Trends and forecasting of meat production and consumption in Indonesia: Livestock development strategies

V Tenrisanna and S N Kasim
Faculty of Animal Science, Universitas Hasanuddin, Makassar, Indonesia

E-mail: vidyawaty@unhas.ac.id

Abstract. This article aims to discuss trends and forecast meat production and consumption for 2027 in Indonesia by using different statistical forecasting methods. Forecasting of meat production and consumption is important to be carried out so that food security development can be planned strategically in the future. Meat production and consumption are observed in the period from 1990 to 2017. The types of meat analyzed include beef, poultry, sheep, and pork. Based on the seasonality and trend data, the forecasting methods used are Double Exponential smoothing and Holt-Winters seasonal smoothing. All data is analyzed using STATA software. The accuracy of forecasting is examined based on the root mean squared error. Accordingly, the Double Exponential smoothing method is more accurate than the Holt-Winters seasonal smoothing method in predicting meat production and consumption for 2027 in Indonesia. Overall, meat production and consumption are projected to increase by 4,449,286 tonnes and 5,061,993 tonnes respectively. Hence, meat consumption is higher than meat production. Therefore, livestock technology innovation should be carried out thoroughly in the fields of breeding, processing/production, marketing and increasing the capacity of human resources both farmers and extension workers to produce livestock products efficiently and effectively.

1. Introduction
Meat production and consumption in Indonesia continues to increase. In 2017, 3.5 million tons of meat production consisting of 0.5 million tons of beef and buffalo, 0.1 million tons of sheep, 0.3 million tons of pigs, 0.3 million tons of free-range chicken, laying hens 0, 1 million tons, broiler chickens 2.0 million tons, and other livestock 0.05 million tons. Also, the total consumption of meat per capita per day is 4.2 grams in 2017 [1]. Recently, beef consumption is relatively low compared to other types of meat consumption such as poultry meat, sheep, horses, pigs, sheep, and others, which is around 2 kg per capita per year. The supply of beef and live cattle is from domestic and imported. Beef demand that is not balanced with supply causes beef prices to increase each year.

The increase in meat consumption in Indonesia is influenced by several factors such as income and education. In general, food consumption is affected by several factors such as income, urbanization, trade liberalization, consumer attitudes, and behavior, retailing, food industry marketing, Transnational food corporations (franchises and manufacturers), age, education, labor force status [2, 3]. According to Rutherford [4], the trend of increasing consumption of livestock products in Asia is mainly due to economic development and dietary patterns.

Predicting meat consumption and livestock production are important to plan effective and efficient strategies. For business operations in retail companies which work with food products with short life
cycle and perishables, the accuracy of the forecast is of crucial importance because of the volatile demand pattern, influenced by an environment of rapid and dynamic response [5]. Generally, accurate and reliable forecasts can help the government, stakeholders, and breeders in taking policies or strategies for developing the livestock business.

The purpose of this study is to predict the amount of meat consumption and production in Indonesia for 2027 by using two statistical methods namely the Holt-Winters seasonal smoothing method and the double exponential smoothing method. Trends and forecasting of meat production and consumption will be discussed and estimated thoroughly.

2. Data and estimation

2.1 Source of data
The meat production data is collected from FAO website [6], and meat consumption data is collected from OECD website [7]. The time series data is from 1990 to 2017. In this study, only four types of meat are analyzed which are beef, poultry, sheep and pork.

2.2 Data analysis
There are two forecasting methods applied in this study namely Double Exponential Smoothing and Holt Winters Seasonal Smoothing. Both methods are chosen due to the time series data contain with trend and seasonal factors or movements.

Exponential smoothing proceeds as do moving averages by smoothing past values of the series; the calculations for producing exponentially smoothed forecasts can be expressed as an equation [8].

The seasonal Holt–Winters methods forecast univariate series that have a seasonal component [9].

The double-exponential smoothing procedure is designed for series that can be locally approximated as [9]:

\[ \hat{x}_t = m_t + b_t t \]  

(1) where \( \hat{x}_t \) is the smoothed or predicted value of the series \( x \), and the terms \( m_t \) and \( b_t \) change over time.

The Holt–Winters method forecasts series of the form [9]:

\[ x_{t+1} = a_t + b_t t \]  

(2) where \( x_{t+1} \) is the forecast of the original series \( x_t \), \( a_t \) is a mean that drifts over time, and \( b_t \) is a coefficient on time that also drifts.

Selection of an error measure has an important effect on the conclusions about which of a set of forecasting methods is most accurate [10]. Thus, error measures such as mean absolute percentage error, relative absolute error and mean square error maybe used for validating the model [11]. In this study, Root mean square error (RMSE) is used to select the most accurate method analysis. The RMSE is one of the most commonly used measures of forecast accuracy. The root mean squared error is [8]:

\[ \text{RMSE}=\sqrt{\frac{\sum (A_t-F_t)^2}{n}} \]  

(3) where \( A_t \) is an actual value in period \( t \), \( F_t \) is forecast value in period \( t \), and \( n \) is number of periods used in the calculation. The smaller the RMSE, the better the fit [12].

All data is analyzed by using STATA software.
3. Results and discussions

3.1 Meat production

Livestock production of meat in Indonesia derived from large livestock (cattle, buffaloes, and horses), small livestock (goat, sheep, and pigs), poultry (native chickens, layers, broilers, ducks, and Muscovy ducks), and various livestock (rabbits, quails, and pigeons) [1]. In 2017, the Gross Domestic Product growth in the animal husbandry subsector showed a positive trend of 3.83%. According to the Bureau of Statistics, as of August 2017, there were 3.84 million workers involved in the animal husbandry subsector [13].

Farmers in Indonesia generally raise on a household scale of 2–4 head of cattle, where the community generally makes livestock only as a side business. Recently, nationally some livestock commodities are still imported to meet domestic demand. However, some regions such as the province of South Sulawesi can produce beef cattle and meet the demand from other regions in Indonesia. Meat production in South Sulawesi is dominated by beef and pork with production values tending to fluctuate. The need for beef in South Sulawesi is 10,000 tons per year and this area can supply beef to other regions. Every year around 24 thousand heads are supplied from this beef cattle center to other areas for breeding and beef cattle such as Sulawesi, Kalimantan, and Eastern Indonesia (Papua, Ambon, Ternate), and Kalimantan [14].

As can be seen from figure 1, production trends of beef meat, poultry, sheep and pork meats fluctuated and slightly increased between 1990 and 2017. Total meat production in 2017 was 3,204,267 tons. Poultry production was the highest among the four types of livestock production. From 1999 to 2017 there was a significant increase in poultry production from 589,121.3 tons to 2,421,811 tons. The major structural changes that have occurred in poultry production and marketing in recent decades have been driven by the growing consumer demand for cheap animal protein [15]. This situation has also happened in Indonesia. As a result of structural changes in Indonesia's poultry industry, from 1969 to 1993 poultry meat production increased from 13 to 37.2% [4].

![Figure 1. Meat production in Indonesia, 1990-2017. Source: © Food and Agriculture Organization of the United Nations (FAO) [6].](image)

In this study, forecasting analysis results show that meat production in 2027 includes 645,880.8 tons for beef, 3,280,982 tons for poultry, 74,259.51 tons for sheep and 504,187.3 tons for pork. Next, total meat production for 2027 is 4,449,286 tons (figure 2). The double exponential smoothing forecast has been selected because its root mean squared error is smaller than Holt Winters’s RMSE.

3.2 Meat consumption

Meat consumption trends in Indonesia fluctuated and tend to increase from 1990 to 2017 (figure 3). As can be seen from Figure 3, in 2017, the highest meat consumption was poultry meat (2,305,000 tons)
and the lowest consumption was sheep meat (127,380 tons). Beef consumption increased slightly from 1990 to 2017, 305,855 tons and 712,876 tons respectively. Thus, Indonesia has responded by increasing beef supply from all sources, both domestic and overseas. On the contrary, pork consumption decreased from 546,873 tons in 1990 to 345,010 tons in 2017. Overall, total meat consumption was 3,490,266 tons.

Total meat consumption per capita in Indonesia for 2018 was 11 kg per capita, consisting of beef consumption 2 kg/capita, 7.6 kg/capita consumption of poultry meat, 0.4 kg/capita sheep meat consumption and 1 kg/capita pork meat consumption. Meat consumption in Indonesia is low when compared to neighboring countries such as Malaysia with a total meat consumption of 60.4 kg capita, Thailand 19.2 kg/capita, and Australia 92.2 kg/capita [7]. High levels of beef consumption in developed countries have remained stable or declining, while consumption in developing countries has increased rapidly from a low level, driven by population growth, urbanization, and income growth. Growth in demand in developing countries has exceeded supply, leading to increased prices and imports [16].

Meat consumption is driven by several factors. Studies on the drivers of food consumption have been done previously. According to [2], the drivers of food consumption are income, urbanization, trade liberalization, transnational food corporations (franchises and manufacturers), retailing, food industry marketing, consumer attitudes, and behavior. Next, a study on future beef demand drivers such as food safety, food quality, price, nutrition, health, sustainability, social aspects [17].

The forecast for meat consumption shows that total meat consumption will reach around 5,061,993 tonnes in 2027 (see Figure 4). The Double Exponential Smoothing forecast has been selected because its root means the squared error is smaller than Holt Winters’s RMSE. This figure shows that meat consumption in Indonesia continues to rise steadily, and faster than increases in domestic production. Therefore, strategic steps should be taken in fulfilling the meat consumption, nowadays and for the years to come.

A study on future beef demand in the US suggested that there are several important needs for future demand: (a) Lever retail scanner data improve demand monitoring; (b) Need to know more about growing heterogeneity; (c) Changing information technology effect on demand; (d) Impacts of generational shifts on-demand strategies; (e) Global beef demand and US strategy [17]. These factors could be taken into account for Indonesia in building strategies for fulfilling meat consumption.

The drawback of this study is that not all types of types of meat consumed and produced are included in the analysis such as horses, rabbits, quails, pigeons and so on. Thus, the number of meat
production and consumption could increase significantly when all types of meat consumed and produced were included in the analysis.

![Meat Consumption in Indonesia, 1990 to 2017](image1)

**Figure 3.** Meat Consumption in Indonesia, 1990 to 2017. Source: © Organisation for Economic Co-operation and Development (OECD) [7].

![Meat Consumption Forecast](image2)

**Figure 4.** Meat Consumption Forecast. RMSE Holt Winters = 173.4469 RMSE Double Exponential Smoothing = 168.56642

### 3.3 Livestock development strategies

Nowadays, the volume of livestock production is still far to meet meat consumption. Likewise, the prediction result for 2027 shows the same condition whereas the meat consumption outweighs the meat production. Several programs have been implemented by the government to increase livestock production, especially beef meat such as artificial insemination, Upsus Siwab program, credit assistance to farmers and training. The Upsus Siwab program aims to increase the population and livestock production for self-sufficiency through the artificial insemination program for cattle with a target of four million artificial inseminations of cows that can produce three million of the calf. Furthermore, the Indonesian Agriculture Ministry through the Directorate General of Livestock and Animal Health will carry out several activities supporting the provision of fodder and legume in 13,000 hectares of land, developing water resources facilities, and distribution of vitamins and vaccines to improve animal health. [18].

The government is currently undertaking improvements to the logistics system and supply chain for cattle and beef commodities through the following steps: a) Procurement and operation of cattle ships designed to meet animal welfare standards. Changing market structure, increasing prices at farmers and lower prices at the consumer level. At present 80% subsidies are allocated to livestock loading
rates on livestock vessels. Providing appropriate subsidies to a government pilot program is an instrument that needs to be applied to achieve a self-sufficiency program. b) Construction of modern abattoirs in production centers; and c) Improved import management and supervision involving all stakeholders [19].

4. Conclusion
The forecasting method chosen for meat production and consumption is the Double Exponential smoothing method because its RMSE value is smaller than the RMSE Holt-Winters seasonal smoothing method. Next, meat production and consumption trends in Indonesia from 2007 to 2027 fluctuated and tend to increase from year to year. Likewise, with the results of forecasting for 2027, meat production and consumption are predicted to increase gradually whereas consumption is larger than production. To anticipate this, government policies must continue to be promoted and implemented such as programs for beef self-sufficiency. Besides, the development and application of technology and innovation, and improvement of human resources, and marketing must be taken seriously.

References
[1] Directorate General of Livestock and Animal Health Service 2018 Livestock and Animal Health Statistics, ed Directorate General of Livestock and Animal Health Service (Jakarta: Directorate General of Livestock and Animal Health Service, Agricultural Ministry)
[2] Kearney J 2010 Food consumption trends and drivers Biol. Sci 365 (1554) 2793–2807
[3] Friedl B, Omann I and Pack A 2006 Socio-economic drivers of (non-) sustainable food consumption. An analysis for Austria. in Proceedings to the Launch Conference of the Sustainable Consumption Research Exchange (SCORE) pp 39-58
[4] Rutherford A 1999 Meat and milk self-sufficiency in Asia: forecast trends and implications Agric. Econ. 21(1) pp 21–39
[5] Da Veiga C P, Da Veiga C R P, Catapan A, Tortato U and Da Silva W V 2014 Demand forecasting in food retail: A comparison between the Holt-Winters and ARIMA models. WSEAS Trans. Bus. Econ. 11(1) 608-14
[6] Food and Agriculture Organization of the United Nations (FAO) 2019 Livestock Primary Available from http://www.fao.org/faostat/en/#data/QL
[7] Organisation for Economic Co-operation and Development (OECD) 2018 Meat Consumption. Available from https://data.oecd.org/agroutput/meat-consumption.htm
[8] Wilson J H and B Keating 2002 John Galt Solutions, Inc. Business forecasting (New York: McGraw Hill Friedai)
[9] Stata A 2015 Stata Base Reference Manual Release 14
[10] Kalekar P S 2004 Time series forecasting using holt-winters exponential smoothing Kanwal Rekhi School of Information Technology 4329008(13)
[11] Dumicic K, Casni A C and Z Gogala 2008 Evaluating Holt’s Double Exponential Smoothing and Linear Trend Forecasting of Basic Tourism Time Series in Croatia. in An Enterprise Odyssey. International Conference Proceedings (University of Zagreb, Faculty of Economics and Business)
[12] Bermúdez J D, Segura J V and Vercher E 2006 Improving demand forecasting accuracy using nonlinear programming software J. Operational Res. Soc. 57(1) 94–100
[13] Reily M 2018 Contributing Greatly, the Livestock Sector Is Targeted to Penetrate the World Market [30 October 2019]; Available from: https://katadata.co.id/berita/2018/07/04/berkontribusi-besar-sektor-peternakan-ditargetkan-tembus-pasar-dunia.
[14] Provinsi Sulawesi Selatan 2015 Seri Analisis Pembangunan Wilayah Provinsi Sulawesi Selayan
[15] Mcleod A, O Thieme and S Mack 2009 Structural changes in the poultry sector: will there be smallholder poultry development in 2030? World's Poul. Sci. J. 65(2) 191–200
[16] Waldron S and Fisher B S 2016 *Australia-Indonesia Policy Dialogue*. in *Indonesia Australia Red Meat & Cattle Partnership* (Perth: the Australian Government and the Indonesia Investment Coordinating Board)

[17] Schroeder T, Tonsor G and J Mintert 2013 *Beef demand: Recent determinants and future drivers* Kansas State Research and Extension. Retrieved from Agmanager info

[18] Waris G and C Harzi 2016 *Artificial Insemination Chosen by Indonesia for Increase the Cattle Population* (Jakarta)

[19] Kementerian Pertanian Republik Indonesia 2017 *Swasembada Daging Sapi Melalui Optimalisasi Pendistribusian Sapi Nasional* [30 October 2019]; Available from: https://www.pertanian.go.id/home/?show=news&act=view&id=2152