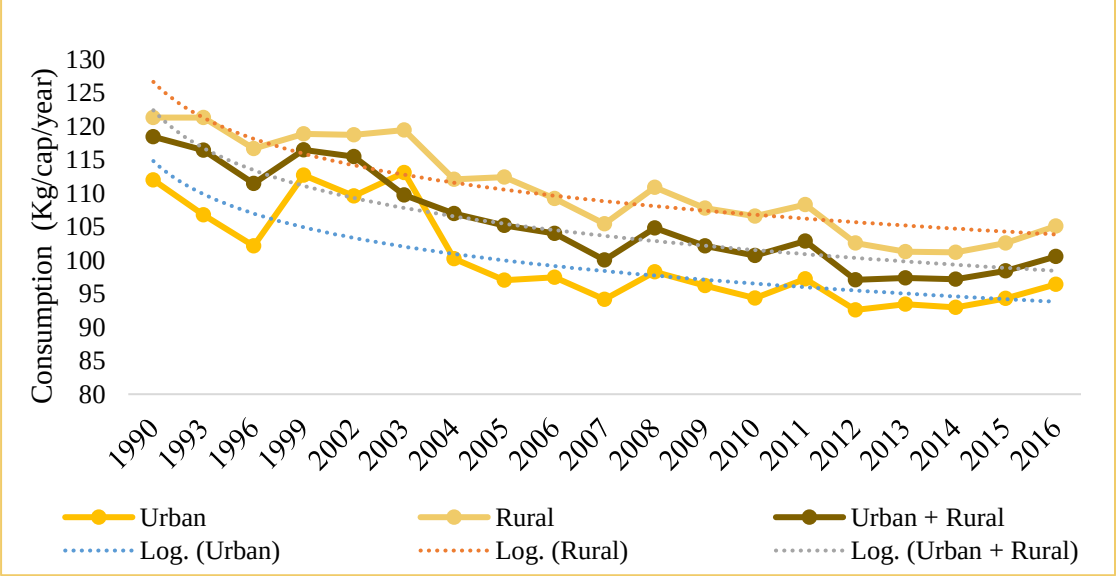
Fish has experienced a growing demand in recent years, as the previous governments have seriously encouraged all levels of the population to eat more fish as part of a healthy diet. The fish consumption level in Indonesia is quite modest, only 38 kilograms per capita per year even though Indonesia has one of the longest shorelines in the world. The current government has set an ambitious target to increase fish consumption to 54.5 kilograms per capita per year in 2019. The fish production system has been in the process of significant transformation as the government is very serious about combating IUU (illegal, unreported and unregulated) fishing in Indonesian

waters. Additional analysis in this report will focus on shrimp, crustaceans and salted fish, which are generally consumed by lower-income groups of the population.

Food consumed outside the home should also be an important variable in estimating food demand, as this captures the actual level of consumption of specific commodities. However, obtaining such data on the amount food consumed outside homes is challenging and time-consuming to disaggregate from the total consumption at a household level. Among the middle income group the amount of food consumed outside the home is likely to be increasing, which affects the characteristics of food consumption and the overall projected demand for food in Indonesia.

6.2 Consumption Trends of Selected Food Commodities

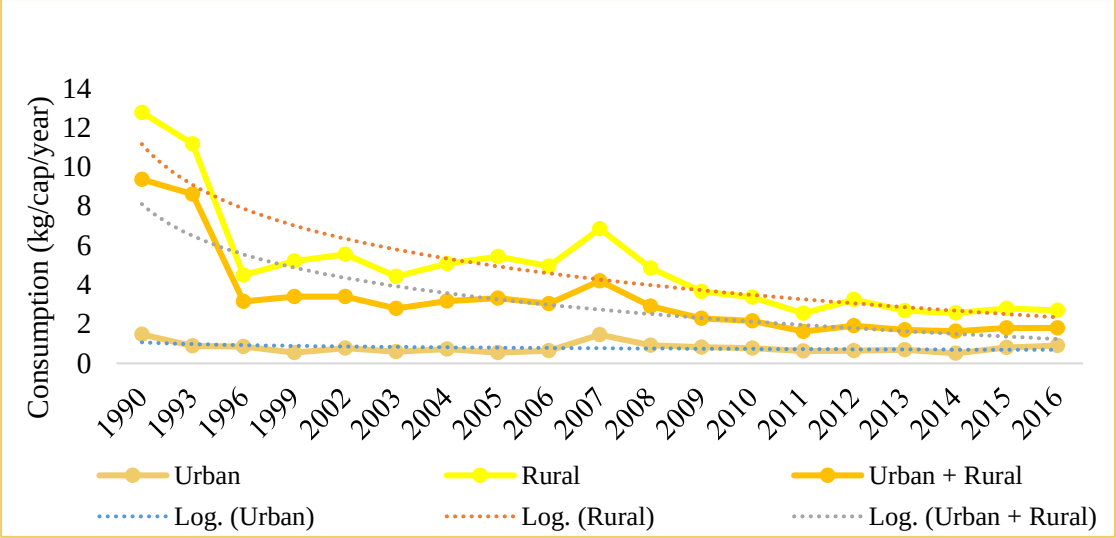
Increasing food consumption quality is becoming an important agenda in human resources development in Indonesia. Changes in food consumption have become important challenges for the government in the fulfillment of food security. The consumption trend of selected food commodities in the last 27 years in Indonesia is summarized in Appendix 2.



Source: Susenas of BPS, 1990-2016

Figure 5: Trend of rice consumption, 1990-2016 (kg/cap/year)

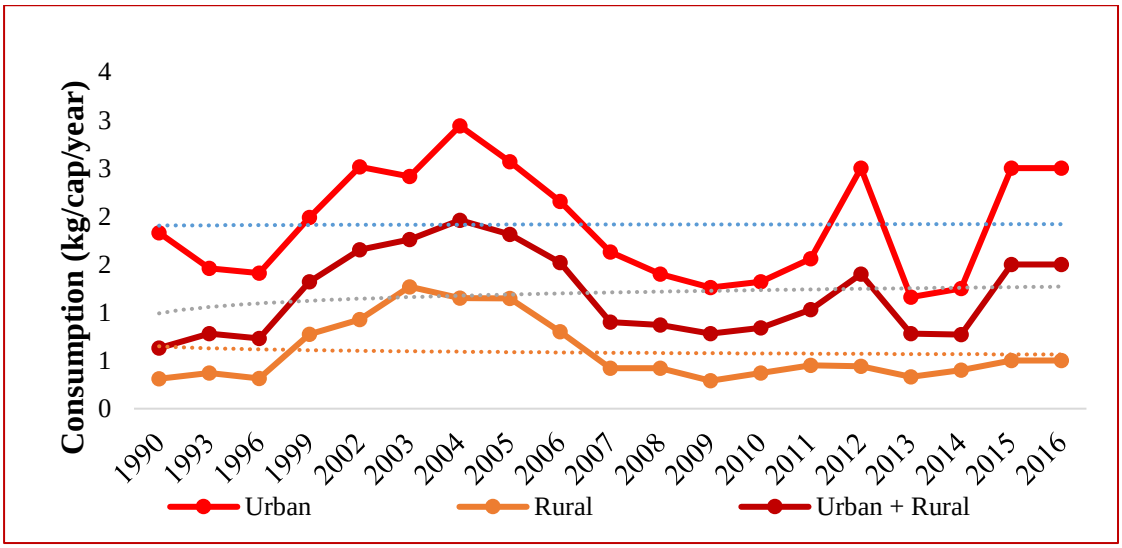
Figure 5 shows the trend of rice consumption from 1990 to 2016. It shows that until 2016, rice consumption was declining. Rice consumption decreased with an annual rate of 0.27 percent in urban and 0.30 percent in rural areas. This figure also shows that rice consumption in rural areas is higher than in urban areas. This rice consumption trend also shows positive changes in consumption, as decreasing rice consumption can help reduce dependence on a single carbohydrate source.



Source: Susenas of BPS, 1990-2016

Figure 6: Trend of maize consumption 1990-2016 (kg/cap/year)

Maize consumption by humans in Figure 6 shows a declining trending line with an increase in the use of maize as feedstock for the feed industry. Maize consumption decreased at a rate of 2.24 percent in urban areas and 4.05 percent in rural areas. Maize consumption is higher in rural areas than urban areas. However, the rate of decline is more significant in rural than urban areas. There was a considerable decrease in 1993 and 1996. Maize consumption from 1990 to 2016 was low compared to other carbohydrate sources such as rice and wheat. In 2016, maize consumption was only 0.9 kilograms per capita per year in urban areas and 2.4 kilograms per capita per year in rural areas.

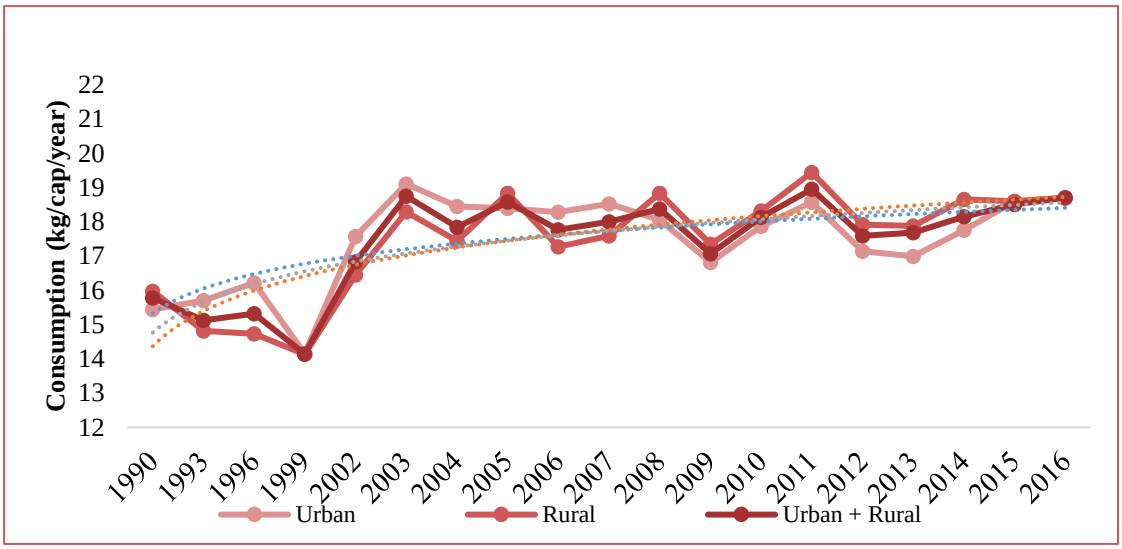


Source: Susenas of BPS, 1990-2016

Figure 7: Trend of beef consumption 1990-2016 (kg/cap/year)

Figure 7 shows beef consumption in Indonesia from 1990 to 2016. In National Social-Economic Survey (Susenas) data, food or processed meat included in the beef category includes dendeng, abon, canned meat, liver, jeroan, and processed foods such as soto, gulai, sop, and rawon. Figure 7 also shows that there are differences in consumption between urban and rural areas. Beef consumption in urban areas is higher than in rural areas. In general, beef consumption continued

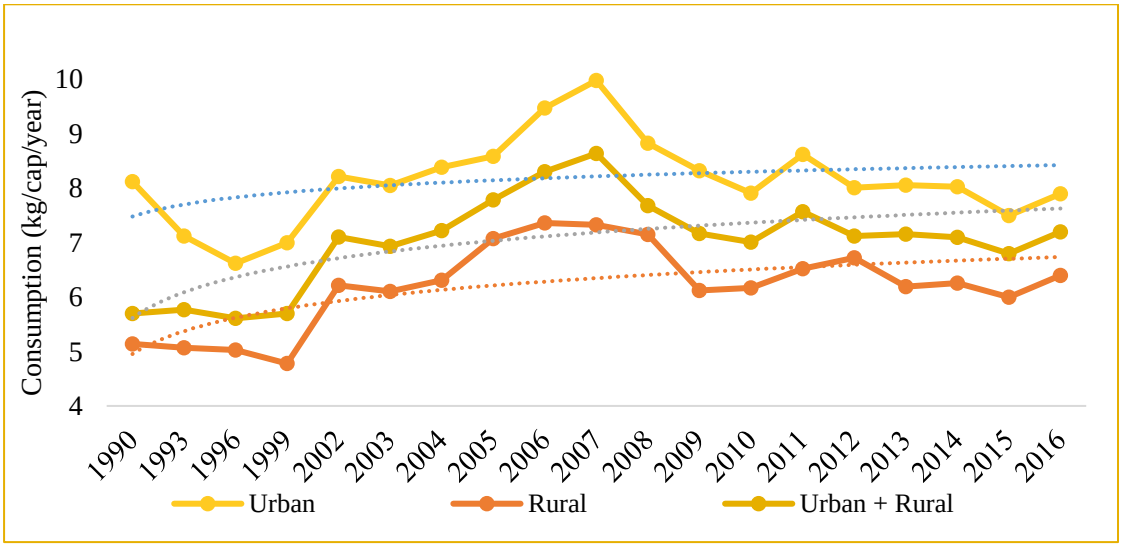
to increase from 1990 to 2004, but decreased in the period from 2004- 2007. Beef consumption increased again from 2011 to 2012, but decreased again in 2013, especially in urban areas. In contrast to urban areas, beef consumption in rural areas is not significant. The annual growth rate of beef consumption is 2.91 percent in urban areas, 10.75 percent in rural areas and 8.10 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 8: Trend of fish consumption 1990-2016 (kg/cap/year)

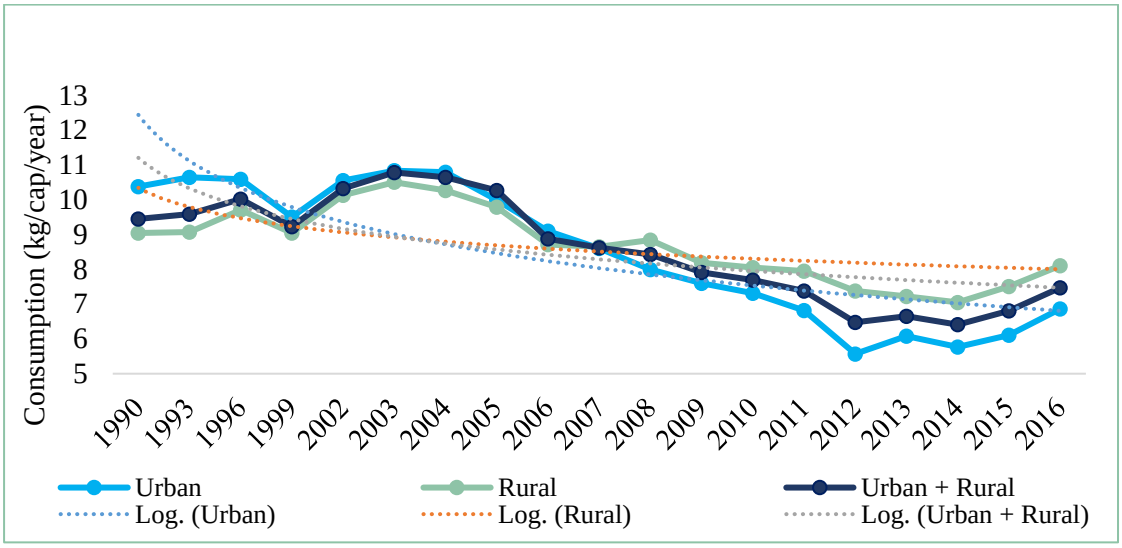
Figure 8 shows fish consumption in Indonesia from 1990 to 2016. Fresh and preserved fish, shrimp and other aquatic animals are included in fish consumption. Fish consumption in Indonesia is very unstable, although an increase in fish consumption is evident from 1999 to 2003. In 1999 average fish consumption in Indonesia was 14.14 kilograms per capita per year. In 2002 fish consumption increased to 16.83 kilograms per capita per year, and in 2003 to 18.75 kilograms per capita per year. There is no considerable difference in consumption between urban and rural areas. The annual growth rate of fish consumption is 1.18 percent in urban areas, 0.50 percent in rural areas and 0.72 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 9: Trend of soybean consumption 1990-2016 (kg/cap/year)

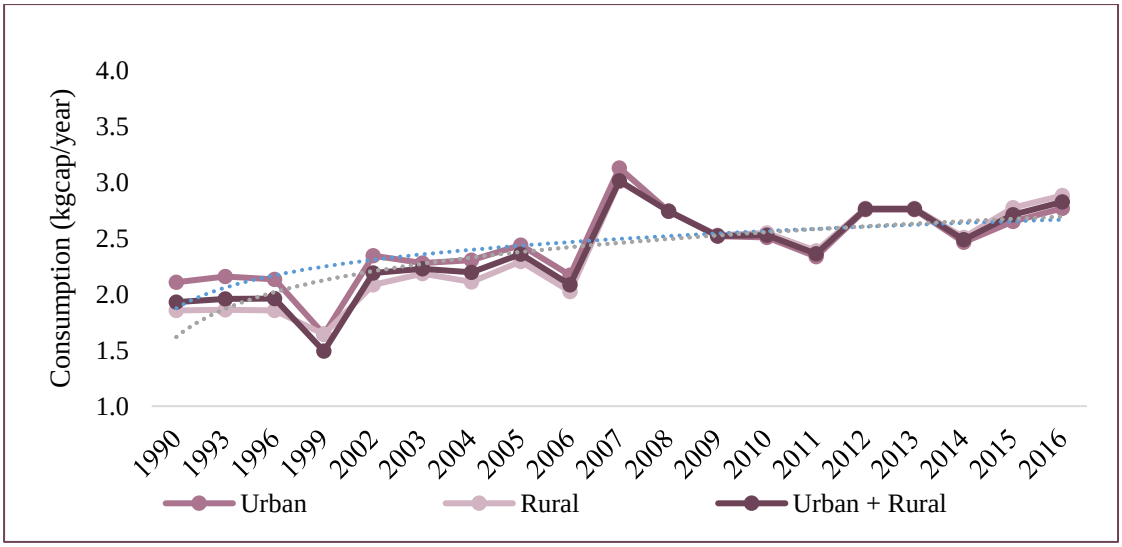
Figure 9 shows soybean consumption in Indonesia from 1990-2016 in kilograms. Foodstuffs or processed products included in soybean consumption include soybeans, tofu, tempeh, *tauco*, *oncom*, and soy sauce. Soybean consumption in Indonesia was highest in 2007 with 9.98 kilograms per capita per year in urban areas, 7.73 kilograms per capita per year in rural areas and 8.64 kilograms per capita per year in urban and rural areas. As a result, we can see that soybean consumption in urban areas is higher than in rural areas. The annual growth rate of soybean consumption is 0.20 percent in urban areas, 1.57 percent in rural areas and 1.66 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 10: Trend of sugar consumption 1990-2016 (kg/cap/year)

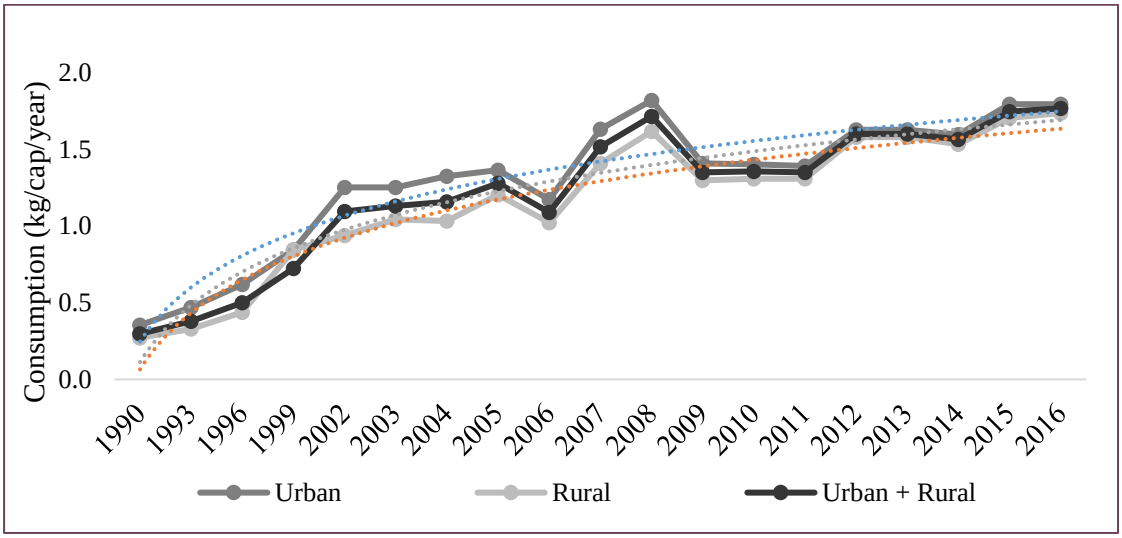
Figure 10 shows sugar consumption from 1990 to 2016. It should be noted that the data only reflects direct consumption, and does not include sugar contained in beverages or processed food. Sugar consumption decreased annually by 0.31% in urban areas, while sugar consumption increased with by 0.55% in rural areas. In figure 6, we can see that from 2007 to 2016, sugar consumption experienced a shift and was greater in rural than urban areas. Previously, from 1990-2007, sugar consumption in urban areas was greater than in rural areas.



Source: Susenas of BPS, 1990-2016

Figure 11: Trend of shallot consumption 1990-2016 (kg/cap/year)

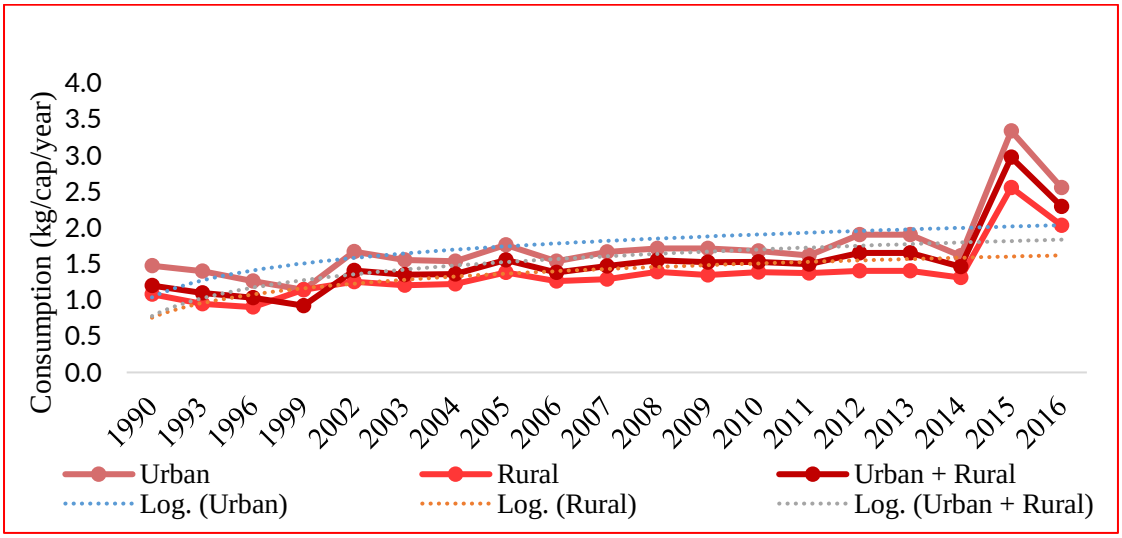
Figure 11 shows shallot consumption in Indonesia from 1990-2016. Shallots are usually used as a seasoning in daily cooking or used as a condiment. The highest consumption figures were in 2007. In 2007, shallot consumption in Indonesia was 3.13 kilograms per capita per year in urban areas, 3.01 kilograms per capita per year in rural areas and 3.01 kilograms per capita per year in urban and rural areas. Shallot consumption in urban and rural areas is not highly significant. The annual growth rate of shallot consumption is 1.67 percent in urban areas, 1.58 percent in rural areas and 2.05 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 12: Trend of garlic consumption 1990-2016 (kg/cap/year)

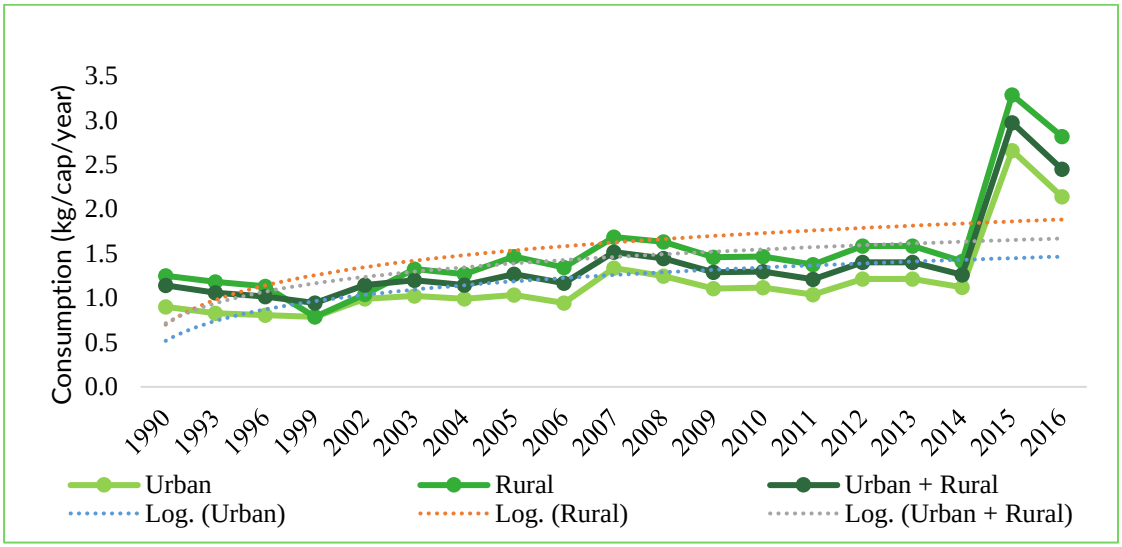
Figure 12 shows garlic consumption in Indonesia from 1990 to 2016. As well as shallots, garlic is also used as a flavoring in cooking. In general, the consumption of garlic in Indonesia continues to increase. In 1990, garlic consumption in urban areas was 0.35 kilograms per capita per year, 0.27 kilograms per capita per year in rural areas and 0.30 kilograms per capita per year in urban and rural areas. In 2016, urban garlic consumption was 1.79 kilograms per capita per year, 1.74 kilograms per capita per year in rural areas and 1.77 kilograms per capita per year in urban and rural areas. There is no visible difference between urban and rural consumption. The average growth rate of garlic consumption is 10.54 percent in urban areas, 11.77 percent in rural areas and 11.24 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 13: Trend of chili consumption 1990-2016 (kg/cap/year)

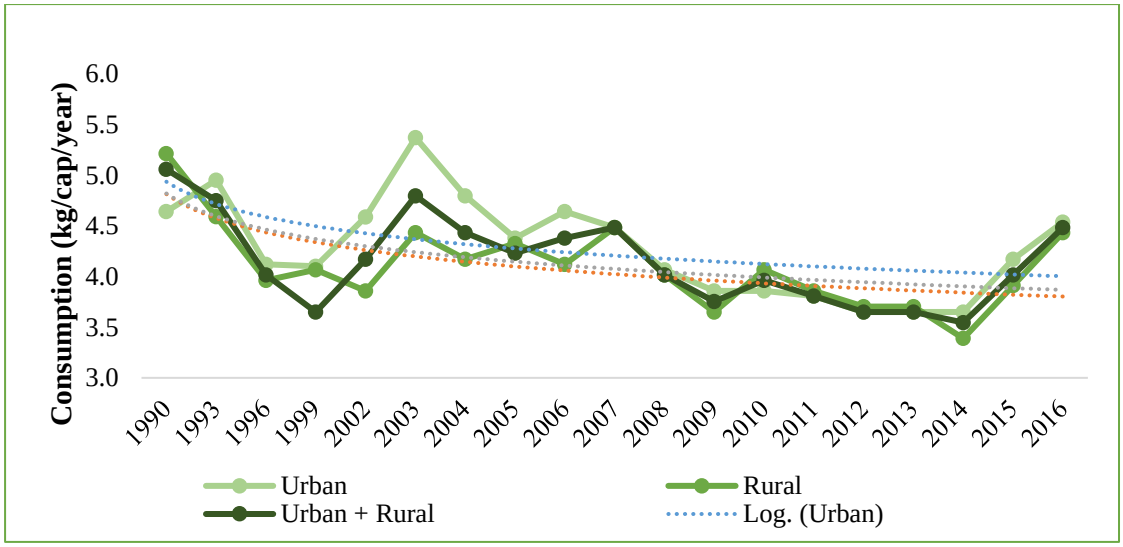
Figure 13 shows chili consumption per capita per year. In general, there is an increase in consumption from 1999 to 2016. There is also a considerable increase in consumption in 2015. In 2015, chili consumption was 3.34 kilograms per capita per year in urban areas, 2.56 kilograms per capita per year in rural areas and 2.97 kilograms per capita per year in urban and rural areas. There is no difference in chili consumption between urban and rural areas. The annual growth rate of chili consumption is 2.20 percent in urban areas, 2.17 percent in rural areas and 2.73 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 14: Trend of cayenne pepper consumption 1990-2016 (kg/cap/year)

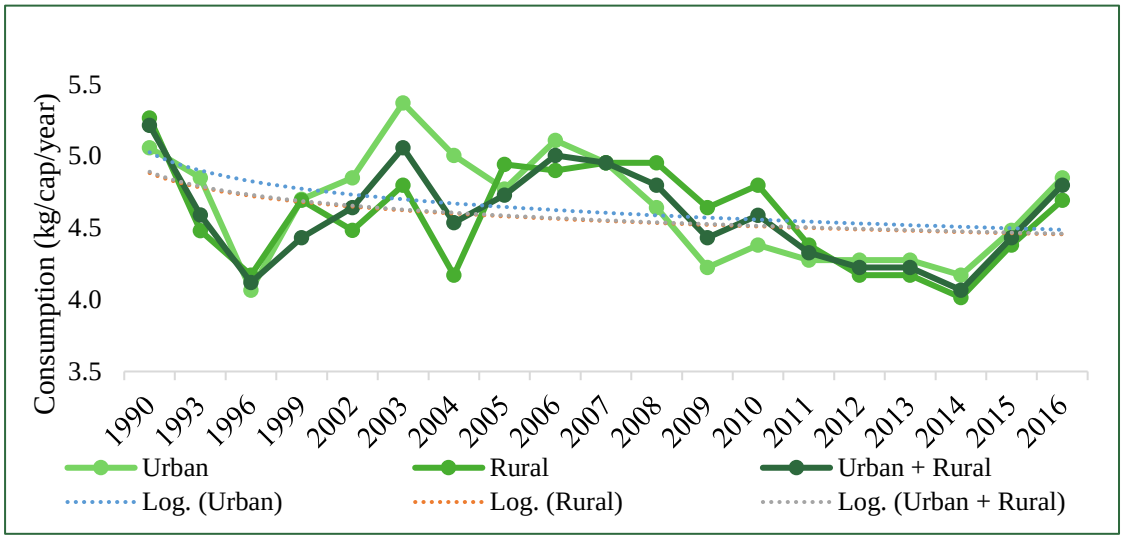
Figure 14 shows the consumption of cayenne pepper (hot chili) from 1990-2016. In general, hot chili consumption increased from 1999 to 2016 and there was a considerable increase in consumption in 2015. In 2015, consumption of cayenne pepper was 2.66 kilograms per capita per year in urban areas, 3.29 kilograms per capita per year in rural areas and 2.97 kilograms per capita per year in urban and rural areas. There is no difference in cayenne consumption between urban and rural areas. The annual growth rate of cayenne consumption is 2.50 percent in urban areas, 1.91 percent in rural areas and 1.83 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 15: Trend of spinach consumption 1990-2016 (kg/cap/year)

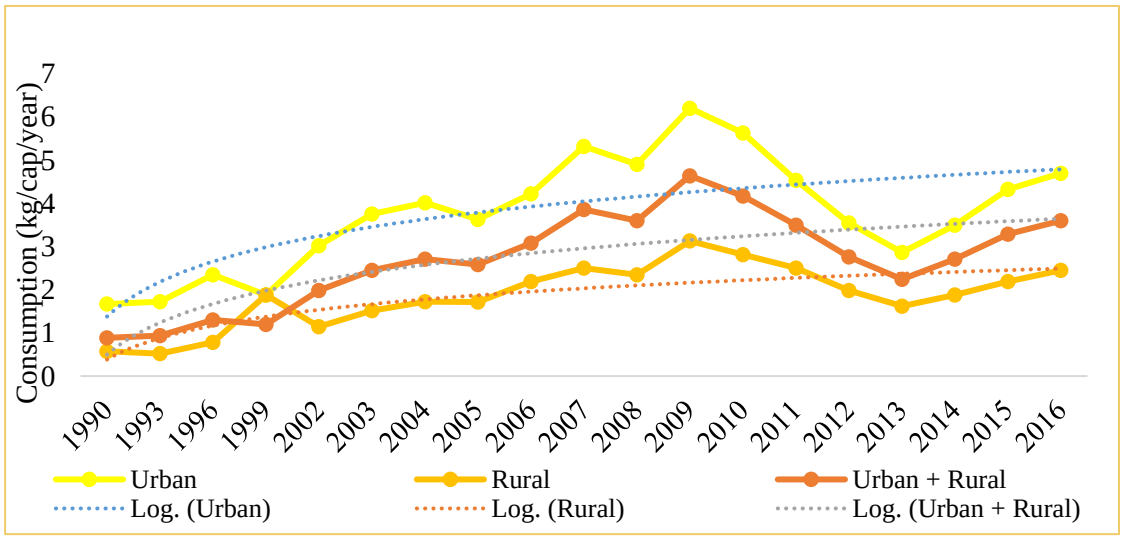
Figure 15 explains the changes in spinach consumption from 1990 to 2016. In general, there were no differences in the consumption of spinach in urban and rural areas. Spinach consumption in Indonesia fluctuated from 1999-2016. Spinach consumption continued to decrease from 1990-1999 in urban and rural areas and consumption went up in 2002-2003. In 1990, spinach consumption in urban and rural areas was 5.06 kilograms per capita per year, while in 1999 it was 3.65 kilograms per capita per year. In 2002, spinach consumption was 4.17 kilograms per capita per year and in 2003 it was 4.80 kilograms per capita per year. Then, until 2016, spinach consumption generally fluctuated. The annual growth rate of spinach consumption in urban areas was 0.07 percent, -1.16 percent in rural areas and -0.98 percent in urban and rural areas. The minus sign shows the average decrease or contraction in consumption of spinach from year to year.



Source: Susenas of BPS, 1990-2016

Figure 16: Trend of swamp cabbage consumption 1990-2016 (kg/cap/year)

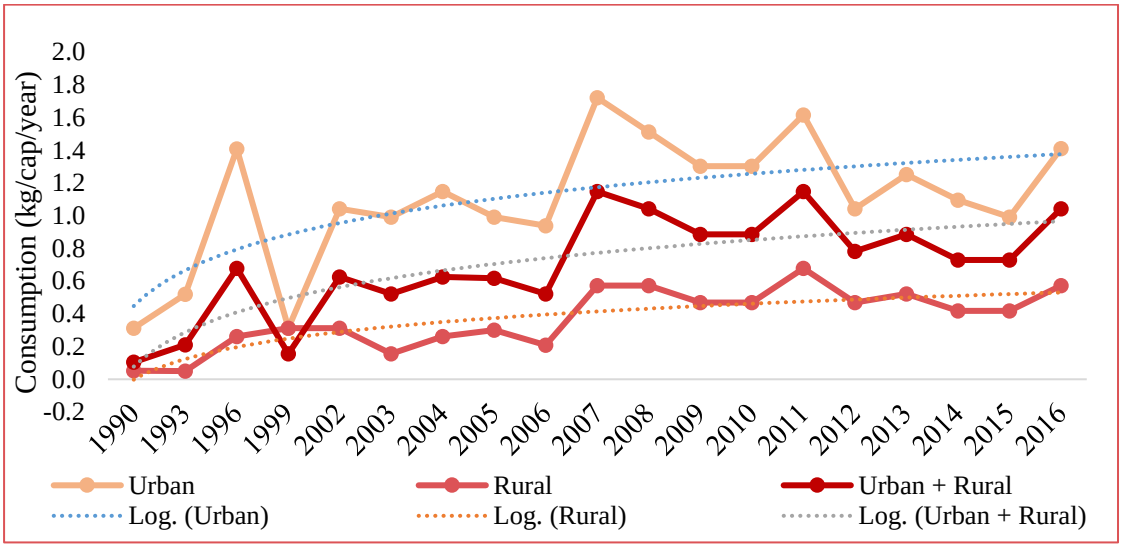
Figure 16 shows swamp cabbage consumption in 1990-2016. As with spinach, swamp cabbage consumption also fluctuated and continued to decline from 1990-1996 in urban and rural areas, and consumption increased from 1999-2003. In 1990, swamp cabbage consumption in urban and rural areas was 5.21 kilograms per capita per year, while in 1996 it was 4.12 kilograms per capita per year. In 1999 it was 4.43 kilograms per capita per year and in 2003 it was 5.06 kilograms per capita per year. The annual growth rate of swamp cabbage consumption was -0.10 percent in urban areas, -0.85 percent in rural areas and -0.61 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 17: Trend of orange consumption 1990-2016 (kg/cap/year)

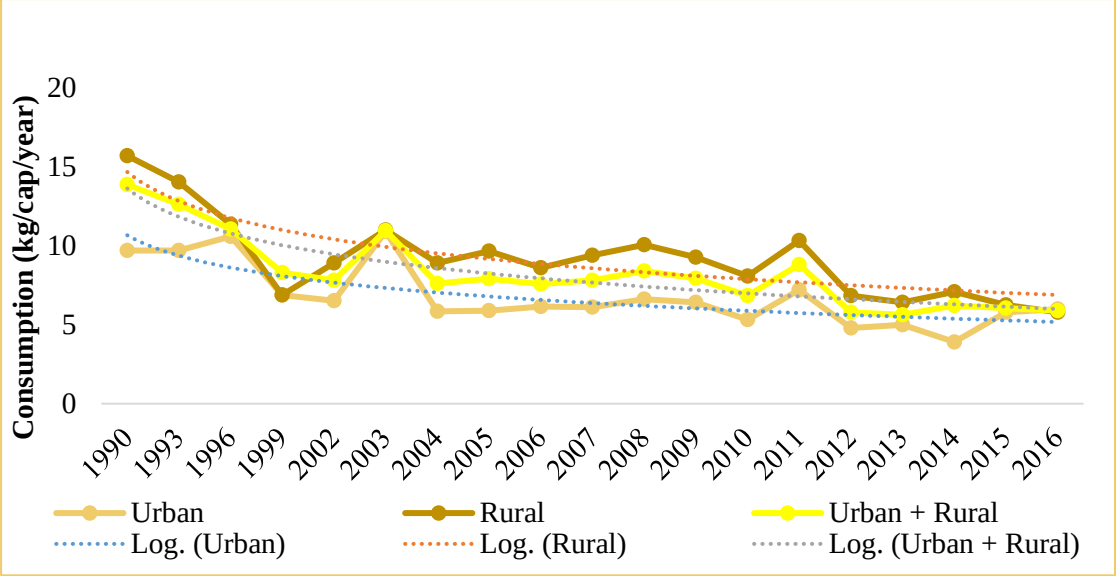
Figure 17 shows orange consumption in Indonesia from 1990 to 2016. In general, the consumption of oranges increased from 1990 to 2009, then consumption declined until 2013, then increased again until 2016. This occurred both in urban and rural areas. Orange consumption is higher in urban areas than in rural areas. Orange consumption in 1990 was 1.67 kilograms per capita per year in urban areas, 0.57 kilograms per capita per year in rural areas and 0.89 kilograms per capita per year in urban and rural areas. Orange consumption in 2009 was 6.21 kilograms per capita per year in urban areas, 3.13 kilograms per capita per year in rural areas and 4.64 kilograms per capita per year in urban and rural areas. Orange consumption in 2013 was 2.87 kilograms per capita per year in urban areas, 1.62 kilograms per capita per year in rural areas and 2.24 kilograms per capita per year in urban and rural areas. Orange consumption in 2016 was 4.69 kilograms per capita per year in urban areas, 2.45 kilograms per capita per year in rural areas and 3.60 kilograms per capita per year in urban and rural areas. The annual growth rate of orange consumption is 6.16 percent in urban areas, 11.10 percent in rural and -7.96 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 18: Trend of apple consumption 1990-2016 (kg/cap/year)

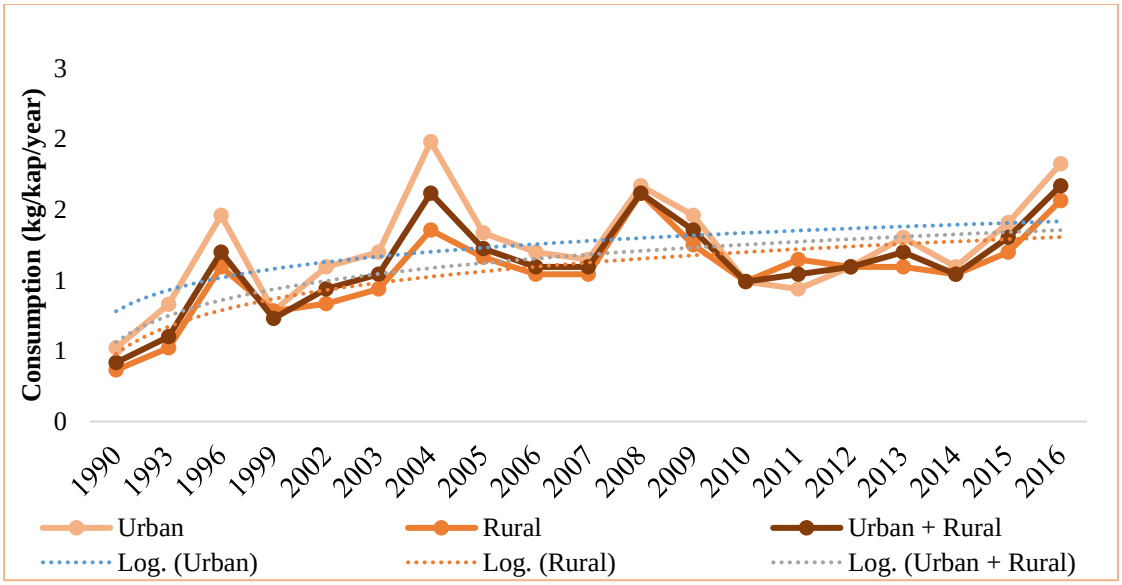
Apple consumption from 1990-2016 can be seen in Figure 18. Consumption of apples in Indonesia from 1990-2016 fluctuated. Apple consumption is higher in urban than in rural areas. Increased apple consumption in urban areas was considerable in 1996, reaching 1.41 kilograms per capita per year, and decreased in 1999 to 0.31 kilograms per capita per year. The highest consumption of apples in urban areas occurred in 2007, when it was 1.72 kilograms per capita per year. The highest consumption of apples in rural areas occurred in 2011 when it was 0.68 kilograms per capita per year. Apples have the highest average consumption growth rate compared to other fruit like bananas, oranges, mangoes and snake fruit in urban, rural, and urban-rural areas. The annual growth rate of apple consumption is 25.31 percent in urban areas, 30.35 percent in rural areas and 37.43 percent in urban and rural areas.



Source: Susenas of BPS, 1990-2016

Figure 19: Trend of banana consumption 1990-2016 (kg/cap/year)

Banana consumption can be seen in Figure 19. Banana consumption in rural areas is higher than in urban areas. In general, banana consumption has declined. In both urban and rural areas, banana consumption fluctuated from 1990-2016. Banana consumption decreased at a rate of 2.19 percent in urban areas and 3.13 percent in rural areas.



Source: Susenas of BPS, 1990-2016

Figure 20: Trend of snake fruit consumption 1990-2016 (kg/cap/year)

Snake fruit consumption from 1990 to 2016 fluctuated. Snake fruit consumption in urban areas is higher than consumption in rural areas. Figure 20 shows that snake fruit consumption tends to increase both in urban areas and rural areas. Snake fruit consumption in urban areas increased with an annual growth of 9.99 percent. Similarly, in rural areas, snake fruit consumption increased at the same rate of 9.99 percent per year. There were also increases in 1996, 2004 and 2008, followed by a decline and then an increase until 2016.

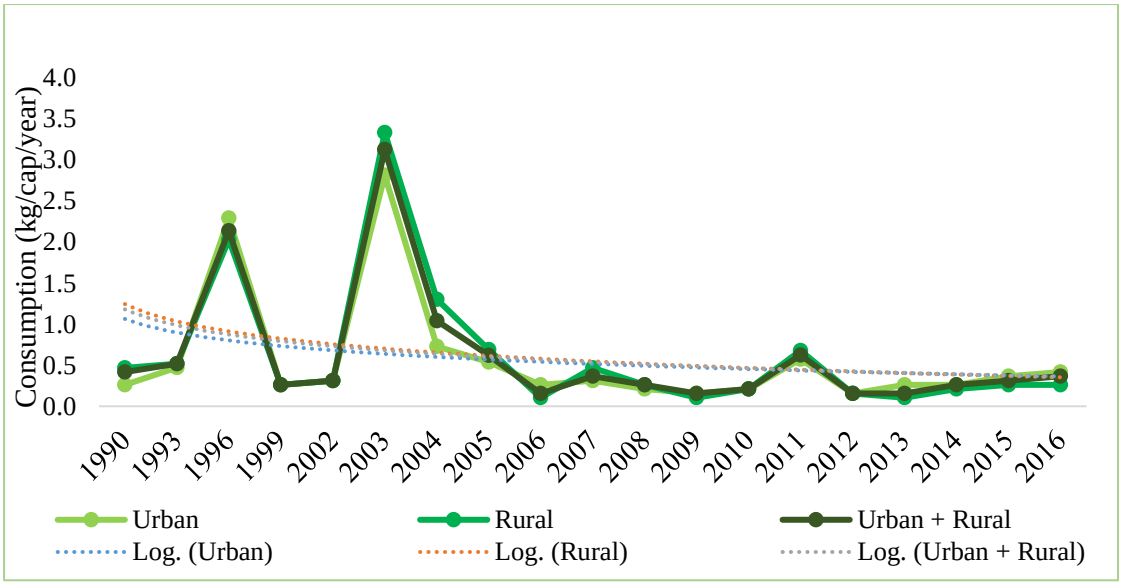


Figure 21: Trend of mango consumption 1990-2016 (kg/cap/year)

Mango consumption from 1990-2016 fluctuated. There were some years in which mango consumption was high, such as 1996 and 2003. Mango consumption in urban areas and rural areas is similar. Figure 21 shows mango consumption in both urban and rural areas has declined. However, because there is some very high quantity consumption in some years, the annual growth rate of mango consumption in rural and urban areas is positive. Mango consumption has increased with an annual growth rate of 27.14 percent in urban areas and 15.41 percent in rural areas. It should be noted that the consumption of mangoes depends on the season. Unlike the Philippines and Thailand, Indonesia does not have a huge amount of mango cultivation technology to permit more than one crop per year. There have been some efforts to introduce early flowering technology (EFT) in order to help deliver an early harvest of mangoes for smallholder farmers, particularly in West Nusa Tenggara and East Java. However, introducing new technology for smallholder farmers might take some time as smallholder farmers have generally used a strategy of "seeing is believing". One should note that the consumption of mangoes is difficult to estimate because the Susenas survey is conducted in March, while the mango season in Indonesia generally occurs mid-year.

6.3 Results of Regression Analysis for the Demand for Rice and Beef

The regression analysis using panel data for 33 provinces across 8 years for rice 7 years for beef could be summarized as follows. The variations of demand for rice could be explained by the variations of rice prices and income per capita. The staple food characteristics of rice are shown by the regression that a one percent rice price increase has caused an increase in rice consumption of 0.023 percent. Moreover, a one percent increase in income per capita has caused a decrease in consumption of 0.007 percent.

Table 7: Regression analysis of panel data on rice consumption

Total panel (balanced) observations: 264

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.466305	0.442622	10.09057	0.0000
LNPRICE	0.023311	0.034887	0.668188	0.5047
LNYCAP	-0.007107	0.064565	-0.110081	0.9124

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.893131	Mean dependent var	4.604695
Adjusted R-squared	0.877263	S.D. dependent var	0.164122
S.E. of regression	0.057498	Akaike info criterion	-2.751206
Sum squared resid	0.757081	Schwarz criterion	-2.277122
Log likelihood	398.1592	Hannan-Quinn criter.	-2.560705
F-statistic	56.28827	Durbin-Watson stat	0.848860
Prob(F-statistic)	0.000000		

The variations of demand for beef can be explained by the variations of beef prices and income per capita. Beef is considered a luxury food in Indonesia, as shown by the regression that a one percent beef price increase has caused a decrease in beef consumption by 0.098 percent. Moreover, a one percent increase in income has caused an increase in beef consumption by 0.58 percent.

Table 8: Regression analysis of panel data on beef consumption

Total panel (balanced) observations: 231

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.275588	1.449704	-2.949283	0.0035
LNPRICE	-0.097621	0.117072	-0.833850	0.4052
LNYCAP	0.578674	0.176592	3.276905	0.0012

Effects Specification	S.D	Rho
Cross-section random	0.585974	0.8159
Idiosyncratic random	0.278366	0.1841

Weighted Statistics

R-squared	0.053719	Mean dependent var	0.097130
Adjusted R-squared	0.045418	S.D. dependent var	0.285179
S.E. of regression	0.278628	Sum squared resid	17.70040
F-statistic	6.471591	Durbin-Watson stat	1.595949
Prob(F-statistic)	0.001846		

Unweighted Statistics

R-squared	0.203821	Mean dependent var	0.549610
Sum squared resid	95.37443	Durbin-Watson stat	0.296190

Chapter 7

Food Consumption Profile at the Baseline 2017

This chapter examines Indonesian food consumption using the baseline of 2017, and consists of food intake in terms of energy consumption and protein consumption. Energy consumption is measured in terms of kilocalories per capita per day, where the minimum requirement for the energy adequacy number (AKE) is 2,150 kcal per capita per year. Protein consumption is measured in terms of grams per capita per year, where the minimum requirement for the protein adequacy number (AKP) is 57 grams per capita per year

7.1 Energy and Protein Consumption

The measurements of the energy adequacy number (AKE) and protein adequacy number (AKP) which has been used as the national reference were formulated during the National Workshop on Food and Nutrition (WNPG) in 2012. It is not clear whether the AKE and AKP will be adjusted at WNPG 2018. According to the National Socio-Economic Survey (Susenas) 2017 which will be used as the basis of food consumption in this study, the last two poorest income quintiles or the households falling into Quintile 1 and Quintile 2 cannot meet the AKE and AKP (Figure 22 and Figure 23).

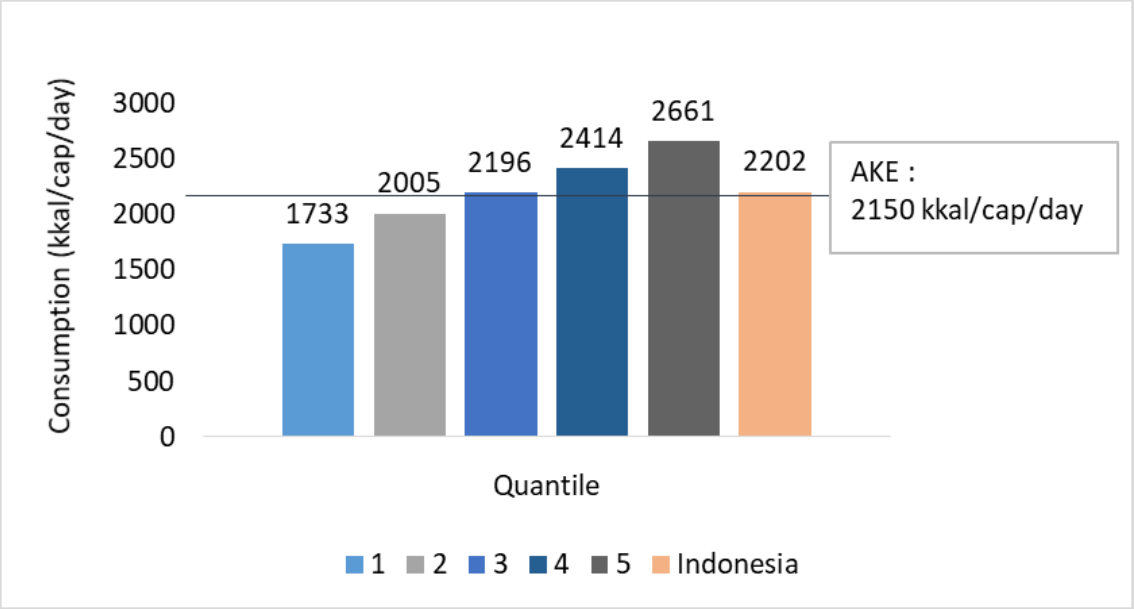


Figure 22: Average consumption of energy (carbohydrates) by income group

In 2017, the average energy consumption of the Indonesian population was 2,202 kcal per capita per day, which exceeded the AKE set by the WNPG in 2012 by 2.5 percent. Food and nutrition economists generally use the following criteria to examine the nutrition adequacy number (AKG), namely: less than 80 percent of the AKG is considered inadequate, between 80 and 110 percent of the AKG is considered adequate, and higher than 110 percent is considered more than adequate. Figure 2.2 shows that the two lowest income quintiles in Indonesia fall into the category of nutrition deficiency with a figure of less than 80 percent. The energy consumption of people living in the first two highest quintiles exceeded the AKG, at 123.8 percent and 112.3 percent respectively. This finding is also consistent with the economic theory that food consumption in terms of energy adequacy increases as income increases.

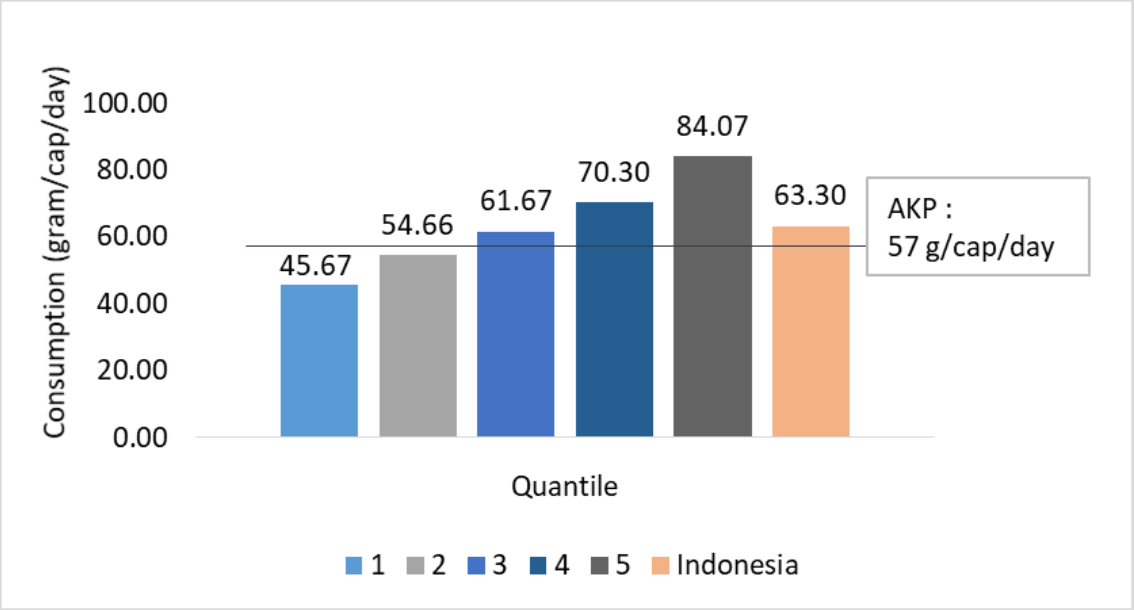


Figure 23: Average consumption of protein by income group

Similar figures are also found in protein consumption in 2017, as presented in Figure 23. The average protein consumption in Indonesia in 2017 was 63.30 grams per capita per day, which exceeded the protein adequacy number (AKP) of 57 grams per capita per year or equivalent to 111 percent. By income group, the consumption patterns of protein are similar to those of carbohydrate consumption, which increases as income increases. It ranges from 45.67 gram in the lowest quintile to 84.07 grams per capita per year in the highest income group quintile. Protein consumption of the first two income group quintiles has not reached the recommended AKP or has fallen into protein deficiency as these income groups only consume protein at a figure of about 80 percent. The contrasting figures are found in the protein consumption of quintiles four and five, which fall into over consumption of 123.3 percent and 147.5 percent respectively.

7.2 Consumption of Selected Food Commodities by Income Group

The baseline consumption of selected food commodities in 2017 is presented in terms of income group and province, which have quite a strong relationship. In economics, Bennett Law is generally employed to examine the relationship between income groups and the quality of food consumption. Improvement of food quality increases as the household income increases.

Average rice consumption in 2017 was recorded at 97.6 kilograms per capita per year, which was significantly lower than the official rice consumption on 114 kilograms per capita. Further explanation of rice consumption could be found in the subsequent sections and chapters. In general, rice consumption in rural areas in Indonesia is a bit higher than urban areas. Under a market economy, the following explanation makes more sense. Firstly, the income level of people living in urban areas is generally higher than that in rural areas. Secondly, food access in urban areas is relatively high compared to rural areas. Lower income groups tend to spend a greater proportion of their income on food, preferring to buy cheap but filling food, predominantly carbohydrates. Since the Asian Economic Crisis in 1998, the Government of Indonesia has provided a rice subsidy to the lowest income group of the population of about Rp 20 trillion each year. This rice subsidy, known as Rice for the Poor (Raskin or Rastra) program has been also used as a price stability policy instrument. When relatively poor people cannot have access to rice as a staple food, they look for rice in the open market, which contributes to the increase of the price of rice. This was the case when there were increasing rice prices in early 2015 and 2017, mostly due

to the delay in Rastra distribution to poor families. The increase in the price of rice in 2017 increased the number of poor people by 6,900 and from 27.76 million people in September 2016 to 27.77 million in March 2017, although the poverty percentage of the population decreased from 10.70 to 10.764 percent in the same period.

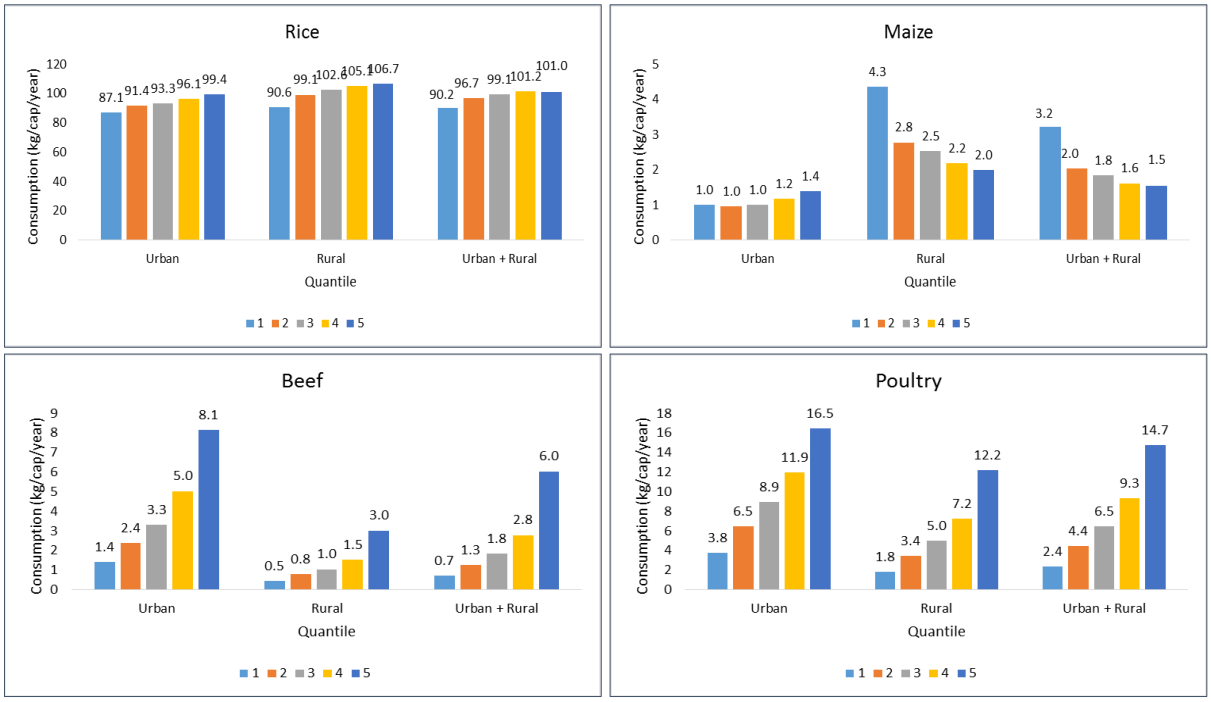


Figure 24: Consumption of rice, maize, beef and poultry by income group

Average rice consumption in Indonesia has shown an interesting pattern of changes. Rice consumption has increased as income has increased, from 90.4 kilograms per capita in Quintile 1 up to 101.2 kilograms per capita in Quintile 4. However, rice consumption in the highest income group, or in Quintile 5, has decreased to 101.0 kilogram per capita. Interpreting this pattern should be conducted with caution. Low rice consumption in the low income group is mostly an access problem, which correlates with the potential for undernutrition problems among poor families. However, a decline in rice consumption in high income groups might indicate a consumption shift from carbohydrate sources of food to higher quality foods such as proteins, fats and vitamins, which the highest income quintile consumes in much greater quantities.

These findings have been confirmed in the study by Timmer et al. (2010) on the dynamics of declining rice consumption in Indonesia and in Asian countries in general. There are two reasons to understand the long-run dynamics of rice consumption. Firstly, in market-driven economies, consumer demand provides signals to producers about what they should grow, market and deliver to the retail sector. Market economies are demand-driven economies. Understanding the behavior of rice consumers is very useful to support the decision making process of rice production as efficiently as possible. Secondly, underlying the smooth trends of rice consumption are four key factors whose relative contributions to future demand growth are likely to change compared with past experience. These four basic forces are (1) population growth, (2) income growth and its distribution, (3) declining real prices for rice, and (4) the gradual shift of workers from rural to urban employment that accompanies a successful structural transformation (Timmer, 2010). At a macro level, investments that keep rice production rising smoothly at the rate of projected rice consumption are the surest way to provide food security in Indonesia. At a micro level, fulfilling the energy and protein intake, at least to meet the energy adequacy level (AKE) and protein

adequacy level (AKP), is necessary. This should become the main priority of food policy for the central government and local governments.

Figure 24 also shows that the average consumption of beef and poultry, as protein sources, is extremely high in the highest income group. The average beef and poultry consumption in Quintile 5 is 6.0 and 14.7 kilograms per capita per year, much higher than the national average of 2.5 and 7.5 kilograms per capita per year respectively. These two protein sources are really income-elastic as the consumption of beef and poultry is much lower in the lower income group and in rural areas. The pattern of beef consumption in urban areas is skewed to the highest income group, showing a disparity of 8.1 kilograms for the highest group to 1.4 kilograms per capita per year for the lowest income group, or about a 5.8 to 1 comparison. A similar pattern is also found for beef consumption in rural areas, showing a disparity of 3.0 kilograms for the highest group to 0.5 kilograms per capita per year for the lowest income group, or about a 6 to 1 comparison. Moreover, the beef consumption disparity between urban areas and rural areas is also quite high, which may indicate that populations living in rural areas might find different sources of animal protein. High dependence on beef imports of 35 percent or more might also explain such a disparity, as urban populations might find beef more easily compared to residents in rural areas. Rural populations might be able to raise cows, buffalo and other livestock, but they usually treat these animals as investments, instead of as a farm business. Indonesia has not been successful in implementing a program of self-sufficiency for beef because farmers have differing visions of the livestock business (Arifin, 2015).

Interestingly, the disparity pattern of poultry consumption is quite unique, and different from that of beef consumption. The pattern of poultry consumption in urban areas is also skewed to the highest income group, although not as sharply as beef consumption. The consumption disparity is 16.5 kilograms for the highest group and 3.8 kilograms per capita per year for the lowest income group, or about a 4.3 to 1 comparison. However, the skew of poultry consumption in urban and rural areas is very high, showing disparity of consumption between 12.2 kilograms for the highest group to 1.8 kilograms per capita per year for the lowest income group, or about a 6.8 to 1 comparison. This implies that people living in urban areas have better access to poultry compared to their peers in rural areas. The poorest people in rural areas may only have chicken in their menu once a week during the course of a year. Although poultry meat (and eggs) can be considered the cheapest source of animal protein, the income elasticity of poultry for rural people is quite high, which could shape the whole demand for such sources of protein.

A contrasting figure is found in maize consumption, as the average amount of direct maize consumption for humans in 2017 was 2 kilograms per capita per year, but declines as income increases. Maize consumption of the lowest Quintile 1 was 3.2 kilograms, but the highest Quintile 5 was 1.5 kilograms per capita per year. Although there has been a change in recent years in the use of maize from direct food to animal feed, maize represents the behavior of inferior goods. The average maize consumption of Quintile 1 in rural areas was 4.3 kilograms, but the consumption in the highest Quintile 5 was 2 kilograms per capita per year. Rural populations in Indonesia, especially in dry regions in Eastern Indonesia have traditionally consumed maize as their daily staple, or at least the second most important staple food after rice. The future consumption of maize in Indonesia might change substantially if the feed industry and poultry business change significantly. The current government of Indonesia has put much effort towards increasing maize, rice and soybean production to achieve self-sufficiency by increasing harvesting areas, stimulating intensive use of modern inputs such as fertilizer and pesticides, and managing the value chains and related trade and border policy. At the time of writing this report, BPS has not issued any estimates on maize production, as well as rice and soybean production. BPS in cooperation with the Agency for Technology Assessment and Application (BPPT) are improving the methodology of production

estimates of major food crops in Indonesia, and the earliest production estimates will be released later this year (2018).

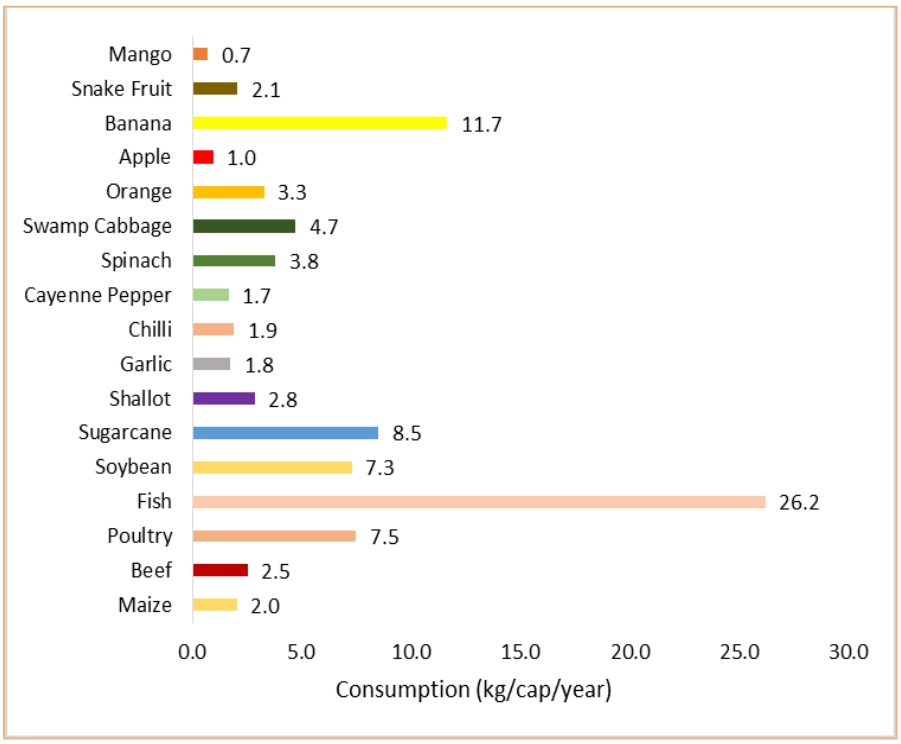


Figure 25: Average consumption of important food commodities

Consumption of other important commodities such as fish, soybeans, vegetables and fruit have a similar pattern, where the consumption increases as income also increases. The average consumption of soybeans and fruit commodities is generally higher in urban areas and in high income groups. Taking into consideration that these commodities fall into a "high quality food" category, the Bennett Law also holds, as increased income is followed by an improvement in food quality. The shifting allocation of the consumption budget from carbohydrate-based to protein and vitamin-based food generally occurs in urban areas and in high income groups. It is fair to assume that, at some point, populations in rural areas and in low income groups will eventually allocate a greater proportion of expenditure to high quality foods as their income also increases. Interestingly, the average consumption of fish and vegetables is generally higher in rural areas than urban areas. The first and foremost logical explanation for this tendency is that food access to fish and vegetables for rural people is generally better than their counterparts in urban areas. This food access could be driven by the availability of these protein and vitamin sources instead of income factors, as the rural income is generally lower than the urban income. Figure 25 represents the average consumption of some of the important commodities explained above. More complete figures of the consumption patterns of these food commodities by income group could be seen in the Appendices.

7.3 Consumption of Selected Food Commodities by Province

Examining food consumption patterns by province is necessary to map out food access and availability, especially in relation to household income. One should note that rice consumption in this study includes rice, rice flour, glutinous rice, vermicelli, baby pulp and rice-based finished foods. The average rice consumption of 97.6 kilograms per capita in Indonesia tends to be evenly spread across the country, except for Bali and Papua. Rice consumption in Bali in 2017 was 117.3

kilograms per capita or the highest in country, while rice consumption in Papua was 70.5 kilogram per capita or the lowest in the country. Two of the most logical explanations for high rice consumption in Bali are as follows: firstly, Bali is one of the main rice production centers in Indonesia and has experienced a longtime rice surplus, so rice availability in this province is relatively high compared to other provinces. Secondly, Bali is the most famous tourist destination in the country, so the number of visitors has perhaps increased the total consumption of rice. The average rice consumption might be calculated based on the total population of Bali, excluding the number of tourists. Similarly, the most logical explanation of low rice consumption in Papua could be associated with the low food availability in the province and by the fact that the local population in Papua consumes local staple foods such as sago and tubers, although rice consumption has increased in recent years. An additional explanation could be that household incomes in Papua are some of the lowest in the country, creating problems with food access for residents in the province.

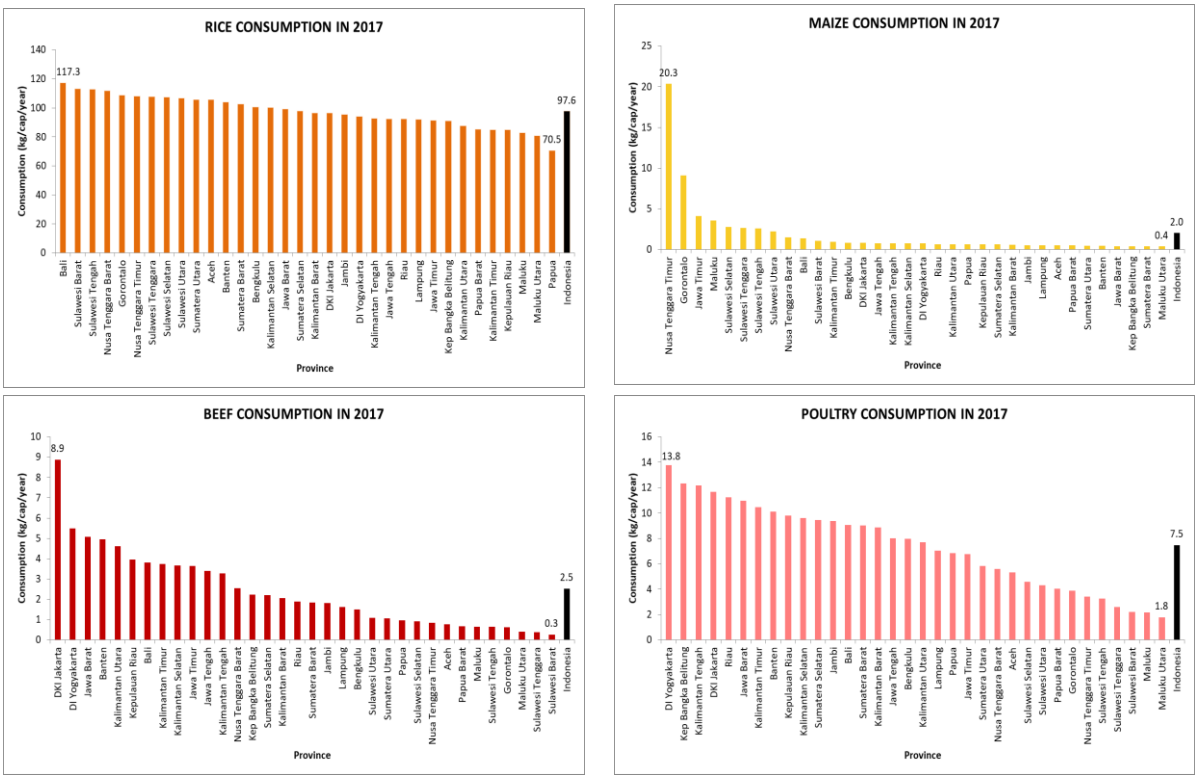


Figure 26: Consumption of rice, maize, beef and poultry by province

A more careful explanation is probably needed for high levels of rice consumption, or over 100 kilograms per capita, in the provinces of Gorontalo and East Nusa Tenggara (NTT), which are some of the poorest regions in Indonesia and not rice production centers. Although Gorontalo is not as poor as NTT province, better food access in Gorontalo probably makes more sense as an explanation for these figures, compared to household income.

The pattern and behavior of maize consumption in 2017 shows that the highest consumption level of 20.3 kilograms per capita was found in the province of East Nusa Tenggara (NTT), and this was also over 10 times the national average. The lowest consumption level of 0.4 kilograms per capita per year was found in the province of North Maluku. Local populations in NTT have long been used to having maize and cassava as their staple food, in addition to rice, which historically came later. The availability of maize per capita in NTT is also one of the highest as the agro-ecosystem

of this province is quite suitable for maize farming and the local population has been farming maize for years. The next largest consumption of maize is in Gorontalo with a consumption of 10 kilograms per capita, followed by East Java, Maluku and South Sulawesi, as presented in Figure 26. In short, it could be concluded that consumption of staple foods is more strongly associated with food availability and food access than household income alone.

As explained previously, the pattern of beef and poultry consumption is more influenced by income level, as these protein sources of food have high income elasticity. The consumption of beef in 2017 in the DKI Jakarta region was the highest in the country, averaging 8.9 kilograms per capita per year. The average household income in Jakarta is far higher than that of people in other provinces, affecting access to beef. The lowest level of beef consumption was found in West Sulawesi which has a consumption rate of 0.3 kilograms per capita per year.

The highest level of poultry consumption in 2017 was recorded in the province of DI Yogyakarta, averaging 13.6 kilograms per capita per year, while the lowest level of poultry consumption was found in North Maluku, averaging of 1.8 kilogram per capita per year. The pattern of poultry consumption is similar to that of beef consumption as household income could play a part as the most dominant determinant of poultry consumption. Poultry consumption is more evenly distributed across the country, unlike beef consumption where many more provinces have a consumption level below the national average of 2.5 kilograms per capita. Poultry consumption has historically served as an affordable protein source across the country, including for the lowest quintiles of income groups.

The average consumption of fish in 2017 was recorded as 26.2 kilograms per capita per year, and fish consumption in the province of Maluku was the highest with 46.9 kilograms per capita per year. Maluku is one of the archipelagic provinces in Indonesia and therefore has the highest availability of fish. The Ministry of Maritime Affairs and Fisheries has promoted some policy instruments to increase the catch-harvest and fish production in general by providing incentive systems for fishing vessels, gillnets and subsidized credits. The performance of these policies might take some time to have a significant effect on fish production and productivity. Once the fish production centers have fewer problems with catch-harvests, aquaculture and making fish more widely available to the population, the patterns of fish consumption in the country might change. Therefore, supporting policies for fish production is really necessary in order to maintain or improve the consumption of fish in the country. Fish consumption might also improve food quality and thus boost the nutrition levels of the population.

Another important food commodity as a protein source is soybeans, and the average soybean consumption in 2017 was 7.3 kilograms per capita per year. The province of East Java has the highest soybean consumption of 12.7 kilograms per capita per year, while the province of North Maluku has the lowest level of soybean consumption, averaging 2.1 kilograms per capita. Soybeans are mostly consumed in terms of processed products such as tempeh and tofu, followed by soy sauce and bean consumption.The growing demand for soybeans needs to be fulfilled from soybean imports as domestic soybean production is lower than the consumption level. Total soybean production is less than one million tons per year, while the total soybean consumption in 2017 was over 2.1 million tons. Soybean consumption is expected to increase as the food industry using soybeans as the raw materials is also expected to rise.

The most consumed vegetable in 2017 was kangkung (swamp cabbage), and the average consumption was 4.7 kilograms per capita per year. The most consumed fruit in 2017 was bananas as the average consumption was 11.7 kilograms per capita per year. Kangkung and bananas are the most affordable vitamin and fiber sources of food, including among the poor or the lowest

income group of the population. The pattern and behavior of vegetables and fruit in Indonesia are mostly affected by the price, compared to other determinants such as income level. The complete figures of important food consumption in 2017 by province could be seen in Appendix 4.

7.4 Derived Price of Selected Food Commodities by Income Group

The price of food commodities in this section is derived by dividing the total expenditure on certain food by the quantity of food being consumed. One should not interpret that the nominal price of food sold to the people in different quintiles of income group differs significantly. This derived food price shall show the value of food commodity for people in certain income groups, as the consumption patterns among income groups differ significantly. As an example, we can look at the derived rice price, presented in Figure 27.

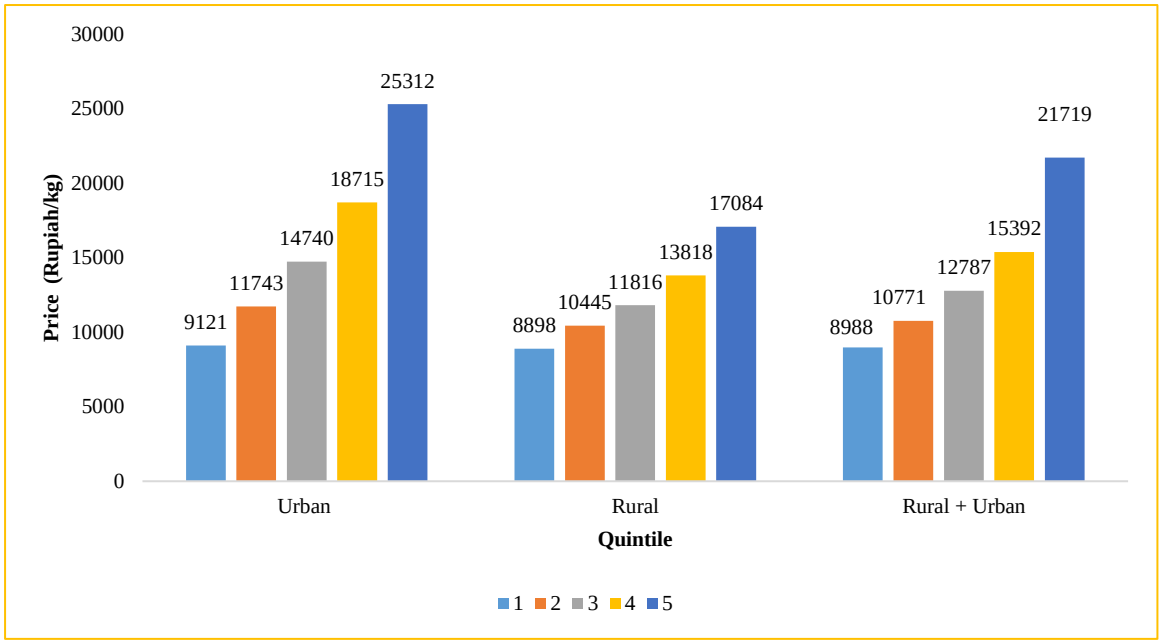


Figure 27: Derived price of rice in rural and urban area

In general, the lowest income group pays for food commodities at a lower price compared to the highest income group. In this case, the lowest income group pays Rp 8,988 per kilogram for rice, which is far lower than the highest income group at Rp 21,719 per kilogram of rice. One should interpret this figure carefully however as it could lead to an inaccurate conclusion about the price disparity of the very same rice for different income groups. Interpreting it as, “people in a higher income group consume better quality of rice compared to fellow citizens in a lower income group” is an acceptable conclusion. The derived price of rice paid by people in Quintile 5 in urban areas is Rp 25,312 per kilogram which is much higher than Rp 9,121 per kilogram, most probably because of the different quality of rice being consumed by high income groups. Similarly, the derived price of rice paid by people in Quintile 5 in rural area is Rp 17,084 per kilogram which is much higher than Rp 8,898 per kilogram. The quality issue of rice being consumed probably plays a more important role in the behavior of the derived price of rice according to Susenas data.

This also applies to other food commodities, where the price paid by people in lower quintiles is generally lower than that paid by people in higher quintiles, because of differences in food quality. The complete set of derived prices of other food commodities can be seen in Appendix 5.

Chapter 8

The Best Model of Income and Food Consumption Relations

This chapter examines the best model of the relationship between income and food consumption using the baseline of Susenas data from 2017. We compare the best linear, polynomial (degree-r), semi-logarithmic, double logarithmic and exponential models under certain specifications for selected commodities. One should note that in this exercise, the consumption of selected food commodities is direct household consumption, not including food being used for feed, seed, industrial use, and loss and waste. Later in Chapter 9, the report also presents the projected consumption using scenarios of food consumption after considering non-food use such as industrial use, loss and waste. The following Table 9 presents the best model of the relationship between income and food consumption in Indonesia, covering rural and urban areas.

Table 9 : The best model of income and food consumption relations in Indonesia

Food Groups	Selected Commodity	Best Model	Specification*
Cereals	Rice	Semi-log	Q = 6.03 Ln(I) + 15.46
	Maize	Double log	Ln(Q)= - 0.36 Ln(I) + 5.58
Animal Products	Beef	Linear	Q = 3E-06 I - 0.36
	Poultry	Semi-log	Q = 6.91 Ln(I) - 86.619
	Fish	Semi-log	Q = 12.09 Ln(I) - 138.51
Beans and Nuts	Soybean	Semi-log	Q = 2.26 Ln(I) - 23.48
Vegetables	Shallots	Semi-log	Q = 0.99 Ln(I) - 10.71
	Garlic	Semi-log	Q = 0.68 Ln(I) - 7.46
	Red Chili	Semi-log	Q = 0.92 Ln(I) - 10.63
	Hot Chili (Cayenne)	Semi-log	Q = 0.50 Ln(I) - 5.21
	Spinach	Semi-log	Q = 1.16 Ln(I) - 11.93
	Kangkung	Semi-log	Q = 0.91 Ln(I) - 7.71
Fruits	Orange	Semi-log	Q = 3.34 Ln(I) - 42.24
	Apple	Linear	Q = 2E-06 I - 0.61
	Banana	Double log	Q = 0.33 Ln(I) - 2.03
	Snake Fruit	Semi-log	Q = 1.10 l Ln(I) - 12.92
	Mango	Double log	Ln(Q) = 1.05 Ln(I) - 14.88
Others	Cane Sugar	Semi-log	Q = 1.85 Ln(I) - 16.72

Q: amount of consumption (kg/capita/year)

I: household income (capita/year)

*Complete figure of these relations are presented in Appendix 6

The model selection exercise consists of three sets of models for each commodity, the model for all Indonesia (rural and urban consumption) such as presented in Table 9, for rural areas like Table 10 and for urban areas like Table 11. This division is necessary as the characteristics of food consumption in rural areas and urban areas differ significantly. Semi-logarithmic (linear form for dependent variables and logarithmic form for independent variables) and double logarithmic (logarithmic form for both dependent and independent variables) models seem more dominant in the model selection process to describe the best relationship between household income and consumption of selected food commodities in Indonesia.

Table 10: The best model of income and food consumption relations in Rural Area

Food Groups	Selected Commodity	Best Model	Specification
Cereals	Rice	Semi-log	Q = 9.75 Ln(I) - 30.60
	Maize	Double log	Ln(Q) = -0.44 Ln (I) + 6.86
Animal Products	Beef	Linear	Q = 2E-06 I - 0.19
	Poultry	Semi-log	Q = 6.46 Ln(I) - 81.10
	Fish	Semi-log	Q = 15.38 Ln(I) - 180.63
Beans and Nuts	Soybean	Semi-log	Q = 2.70 Ln(I) - 30.05
Vegetables	Shallots	Semi-log	Q = 1.40 Ln(I) - 15.93
	Garlic	Semi-log	Q = 0.82 Ln(I) - 9.44
	Red Chili	Semi-log	Q = 1.11 Ln(I) - 13.20
	Hot Chili (Cayenne)	Semi-log	Q = 0.86 Ln(I) - 9.74
	Spinach	Semi-log	Q = 1.66 Ln(I) - 18.60
	Kangkung	Double log	Ln(Q) = 0.31 Ln(I) - 2.68
Fruits	Orange	Semi-log	Q = 3.17 Ln(I) - 40.06
	Apple	Linear	Q = 1E-06 I - 0.47
	Banana	Double log	Q = 0.37 Ln(I) - 2.49
	Snake Fruit	Semi-log	Q = 1.63 Ln(I) - 20.02
	Mango	Linear	Q = 7E-07 I + 0.01
Others	Cane Sugar	Semi-log	Q = 3.44 Ln(I) - 37.13

Q: amount of consumption (kg/capita/year)

I: household income (capita/year)

*Complete figure of these relations are presented in Appendix 6

Table 11: The best model of income and food consumption relations in Urban Area

Food Groups	Selected Commodity	Best Model	Specification*
Cereals	Rice	Semi-log	Q = 6.57 Ln(I) + 2.67
	Maize	Linear	Q = 2E-07 I +0.87
Animal Products	Beef	Linear	Q = 3E-06 I + 0.45
	Poultry	Semi-log	Q = 6.81 Ln(I) - 84.636
	Fish	Semi-log	Q = 11.28 Ln(I) - 130.55
Beans and Nuts	Soybean	Semi-log	Q = 1.16 Ln(I) - 7.38
Vegetables	Shallots	Semi-log	Q = 0.73 Ln(I) - 7.16
	Garlic	Semi-log	Q = 0.53 Ln(I) - 5.43
	Red Chili	Semi-log	Q = 0.72 Ln(I) - 7.78
	Hot Chili (Cayenne)	Semi-log	Q = 0.39 Ln(I) - 3.98
	Spinach	Semi-log	Q = 0.84 Ln(I) - 7.81
	Kangkung	Double log	Ln(Q) = 0.12 Ln(I) - 0.10
Fruits	Orange	Semi-log	Q = 3.39 Ln(I) - 42.65
	Apple	Linear	Q = 2E-06 I - 0.54
	Banana	Double log	Ln(Q) = 0.41 Ln(I) - 3.31
	Snake Fruit	Semi-log	Q = 0.64 Ln(I) - 6.61
	Mango	Linear	Q = 7E-07 I + 0.01
Others	Cane Sugar	Semi-log	Q = 1.2 Ln(I) - 9.47

Q: amount of consumption (kg/capita/year)
I: household income (capita/year)
*Complete figure of these relations are presented in Appendix 6

One example of the income-consumption functional relations in cereals, protein sources and fruit is presented in the following Figure 28. For rice consumption, the best model is semi-logarithmic for all three functional relations in rural areas, urban areas, and in Indonesia as a whole. The patterns of functional relations are similar, rice consumption increases at a very steep rate at lower income levels in line with a rise in income and the trend is slower at higher income levels. The functional relations between income and rice consumption in rural areas has a much steeper increase than in urban areas. This could imply that the Engle Law applies here, where income elasticity for rice in urban areas is much lower than in rural areas and across Indonesia as a whole.

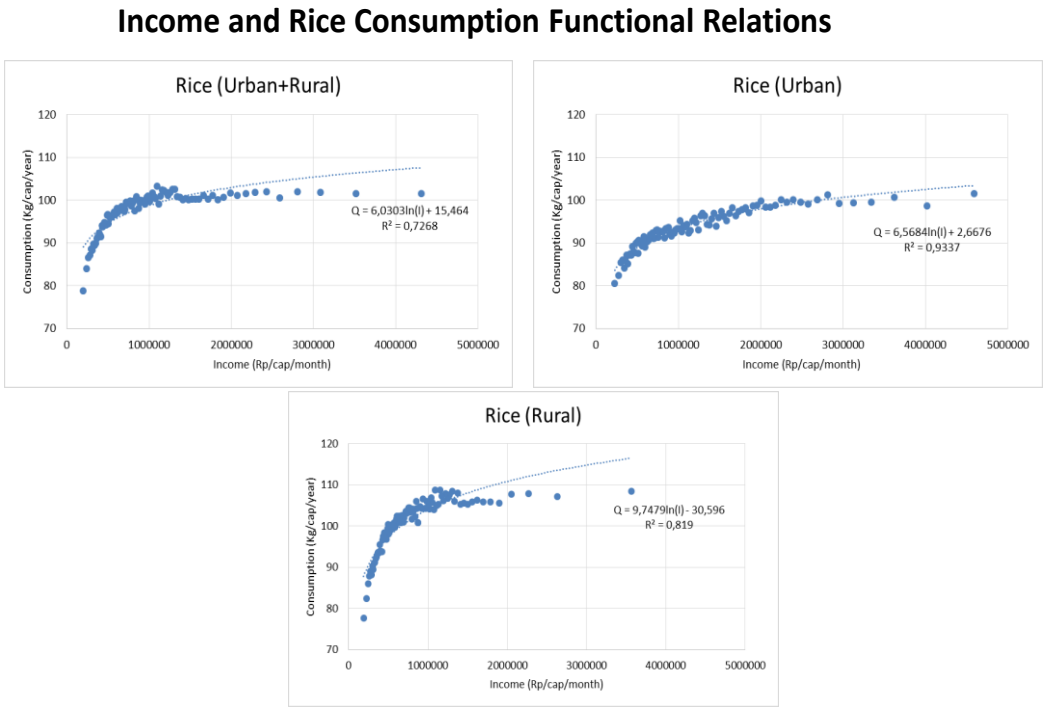


Figure 28: Income and rice consumption functional relations

For all three functional forms, the semi-log model has resulted in high values of R2 0.73, 0.82, and 0.93 respectively for income and rice consumption relations in Indonesia (rural and urban areas), rural areas and urban areas. In urban areas, increasing income does not necessarily increase rice consumption, and it actually decreases rice consumption in the highest income group. This model selection is very consistent with the previous analysis of rice consumption at the baseline of 2017 as presented at Section 7.2.

The best models for income and maize consumption relations for rural areas and for total rural and urban areas are double logarithmic, which is a negative trend and convex to the point of origin, or declining from the upper left to the lower right. Maize consumption decreases as income increases in rural areas and across Indonesia as a whole the trend is equal to the coefficient income in the logarithmic form. In this case, maize could represent an example of inferior goods, as higher income people tend not to consume more maize. The coefficients of determination R^2 of these two functional relations are 0.70 and 0.72 respectively and show that these two double-log models could best describe income and maize consumption relations. In urban areas, the best model is linear and quite flat, although the coefficient of determination R2 is 0.76. This means that as

income in urban areas increases, maize consumption also increases although it is very small, as presented in Figure 29.

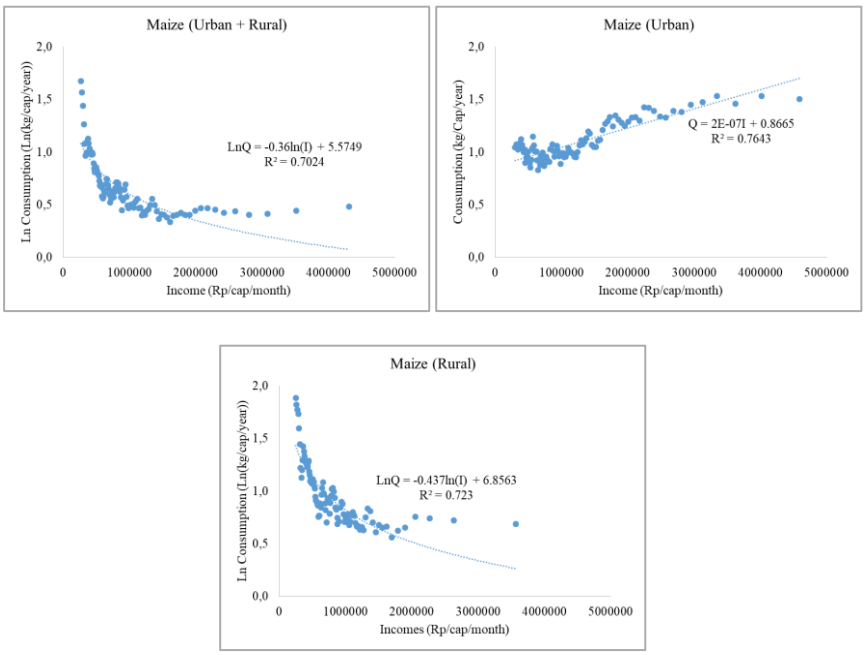


Figure 29: Income and maize consumption functional relations

People living in urban areas generally do not consume maize directly, but rather indirectly as a feed used in the poultry industry. The best functional forms between income and poultry consumption show positive relations in all three models in rural, urban and rural-urban areas across the whole country. This means that poultry consumption increases as the household income increases, in the semi-log functional forms (please refer to Table 9, 10 and 11). In contrast to the models for poultry consumption, the functional relations between income and beef consumption show all linear relations in rural areas, urban areas and rural-urban areas. The coefficient determinations R^2 of these functional relations are respectively 0.98, 0.97, and 0,98, meaning that these linear models are good predictors of functional relations between income and maize consumption in Indonesia. The complete figures of income and consumption relations of beef, soybeans, sugar, vegetables and fruit are in Appendix 6.

Chapter 9

Food Demand Projection for 2025 and 2045

9.1 Demand Projections for Food Consumption and Non-Food Consumption

This chapter examines three demand projections for food consumption for 2025 as a medium milestone and for 2045 as a mark of 100 years of Indonesian independence. The structure of this chapter consists of three food demand projections, namely: (1) Food demand for consumption (intake only), calculated based solely on the Susenas 2017 dataset; (2) Food demand 1 after considering domestic uses of food for feed, seed and non food industries according to National Food Balance Sheet (NBM), and (3) Food demand 2 after considering the NBM and additional loss and waste data published by the FAO (2011).

Table 12 Basis assumption of non-food consumption demand

Commodity	Food Balance Sheet				FAO (2011)
	Feed (%)	Seed (%)	Non Food Industry (%)	Lost& Waste (%)	Lost & Waste (%)
Rice	0.28	0.00	0.00	3.41	28
Maize	0.06	0.00	0.00	0.05	28
Sugarcane	0.00	0.00	0.00	0.00	?
Soybean	0.00	0.00	0.00	0.05	10
Fruit	0.00	0.00	0.00	0.04	42
Vegetable	0.00	0.00	0.00	0.54	42
Beef	0.00	0.00	0.00	1.95	19
Poultry	0.00	0.00	0.00	0.15	19
Fish	0.00	0.00	0.00	0.69	24

Source: FAO (2011)

The main difference in these three scenarios is that the income growth has been corrected by the inflation rate, thus reflecting the consumer's purchasing power at any given time. Some important results could be summarized as follows: The projected food demand or per capita food demand for consumption (intake) and non food consumption illustrates how food demand changes as income changes. Overall, the per capita projection of food demand has increased, except for maize. The projected maize consumption has decreased because corn commodity is an inferior commodity, which means that income increase does not encourage the increase of maize consumption per capita, but vice versa (Figure 30-32).

The amount of non-food obtained from the estimation based on the Food Balance Sheet (NBM) is the amount of rice for the use of feed which is 0.28 percent and 0.06 for maize. The loss or waste rate for rice was 3.41 percent, 0.05 percent for maize, 0.05 percent for soybeans, 0.04 percent for fruit, 0.54 percent for vegetables, 1.95 percent for beef, 0.15 percent for poultry and 0.69 percent

for fish. The estimated amount of food loss on the Food Balance Sheet is quite small compared to that of the FAO, so the last food projection (Food Demand 2) is formulated after considering a different food loss and waste rate according to FAO 2011. The food loss and food waste rate is very high: 28 percent for rice and maize, 10 percent for soybeans, 42 percent for vegetables and fruit, 19 percent for cattle and poultry meat and 24 percent for fish.

The projected per capita consumption of rice, beef, poultry, fish, vegetables, fruit, soybeans and cane sugar has increased between 2017 and 2045, although the magnitudes are slightly different. For complete figures, please refer to Appendix 8. The national projection of per capita food demand for consumption (intake) for the baseline scenario shows that the highest per capita increase in food demand for consumption in 2025 and 2045 is for apples, vegetables like red chilies and cayenne pepper and all animal products (Figure 30).

The projection of per capita rice consumption in 2025 and 2045 has gradually increased by 1.5 percent to 99.08 kilograms per capita per year and 2 percent to 99.55 kilograms per capita (Figure 30). The increase in rice consumption is relatively small compared to the increase in other food commodities for 2025 and 2045.

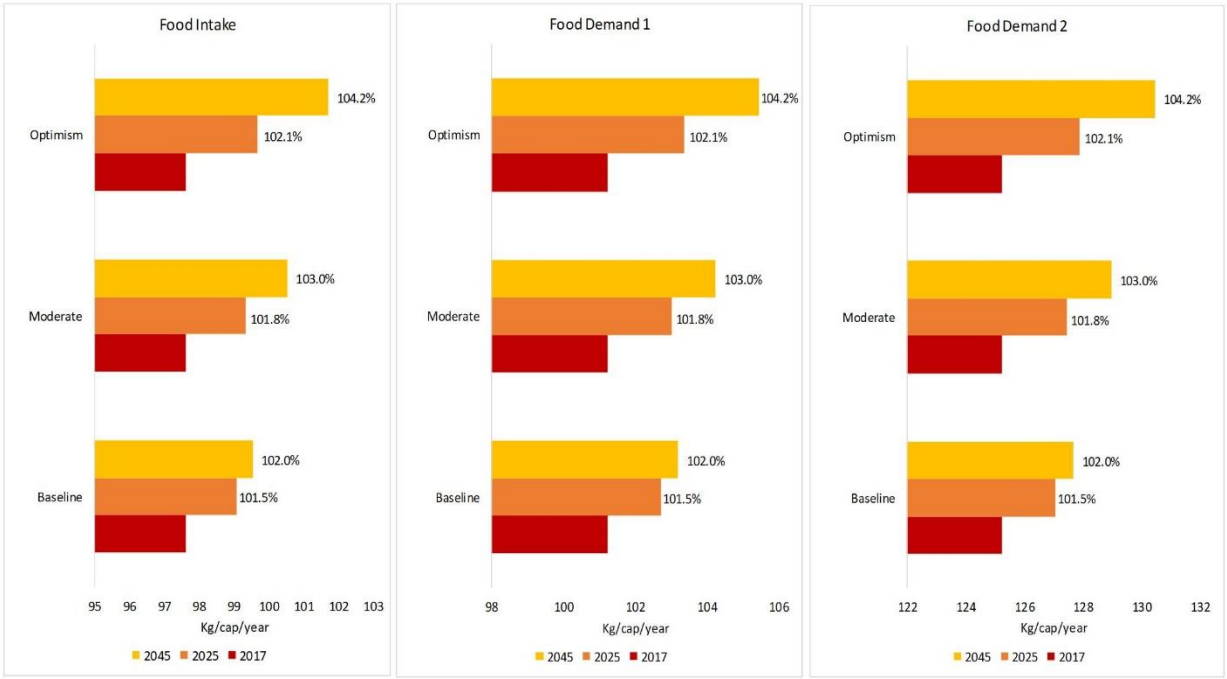


Figure 30: Projection of rice consumption per capita in 2025 and 2045

This projected increase in rice consumption in Indonesia is similar to the results of a modeling study by Gunning-Trant et al (2015), although the magnitude is somewhat different. Projecting the demand for food using the AIDS model and employing Susenas data is likely to result in similar increases in the quantity consumed. However, the results are different from the common trends in the world demand for rice, such as suggested by Timmer et al.(2010), where rice consumption in other Asian countries is generally declining. Except for the difference in consumption declines, other patterns of rice consumption in Indonesia in this study are similar to those of other countries. For example, rice consumption has different characteristics among the income groups and among rural and urban areas. Only the Quintile 5 income group in Indonesia has experienced declining rice consumption, while in other Asian countries, rice consumption declines are also found in medium and lower income groups. This study suggests that the income elasticity of the demand

for rice in Indonesia is positive at 0.06 for rural and urban areas (and 0.07 in urban areas and 0.10 in rural areas). In rice producing regions in other parts of the world, most income elasticities for urban households are now zero or negative. Income elasticities for rural households are positive, similar to that of other Asian countries, as rural incomes are generally lower than urban incomes. Finally, food tastes in Indonesia and Asian countries are changing to become more homogenous, especially in urban areas, with traditional rice eaters reducing rice consumption.

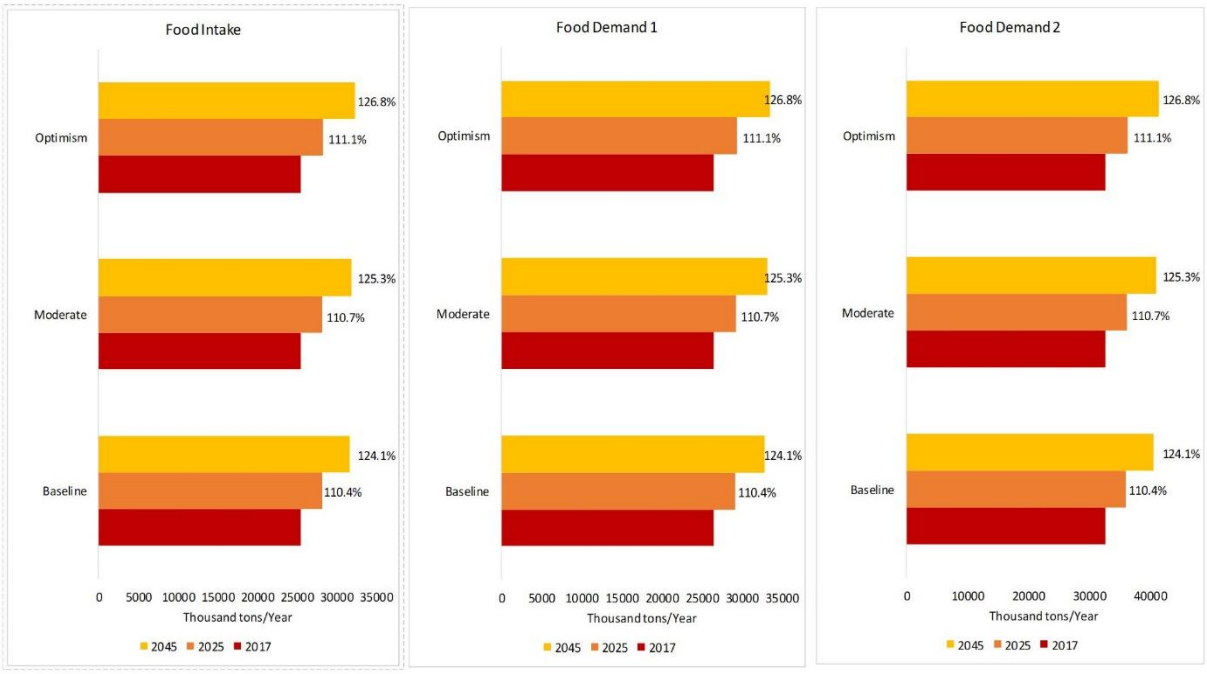


Figure 31: Projection of total rice consumption in 2025 and 2045

Figure 31 presents the projection of total rice consumption in 2025 and 2045 using the baseline data of 2017. Based on the baseline scenario, the total rice consumption for food intake in 2017 was 25.6 million tons, which later increases to 28.2 million tons in 2025 and 31.7 million tons in 2045. The projected rice consumption will be higher under the moderate and optimistic scenarios where economic growth is 5.70 percent and income growth per capita is 4.99 percent. The study also simulates different food demands by incorporating the data form the Food Balance Sheet (NBM) and incorporating high food loss and waste estimates by the FAO (2011). The projected total rice consumption for these two simulation estimates are even higher, i.e. 26.5 million tons in 2017, 29.3 million tons in 2025 and 32.9 million tons in 2045 under the scenario of Food Demand 1, using the data from NBM. Whereas under the scenario of high food loss and waste, the projected demand for rice would be 32.8 million tons in 2017, 36.2 million tons in 2017 and 40.7 million tons in 2045.

These estimates provide important policy relevance that rice remains a staple food, even in 2045 or a century after Indonesia's independence. As the policy strategies of the current government are to maintain food security, especially staple foods, elements of food consumption could determine the level of food accessibility and therefore food security in the country. The food demand dimension is equally important to the supply dimension, thus improving food production and productivity in the country. This demand dimension is mostly market-driven and income-driven, as the highest quintile of income groups experience declining rice consumption and maize consumption. The high income group of rice consumers demand high quality rice, even if it is not cheap. For the middle and lower income groups, ensuring access to rice consumption is equally

important to the stability of the retail price of rice. Income elasticity regarding the demand for rice in Indonesia is still positive and higher in rural areas, so the policy of food assistance or food subsidies targeting the poorest group of rice consumers remains relevant in maintaining food and nutrition adequacy, including both energy adequacy and protein adequacy. The details of such food policy and targeted subsidies, especially if the government is planning to transform in-kind food assistance to a card-based and non-cash subsidy, could be adjusted with the latest development of infrastructures, logistic systems, available data technology and preparedness of the stakeholders involved in the transformation process.

In the animal products category, poultry showed the highest increase compared to other animal products, at 22.1 percent in 2025 or 9.13 kilograms per capita per year, and 29.3 percent in 2045 or 9.66 kilograms per capita per year. Meanwhile, the consumption projection for beef which is projected for 2025 and 2045 increases by 10.3 percent to 2.79 kilograms per capita per year and 20.4 percent to 3.04 kilograms per capita per year respectively.

The consumption projection for fish is projected to increase by 11 percent to 29.09 kilograms per capita per year in 2025 and by 14.6 percent to 30.04 kilograms per capita per year in 2045. In general, the income elasticities of these three sources of animal protein are generally higher than those of rice and maize. Beef is generally consumed by higher incomes groups living in urban areas. Poultry is consumed by all income groups, including the lowest quintiles. Poultry sometimes serves as a substitute for beef, especially when the price of beef remains high. The characteristics of fish consumption are somewhat different from that of beef and poultry, as sea fish is generally consumed by people living in cities and coastal zones, and fresh-water fish is consumed by urban people and in some rural areas with access to lake and river water. Although this study does not differentiate fish consumption between sea fish and fresh-water fish, increasing fish consumption could be attributed to increasing incomes and population.

The policy relevance to ensure food accessibility to sources of animal protein is linked to infrastructure improvements of the marketplace, including both modern retail markets and traditional markets. Since the urban population will be more dominant in 2025 and 2045, policy on improving the value chain systems of these protein sources would contribute significantly to the changing diets of the Indonesian population, from all income groups. The most direct consequences of increasing demand for poultry in the future is an increasing demand for feed, which is mostly fulfilled from imported feed, either in the form of the direct import of feed or imported of maize which can be processed by the domestic feed industries. Maintaining the price stability of feed would then have an impact on the price of poultry and fish. The instability of feed markets, due to the tight control of maize imports since 2015 has affected the Indonesian poultry industry. The feed industry has had to survive by substituting maize for wheat as feedstock. As a result, the total amount of wheat imports rose to over 11 million tons in 2017, and Indonesia has become the largest wheat importer after Egypt. Therefore, the policy on food accessibility to animal protein sources such as poultry and fish should be integrated with the production and trade policy of maize as an important source of feedstock for the feed industry.

These value chain policies of animal products such as beef, poultry and fish do not only directly affect food accessibility among all income groups, but also affect many value chain players like retailers, processors, wholesalers and collector traders who connect directly to rural areas and to farmers or producers of protein sources. These players would help farmers to open up market access to their products, and help to solve the perennial issues of asymmetric constraints of information, technology, price transparency, etc. These players could also help in conveying the messages of urban consumers to the farmers and other actors along the value chains, such as product specification, food safety, health and hygiene requirements, halal certification and other

quality standards that have shaped the characteristics of the value chains of these protein sources. Similarly, these modern retail markets and traditional markets as well as other actors along the value chains might also determine the access levels and ease of consumers in getting unhealthy foods, both processed and fresh, provided by farmers and other actors.

With regards to fruit and vegetables, the highest demand projection for food consumption per capita was apples, with an increase of 55 percent in 2025 to 1.49 kilograms per capita per year and 73.5 percent in 2045 to 1.66 kilograms per capita per year. This increase is the highest increase among all selected food commodities in this study. The policy issues that might appear in the future include the fact that Indonesian apple production simply does not fulfill the growing demand for apples, especially by urban populations and higher income groups. Indonesia relies on imported apples, including those from developed countries such as the United States and Australia. Projected demand for local fruit such as oranges, bananas, snake fruit and mangoes in 2025 and 2045 is not as high as the projection for apples - and the market is dominated by imported apples. Demand for oranges is projected to reach 4.09 kilograms and 4.35 kilograms per capita in 2025 and 2045 respectively; whereas the demand for mangoes remains very small and is projected to reach 0.73 and 0.80 kilograms per capita in 2025 and 2045 respectively. Urban populations can buy these fruits in either traditional markets or modern retail markets that have experienced rapid growth in the last two decades.

In addition, the highest per capita consumption projections in the vegetables category relate to hot chillies (cayenne pepper) and red chillies. Both experience a significant increase in 2025 and 2045. The projected demand for hot chillies or cayenne pepper is 1.78 and 1.82 kilograms per capita in 2025 and 2045 respectively. The demand for red chilies is projected to reach 2.14 and 2.21 kilograms per capita in 2025 and 2045 respectively. The demand patterns of these vegetables often create political tensions as chillies contribute significantly to the inflation rate. Consumer characteristics in Indonesia usually require fresh chilli products, instead of dried chillies and other forms of processed products.

The policy relevance of fruit and vegetable demands in the future is that actors in the value chains need to have access to cold-storage facilities, including ones using controlled atmosphere systems (CAS) that could improve the efficiency of the value chains. The marketing systems of horticulture products in general requires continuous improvements related to the logistics systems of transportation and distribution as the current systems often create price disparities between consumer and producer centers. The policy should be more balanced between demand-side management and supply-side or productivity improvements, as the majority of horticulture production centers are in Java. Indonesia should shift horticulture policy strategies from over-protection for the sake of price stabilization, to improving the performance of traditional markets, as the majority (over 80 percent) of horticulture products are marketed through cooperation with wholesale markets (*pasar induk*), which are available in nearly all big cities in Indonesia. Large and medium cities should implement spatial planning and zoning policies for end-to-end waste management from these traditional markets. Finally, the government has to revise trade policies and subsequent procedures related to horticulture (and animal products) in compliance with the decision of the dispute settlement body (DSB) of the World Trade Organization (WTO) that punished Indonesia in 2015 due to quantitative import restrictions.

Moreover, partnering with modern supermarkets should also be conducted, as supermarket chains have generally provided better services regarding horticultural products, such as food safety, private grades and fruit and vegetable standards. Small farmers and farmers' groups who meet the requirements imposed by the supermarkets might have a better chance of earning higher farm incomes. In other words, the government needs to adjust its policies to support farmers who are

willing to implement agricultural diversification in the horticulture sector and who can meet rising quality and safety standards set about by retail markets or by consumers through modern retail markets and supermarkets. These policies would also benefit urban consumers who will make up over 70 percent of the Indonesian food market in the future. The policies could include proper commercial regulations and enable a business environment where many actors along the horticulture value chains could interact sustainably and commercially.

Overall, the projection of per capita consumption for selected commodities has generally increased in response to an increase in revenue in 2025 and 2045. The higher the purchasing power of the people, the higher the per capita consumption, which is a result seen in the projections of each scenario (baseline, moderate, and optimistic).

9.2 Demand Projections for Total Food Consumption and Non-Food Consumption

Demand projections for the total volume of food consumed nationally (excluding feed, seed, industrial use, and loss and waste) is calculated for 2045 using the baseline of 2017, and 2025 as a medium-term milestone. The projected outcome is based on income growth or the growth of GDP per capita at 4.39 percent per year. The results show that total consumption for all food commodities will increase, except for maize. The projection of total maize consumption will decrease by 5 percent per year in 2025 and increase by 9 percent per year in 2045. As mentioned in previous chapters, increases in income do not lead to increases in the total consumption of maize. On the other hand, the total consumption of rice, beef, poultry, fish, vegetables, fruit, soybeans, and cane sugar is projected to increase between 2017 and 2045. By 2025 the highest increase is for the consumption of fruit (such as apples) and poultry. The increase in the total consumption of these commodities by 2045 exceeds 50 percent of the total consumption in 2017. In the case of apples, an increase of almost one and a half times the total consumption is expected. This also occurs in the projection of total consumption for 2045, as the total consumption for fruit and poultry still occupies the top two positions with an increase in total consumption exceeding 150% of the total consumption in 2017.

The projection of the total consumption in 2025 and 2045 for rice increases by 10 percent to 28,219 million tons and 24 percent to 31,723 million tons respectively. Beef is projected to increase by 20 percent in 2025 to 794 million tons and 46 percent in 2045 to 969 million tons. Meanwhile, for other animal products such as poultry and fish, the total consumption will also increase: total poultry consumption is projected to increase by 33 percent and 57 percent in 2025 and 2045 respectively; and fish by 21 percent and 39 percent. Based on these results, the increase in the total consumption for animal products in 2025 and 2045 is larger than the increase in total rice consumption.

The highest projected commodity of total vegetable consumption is red chilies, with an increase of 21 percent in 2025 to 609 million tons and 40 percent in 2045 to 705 million tons. Meanwhile, the highest projected increase for fruit consumption relates to apples, with an increase of 69 percent in 2025 to 423 million tons and 112 percent in 2045 to 528 million tons.

9.3 Food Demand Projection after Incorporating other Domestic Uses, Loss and Waste

The largest increase in projected food demand after incorporating the domestic uses as stated in Food Balance Sheet (NBM) (Food Demand 1) refers to beef, poultry, fish, fruit and vegetables. Demand for these foods grows as income increases (please see Figures 31 and 33). Beef consumption in 2025 and 2045 is projected to increase by 20 percent and 46 percent

respectively. Poultry consumption in 2025 and 2045 is projected to increase by 33 percent and and 57 percent respectively. The largest increase in fruit consumption in 2025 and 2045 refers to apples, which will increase by 69 percent and 111 percent respectively, whereas the largest increase in vegetable consumption relates to cayenne pepper, which will increase by 21 percent in 2025 and 40 percent in 2015. Conversely, the demand projection for rice and maize shows the smallest increase compared to other foods. By 2025 the demand for rice increases by 10 percent and 24 percent in 2045. The demand for maize decreases by 5 percent in 2025, but will increase again by 9 percent in 2045.

These increases in food demand projections in 2025 and 2045 are mostly brought about by increases in the population of 8.7 percent in 2025 and 21.7 percent in 2045. Another factor that causes increased demand is the increase in household income, which leads to an increased demand for food. USDA (2014) has estimated that increasing income by 10 percent will lead to increasing production and consumption by 3 percent. Field investigations and related empirical works have to be conducted quickly to determine whether these USDA findings also apply to Indonesia. One should also note that increasing income could also lead people to consume fewer grains and more meat and higher-value foods (Hofstrand 2014), which is consistent with the findings of this current study.

Another important note regarding the patterns of food demand projections in the future relate to the estimates for Food Demand 1 and Food Demand 2 that have a similar percentage increase, although the values differ slightly. The largest increase in food demand projection in Food Demand 2 is found the same commodities as in Food Demand 1, namely: beef, apples and red peppers. The total demand for beef in 2025 in Food Demand 1 is 809 thousand tons, while in Food Demand 2 is 945 thousand tons. These figures increase again in 2045, where the total demand for feed increases to 988 thousand tons in Food Demand 1 and 1.15 million tons in Food Demand 2. The largest increase in fruit commodities is apples, reaching 424 thousand tons in Food Demand 1 and 602 thousand tons in Food Demand 2. If this trend continues, by 2045, the demand for fruit increases to 529 thousand tons in Food Demand 1 and 750 thousand tons in Food Demand 1. In general, the total food projections increase in 2025 and 2045 across all commodities except for maize. The food projections in Food Demand 2 are much higher than those in Food Demand 1, mostly due to higher loss and waste estimates being used. Complete pictures of food demand projections are presented in Appendix 8.

The main socio-economic factors that encourage increased food demand are increased urbanization and increased income (FAO 2009). By 2025, the population split is projected at 58 percent in urban areas and 42 percent in rural areas, an increase from the 2017 base year of 53 percent in urban areas and 47 percent in rural areas. By 2045, the urban population is expected to increase to 64 percent; whereas the percentage of the population in rural areas will decline to 36 percent (United Nations Population 2014). Increases in urbanization and income are predicted to increase demand for food in urban areas more than in rural areas. In contrast to the projected per capita consumption, almost all commodities are projected to increase. However, the total projected demand for food in rural areas will decrease in 2025 and 2045 across almost all commodities due to the reduced population in rural areas (Appendix 8).

Food demand in urban areas in 2025 and 2045 will increase in all scenarios. The largest increase in urban areas applies to apples, which experience an increase of 63 percent in 2025 and 124 percent in 2045. Based on the demand projections, the largest increase in animal protein in urban areas is poultry meat, which increases 40 percent in 2025 and 82 percent in 2045. The largest increase for vegetable commodities applies to red chilies, which will experience an increase of 40 percent in 2025 and 82 percent in 2045. The lowest increases are projected for rice and maize as

urbanization usually brings changes in lifestyle and consumption patterns (FAO 2009). The increasing proportion of the population living in cities is driving demand for food, as income growth increases demand for higher quality foods such as vegetables, fruit and animal foods and reduces the demand for staple foods such as corn and rice.

Finally, in contrast to food demand in urban areas, food demand for staple commodities in rural areas in 2025 and 2045 is projected to decrease significantly according to the Food Demand 1 and Food Demand 2 scenarios. Based on the demand projections, the largest increase in animal protein demand in rural areas is poultry meat, which increases 18 percent in 2025 and 19 percent in 2045. The largest food increase for vegetable commodities is red chilies, which experience an increase of 8 percent in 2025 and 9 percent in 2045. The largest food increase for fruit commodities is oranges, which experience an increase of 20 percent in 2025 and 22 percent in 2045. In general, the percentage in change of food projection demands in rural areas is smaller that those in urban areas. These are mostly caused by significant changes in the population living in rural and urban areas, with a significantly smaller percentage living in rural areas. The average income of people living in rural areas is also much lower. In rural areas, several commodities are projected to experience declining demand in 2025 and 2045. The demand for apples is projected to decrease by 29 percent in 2025 and 21 percent in 2045. Demand for maize will decrease by 15 percent in 2025 and 22 percent in 2045. Demand for kangkung (swamp cabbage) increases by 2025 and decreases 2 percent in 2045.

9.4 Food Preferences Related to Price and Income Changes

The AIDS model used in this study is able to estimate food preferences, using a proxy of income elasticity, own-price elasticity and cross-price elasticity. Income elasticity is the percentage of changes in food consumption due to the percentage of changes in household income. The higher the income elasticity, the higher the particular food preference. Own-price elasticity is the percentage of changes in food consumption due to the percentage of changes in the food price. Own-price elasticity is usually negative, as the higher the food price, the lower the food consumption. In this case, the higher the own-price elasticity (in absolute terms), the higher the preferences of particular foods. Cross-price elasticity is the percentage of changes in food consumption due to the percentage of changes in the price of other foods. When the cross-price elasticity is positive, the two food commodities concerned are considered complementary goods. When the cross-price elasticity is negative, the two food commodities are considered to be substituting each other. Therefore, the higher the cross-price elasticity, the higher the preferences of particular complementary foods. Table 9.1, 9.2 and 9.3 in the Appendix provide a summary of food preferences, proxied by income elasticity, own-price elasticity and cross-price elasticity.

a. Income Elasticity

Staple foods such as rice and maize are income-inelastic. Maize could be considered an inferior good, as shown by an income elasticity of -0.36. This means that the higher the income, the lower the maize consumption. One should note that income elasticity of maize consumption among urban people is positive, but negative among rural people. Susenas data does not differentiate the type of maize consumption. In reality, maize consumption between rural people and urban people may differ. Urban people generally consume sweet maize known as sweet corn, which may not be the case for the majority of rural people. Rural people in Nusa Tenggara, Gorontalo, and some parts in East Java use maize as a staple food and a source of carbohydrate. Sweet corn is obviously not an inferior good and very much income-dependent, although the elasticity cannot be estimated directly in this study. Among the protein food sources, only beef and poultry are elastic, while the

rest such as fish and soybeans are income-inelastic. No single vegetable commodity is income-elastic. Oranges, apples and mangoes are income-elastic.

b. Own Price Elasticity

Rice is price-inelastic, and maize is price-elastic and higher in rural areas. Protein sources such such as beef, poultry, fish and soybeans are all price-elastic. Some vegetables, namely chilies and spinach are price-elastic. When it comes to fruit, only snake fruit is price-elastic.

c. Cross-Price Elasticity

Initially, cross elasticity between rice and maize is expected to be positive, indicating that maize is a substitute for rice. The AIDS model in this study finds that the relationship between rice and maize is negative, showing a complementary characteristic between rice and maize. The cross price elasticity for maize with respect to the price of rice is -1.40, meaning that a one-percent increase in the rice price decreases the demand for maize by 1.04 percent. The cross price elasticity for rice with respect to the price of maize is -0.02, meaning that a one-percent increase in the maize price decreases the demand for rice by 0.02 percent. A negative cross price elasticity in urban and rural areas for maize with respect to the price of rice is 1.31 percent in urban areas and 2.33 percent in rural areas.

The cross price elasticity for fish with respect to the beef price is 0.23 percent, meaning that a one-percent increase in the beef price increases demand for fish by 0.05 percent. Poultry and fish also are substitutes, shown by the cross price elasticity of 0.10, where a one-percent increase in the poultry price increases the demand for fish by 0.10 percent. Cross price elasticity for fish with respect to the price of poultry is 0.68, where a one-percent increase in the fish prices increases the demand for poultry by 0.68. In this exercise, the demand for animal products is significantly determined by their prices.

The demand for fruit such as mangoes, oranges and apples has a positive cross price elasticity with rice of 0.83, 0.42 and 0.40 respectively. It means that a one-percent increase in the rice price increases the demand for mangoes, oranges and apples. The AIDS model also shows negative cross price elasticity for poultry as the price of beef in urban and rural areas is 0.02 and 0.20. Cross price elasticity in rural areas is more sensitive than urban areas.

Chapter 10

Conclusion and Policy Relevance

10.1 Conclusion

This report has presented the results of modeling the future of Indonesian food consumption for 2045, while also using a specific milestone in 2025. The study also confirms that existing food demand in Indonesia is determined by population factors and the composition of rural and urban populations, and income factors and composition of each percentile group. Some important findings and conclusions of the study can be summarized as follows:

The nutrition adequacy number (AKG) consists of the energy adequacy number (AKE) and protein adequacy number (AKP). The average energy consumption of the Indonesian population was 2,202 kcal per capita per day, which exceeds the AKE of 2,150 kcal per capita per day, or equivalent of 102.5 percent. However, the households falling into Quintile 1 and Quintile 2 of income groups do not meet the AKE. Carbohydrate or energy consumption of people living in the two highest quintiles exceeds the AKE by 123.8 percent and 112.3 percent respectively. This finding is consistent with the economic theory that food consumption in terms of energy adequacy increases as income increases.

The average protein consumption in Indonesia in 2017 was 63.30 grams per capita per day, which exceeds the AKP of 57 grams per capita per year, or equivalent to 111 percent. By income group, the consumption patterns of protein are similar to those of carbohydrate consumption, which increases as income increases. It ranges from 45.67 grams in the lowest quintile to 84.07 grams per capita per year in the highest income group quintile. The protein consumption of the first two income group quintiles does not reach the recommended AKP as these income groups only consume about 80 percent of the recommended protein amount. Contrasting figures are found in the protein consumption of quintiles four and five, which fall into over consumption at 123.3 percent and 147.5 percent respectively.

Consumption of selected food commodities could be summarized as follows: Average rice consumption in 2017 was recorded at 97.6 kilograms per capita per year, which was significantly lower than the official rice consumption on 114 kilograms per capita. Rice consumption in rural areas in Indonesia is slightly higher than in urban areas. Under a market economy, the following explanation is probable: firstly, the income level of people living in urban areas is generally higher than in rural areas. Secondly, food access in urban areas is higher than in rural areas. Lower income groups tend to spend a larger proportion of their income on food, but these are cheap, filling foods such as carbohydrates.

Average consumption of beef as a protein source is highest among the wealthiest consumers. The average beef and poultry consumption in Quintile 5 is 6 and 14.7 kilograms per capita per year, much higher than the national average of 2.5 and 7.5 kilograms per capita per year. These two protein sources are really income-elastic as the consumption of beef and poultry is much lower in the lower income group and in rural areas. The pattern of beef consumption in urban areas is really skewed to the highest income group, showing a disparity of 8.1 kilograms for the highest group to 1.4 kilograms per capita per year for the lowest income group, or about a 5.8 to 1 comparison. A

similar pattern is also found for beef consumption in rural areas, showing a disparity of 3 kilograms for the highest group to 0.5 kilograms per capita per year for the lowest income group, or about a 6 to 1 comparison.

A contrasting figure is found in maize consumption, where the average maize consumption in 2017 was 2 kilograms per capita per year, but this declines as income increases. The maize consumption of the lowest Quintile 1 was 3.2 kilograms, but the highest Quintile 5 was 1.5 kilograms per capita per year. Although there has been a change in recent years in the use of maize from direct food to animal feed, maize still represents the behavior of inferior goods. The average maize consumption of Quintile 1 in rural areas was 4.3 kilograms, but the consumption in the highest Quintile 5 was 2 kilograms per capita per year. Rural populations, especially in dry regions in Eastern Indonesia consume maize as their daily staple as the second most important staple food after rice.

The model used to project the future demand for food in 2025 and 2045 is based on income and food consumption functional relations in rural, urban, and rural-urban areas. For example, the model for rice shows that increasing income does not necessarily increase rice consumption. On the contrary, it decreases rice consumption for the highest income group. Maize consumption decreases as income increases in rural areas and across Indonesia as a whole, and the trend is equal to the coefficient income in the logarithmic form. In this case, maize represents an example of inferior goods, as higher income people tend not to consume more maize.

The projected per capita consumption of rice, beef, poultry, fish, vegetables, fruit, soybeans and cane sugar increases between 2017 and 2045, although the amounts differ. The increase in the consumption of rice is relatively small compared to the increase in other food commodities. Food consumption per capita that experiences the highest increase in 2025 and 2045 includes apples, red chilies and all animal products. The total food demand projections increase significantly in 2025 and 204, as the total population and income per capita also increases. The projected demand for food in urban areas is higher than that in rural areas. The largest food demand increase in urban areas for vegetable commodities is red chilies, which experience an increase of 40 percent in 2025 and 82 percent in 2045. The lowest increase in demand projections for food in urban areas in 2025 and 2045 relate to rice and maize. The increase in rice consumption is relatively small compared to the increase in other food commodities for 2025 and 2045.

For some strategic commodities, the following findings are quite important. The projection of per capita rice consumption at the baseline has gradually increased by 1.5 percent to 99.08 kilograms per capita per year in 2025 and increased by 2 percent to 99.55 kilogram per capita in 2045. The projection of demand for rice after considering the Food Balance Sheet (NBM), the use of non-food, industrial use and food loss also increases to 102.73 kilograms per capita per year in 2025 and 103.22 kilograms per capita per year in 2045. The demand for rice is also projected to increase to 127.09 kilograms per capita in 2025 and 127.70 kilograms per capita 2045 after considering food loss and waste according to FAO (2011). Rice consumption has different characteristics among the income groups and rural and urban areas. Only the highest income group in Indonesia has declining rice consumption, which is somewhat different to other Asian countries, where rice consumption declines are also found in the medium and lower level income groups.

The projection of poultry consumption shows the highest increase compared to other animal products, which was 22.1 percent in 2025 to 9.13 kilograms per capita per year and 29.3 percent in 2045 to 9.66 kilograms per capita per year. The projection of beef consumption increases by 10.3 percent to 2.79 kilograms per capita per year in 2025 and 20.4 percent to 3.04 kilograms per capita per year in 2045. The projection for fish consumption increases by 11 percent to 29.09

kilograms per capita per in 2025 and 14.6 percent to 30.04 kilograms per capita per year in 2045. Beef is generally consumed by higher income groups living in urban areas. Poultry is consumed by all income groups, including the lowest quintiles. Fish is consumed by both urban and rural populations, and increasing fish consumption could be attributed to increasing income and population.

Regarding fruit and vegetables, the highest demand projection for food consumption per capita was apples, with an increase of 55 percent in 2025 to 1.49 kilograms per capita per year and 73.5 percent in 2045 to 1.66 kilograms per capita per year. Consumers of apples are mostly urban populations and fall in high and medium income groups. The projected demand for local fruit such as oranges, bananas, snake fruit and mangoes in 2025 and 2045 is not as high as apples, and the market is dominated by imported apples. The projected demand for oranges is 4.09 kilograms and 4.35 kilograms per capita in 2025 and 2045 respectively. The demand for mangoes remains very small and is projected to reach 0.73 and 0.80 kilograms per capita in 2025 and 2045 respectively. Urban populations can obtain these fruits in either traditional markets or modern retail markets which have experienced rapid growth in the last two decades. The projected demand for hot chilies is 1.78 and 1.82 kilograms per capita in 2025 and 2045 respectively. The demand for red chilies is projected at 2.14 and 2.21 kilograms per capita in 2025 and 2045 respectively. Consumers usually require fresh products, instead of dried chillies and other processed products.

The projected demand for sugar is 8.98 and 9.12 kilograms per capita in 2025 and 2045 respectively. The increase in sugar consumption is not very high compared to other food commodity groups. The total consumption of sugar is projected to reach 25.6 million tons in 2025 and 29.1 million tons in 2045. The projection estimates of sugar consumption do not include indirect consumption of sugar in the forms of cakes, drinks, and other food products that use refined sugar and its derivatives. Under the current low growth rate of sugar production domestically, Indonesia would need to fulfill the sugar demand from imports, as the amount of sugar consumption will increase significantly following growing food industries using sugar.

10.2 Policy Relevance

- As rice remains a staple food, even in 2045, the policy relevance is that elements of food consumption could determine the level of food accessibility and therefore food security in the country. This food policy demand dimension is mostly market-driven and income-driven, where the highest income group quintile experiences declining rice consumption and maize consumption. Ensuring access to rice consumption, especially for low and middle-income groups, is equally important to the stability of the retail price of rice. The policy of food assistance or food subsidies targeting the poorest group of rice consumers remains relevant to maintain food and nutrition adequacy. As the government is planning to transform in-kind food assistance to non-cash subsidies, the implementation of such targeted subsidies could be adjusted with the latest development of infrastructures, logistic systems, available data technology and preparedness of the stakeholders in the overall food system.

- As the income elasticity of beef, poultry and fish remains high, the policy relevance relates to the infrastructure improvement of market places, including both modern retail markets and traditional markets which could shape the performance of value chains of these sources of animal protein. The value chain policies not only directly affect food accessibility among all income groups, but also affect many value chain players like retailers, processors, wholesalers, and collector traders that connect directly to rural areas and farmers. These players could convey the messages of urban consumers to farmers and other actors in the chains, including

product specification, food safety, health and hygiene requirements, and quality standards such as halal certification that shape the characteristics of the value chains of these protein sources.

- For perishable products like fruit and vegetables, the policy relevance is that actors of value chains need access to cold-storage facilities, including medium scale of controlled atmosphere systems (CAS) which could improve the efficiency of horticulture markets. The policy should also provide a balance between demand-side and supply-side or productivity improvement, as the majority of horticulture production centers are in Java. The majority of horticulture products are marketed through cooperation with the wholesale markets (*pasar induk*), so large and medium cities should implement spatial planning and zoning policies for end-to-end waste management at these traditional markets. Partnering with modern supermarkets should also be conducted as supermarket chains have generally provided better service for horticultural products, such as food safety, private grades and fruit and vegetable standards. There also needs to be support for farmers who can meet rising quality and safety standards set by retail markets or by consumers through modern retail markets and supermarkets. These policies would also benefit urban consumers who will make up over 70 percent of Indonesian food market in the future.

- The modeling exercise of food demand in Indonesia in this study is mostly aimed at strengthening national level policy analysis. Specific models at a regional or sub-national level might follow similar a procedure, but extra care should be given to the structure and availability of Susenas data as a baseline. The government will play an important role in response to the results of this study, by getting better prepared to anticipate changes in demand for selected important foods in Indonesia.

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