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FORECASTING LAYER EGG PRODUCTION AS ANIMAL SOURCE FOOD FOR PROTEIN TO REDUCE STUNTING IN WEST JAVA, INDONESIA

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ABSTRACT

Stunting still becomes a global public health challenge affecting millions of people, including Indonesians. To alleviate the situation, Indonesia is fighting to reduce the prevalence of stunting to 10.4% in 2024 by increasing the consumption of Animal Source Foods. This study aimed to forecast the Layer Egg Production in West Java, Indonesia, as an animal source food to provide protein for reducing stunting. The study employed descriptive quantitative and time series approaches using secondary data analysis. The Layer Egg Production for 2023-2025 was forecasted using the Moving Average (MA) and Weighted Moving Average (WMA) using Layer Egg production data for 2000-2022. The WMA method was more accurate as it had a Mean Absolute Percentage Error (MAPE) of 15.32 compared to a MAPE of MA of 16.23. Furthermore, the population projections for West Java 2021-2025 were made by the Geometric method. The study's findings declare that the Layer Egg Production is still low to meet the population demand for West Java. In this case, the population can get 18.77 g of egg per person daily, an average of 2.4g of protein. In addition, the egg contributes 4.2% to the protein required by each person a day.

Keywords: Stunting, Forecasting, Protein, Layer Egg, Production

INTRODUCTION

Childhood stunting is one of the biggest barriers to human growth (WHO, 2014), it affects over 162 million children under the age of five worldwide. A height for age Z- score that is less than two standard deviations of the median of the World Health Organization (WHO) growth charts for child development is referred to as stunting or being too short for one's age (UNICEF, WHO 2018). It is a result of poor nutrition and frequent infections. In addition, it is largely irreversible. Stunting has long-term negative repercussions on people and society, including a decline in cognitive and physical growth, a reduction in productivity (Renyoet et al., 2016), poor health, and a higher chance of developing degenerative illnesses such as diabetes (Adair, 2013). Projection shows that 127 million children under five will be stunted in 2025 if trends continue (WHO, 2018). According to the United Nations 2015, the 2030 Agenda for Sustainable Development Goal (SDG) 2 demands for reducing malnutrition in all its forms including stunting, wasting, and micronutrient deficiencies.

According to the Global Nutrition Report 2014, Indonesia has made a lot of effort towards achieving the stunting target. As a country, Indonesia is fighting to reduce the prevalence of stunting by 10.4% by 2024. Data from the Indonesian Nutrition Status Study (SSGI, 2022) put the prevalence of childhood stunting in Indonesia at 21.6%. In this case, the government of Indonesian is targeting to reduce stunting to 14% by 2024 according to the Presidential Decree Number 72 of 2021 regarding the reduction of stunting. West Java is one of the 12 provinces with the largest cases of stunting at 971.792 cases and a prevalence of 20.2% as shown in Figure 1 that has been named by the Ministry of Health alongside East Nusa Tenggara at 37.8%, West Sumatera at 33.8%, and Aceh at 33.2% (MoH, 2023 ; Yuliastini et al., 2020).

Animal Source Foods (ASF) can assist in the achievement of the nutrition targets endorsed by the World Health Assembly and the Sustainable Development Goals related to reducing stunting and wasting in children under five, as well as obesity and non-communicable diseases (NCDs) in adults (FAO,2022). Animal Source Foods (ASF) are also an essential source of nutrients that offer several benefits for human health (Fernandez, 2022). In this case, animal proteins, including eggs,

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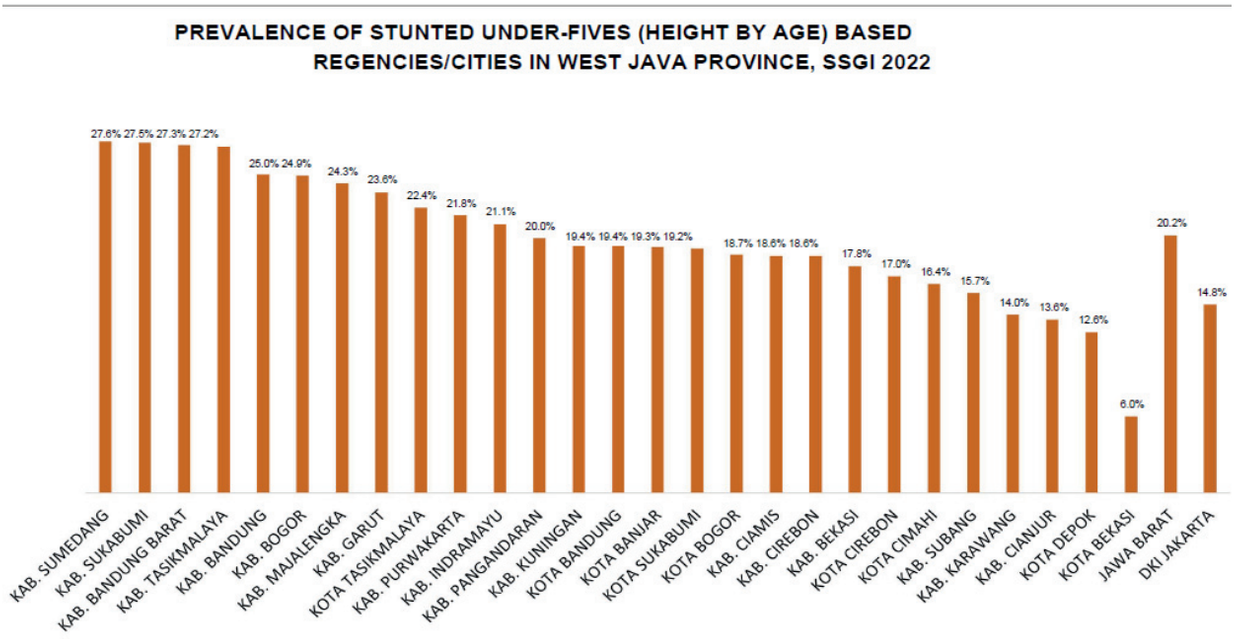

Figure 1. Prevalence of stunted under-five (height by age) based on regencies/cities in West Java Province (Kemenkes, 2021)

meat, poultry products, fish, and dairy products, are considered to have complete proteins (Henchion et al., 2021) since they provide all the essential amino acids required by the human body. Amino acids are the building blocks of proteins and are necessary for various physiological functions, including tissue repair, enzyme production, and hormone synthesis (Adesogan, 2018). Animal source foods are particularly abundant in nutrients such as protein, vitamin B12, iron, and zinc, which can prevent stunting.(Derek Headey, Kalle Hirvonen, 2018) In addition, it also contains omega-3 fatty acids, which are essential for brain function, immune health, red blood cell production, and overall well-being (Khusun, Monsivais, et al, 2022).

Figure 1 shows the rate of stunting in different regencies of West Java with Sumedang as the highest at 27.6%, followed by Sukabumi at 27.5%, Bandung Barat at 27.3%, and Tasikmalaya at 27.2%. Meanwhile, the least prevalence is in Bekasi City at 6.0%. Overall, West Java has a stunting prevalence of 20.2%. West Java is still battling with stunting among children under five. The study aimed to forecast the Layer Egg Production in West Java, Indonesia, as an animal source food to provide protein for reducing stunting.

Table 1. Nutrition Composition of an Egg

Nutrient (Unit)	Whole Egg
Weight (g)	60
Water (percentage)	65-68.5
Calories (Kcal)	70
Protein (g)	6.3
Carbohydrate (g)	0.36
Total fat (g)	4.8
Polyunsaturated fat (g)	1.0
Monounsaturated fat (g)	1.8
Saturated fat (g)	1.6
Cholesterol (mg)	185
Choline (mg)	126
Vitamin A (IU)	270
Vitamin D (IU)	41
Vitamin E (mg)	0.5

METHOD

This study used a descriptive quantitative research method and a time series approach through Secondary Data Analysis. The data used was a time series data of Layer Egg production in West Java during the 2000-2022 period based on Statistics of Indonesia (BPS,2022). It was used for forecasting Layer Egg Production from 2023 to 2025, as shown in Table 3. The population data of West Java for the 2010-2022 period, according to

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BPS 2022, was also used. This population data was used in forecasting the population of West Java for the period 2023 to 2025 using the Geometric method, as shown in Table 5. The research data was collected in April-May 2023.

Data Processing and Analysis

The Data was processed using Microsoft Excel. In addition, several forecasting methods were also used for production analysis, which included Moving Average (MA) and Weighted Moving Average (WMA). These methods need sequential data from several years before.

Moving Average (MA) Equation

$$F_t = \frac{A_{t-1}+A_{t-2}+\cdots+A_{t-p}}{p}$$

where:

t = Time (Years)

F_t = Result *of forecast at time t*

A_t = Actual *data at time t*

P = Data used for forecast

Weighted Moving Average (WMA) Equation

$$F_t = \sum_{i=1}^{p} \alpha_i \; A_{t-i}$$

where:

t = Time (Years)

F_t = Result of forecasting at time-t

A_t = Actual data at time-t

P = Data used for forecasting.

$$\sum_{i=1}^{p} \alpha_i = 1,\ 0 \leq$$

The Mean Absolute Deviation guided the Accuracy of the method used for forecasting (MAD), Mean Square Error (MSE), and the Mean Absolute Percentage Error (MAPE).

1. Mean Absolute Deviation (MAD)

$$\text{MAD} = \frac{\sum_{j=p+1}^{n} |A_j - F_j|}{p}$$

2. Mean Square Error (MSE)

$$\text{MSE} = \frac{\sum_{j=p+1}^{n} |A_j - F_j|^2}{p}$$

3. Mean Percentage Absolute Error (MAPE)

$$\text{MAPE} = \frac{\sum_{j=p+1}^{n} |A_j - F_j| / A_j}{p} \text{ x } 100\ \%$$

Where

Aj = Actual Value

Fj = Forecast value

P = Number of forecast value

The Geometric method was used

Pt = $Po(1+r)^t$

Po = Initial size

Pt = Population at time t

T = Time (years)

R = Finite population multiplier

Table 2. Layer Egg Production (2000-2022) in West Java

Year	Egg Production
2000	114,279.00
2001	68,050.00
2002	78,945.00
2003	77,634.00
2004	89,349.00
2005	93,472.00
2006	95,143.00
2007	105,361.00
2008	105,046.00
2009	95,627.70
2010	103,427.58
2011	115,787.00
2012	120,123.00
2013	131,586,00
2014	134,581.00
2015	133,435.77
2016	139,192.78
2017	693,379.15
2018	802,859.62
2019	468,872.04
2020	587201.77
2021	661,895.15
2022	699,384.40
Amount	5,714,631.96

Average	24,8462.23

RESULTS AND DISCUSSIONS

Based on the data shown in *Table 2*, Layer Egg production had a significant increase in 2017 and later dropped in 2019. The sharp increment can be attributed to the increasing population that creates the demand, increased knowledge regarding the intake of animal protein foods, and an egg-a-day campaign. The decline in layer egg production is noticed in 2019 by 42%. This decrease could be due to the COVID-19 pandemic that distorted many food production systems and the general economy. Forecasting analysis for layer egg production was made using the data in *Table 2* and production for the period 2023 to 2025 was forecasted as shown *Table 3*.

Table 3. Forecasted Layer Egg Production 2023-2025

Year	Projected Layer Egg Production (Tons)
2023	649493.77
2024	680639.77
2025	699384.40
Total	2,029,517.95
Average	**676,505.98**

The forecasting graph of layer egg production shown in Figure 2 shows that there is a general increase in Egg production using the MA and WMA method over the years. The projected production also showed an increment with the average production increase in 2023-2025 by 676505.98 tons.

For the two methods used to forecast layer egg production, that is MA and WMA, the method with the lower MAPE can be used to give a more accurate estimate. In this case, WMA at 3 years (3Ft) has got MAPE of 15.32 compared to MA, which has a MAPE of 16.23 at 3Ft. Therefore, the method with the lower error rate is more accurate forecasting method (Suryana & Sukandar, 2022).

Through the use of the population data of West Java from 2016-2020, the population for 2021-2025 was forecasted using the Geometric method as shown in *Table 5*. The findings indicate an increase in the population of West.

As shown in Table 5, the layer egg production has had a steady annual increase. However, the production increased sharply in 2017 until 2018. Furthermore, there was a decline of layer egg production in 2019 by almost half of the previous production. The production later started to rise again in 2020 by 25.2%. The layer Egg production in West Java is fluctuating. This can be attributed to the income, population demand, cost of production of the eggs, and availability of other animal source foods like meat, chicken, and milk (Suryana et al., 2022). Taking average weight of an egg as 60g and 12.8g of protein from 100 grams with 90% as edible portion (Suryana & Sukandar, 2022), the population is able to have 18.77 g of egg per person per day and which is averagely to 2.4 g of protein per person per day.

Table 4. Accuracy for Forecasting Results of Layer Egg Production (2000-2025)

Egg Production at	Forecasting Method	Validation Analysis		
		MAD	MSE	MAPE
Ft-3MA	Moving Average	153,176.881	84,627,810,766	16.23
Ft-3MWA	Weighted Moving Average	111,972.084	47,165,471,470	15.32
Ft-2MA	Moving Average	129,764.350	65,971,644,486	39.58
Ft-2WMA	Weighted Moving Average	129,764.350	63,222,825,965	39.58

Table 5. Geometric Method to Forecast Population of West Java for 2021-2025

Year	Population	Increase in population	% Increase in population	Projected Year	Population
2016	47,379,389			2021	50,310,377
2017	48,037,827	658,438	1.39	2022	50,687,705
2018	48,683,861	646,034	1.34	2023	51,067,863
2019	49,316,712	632,851	1.30	2024	51,450,872
2020	49,935,858	619,146	1.26	2025	51,836,753

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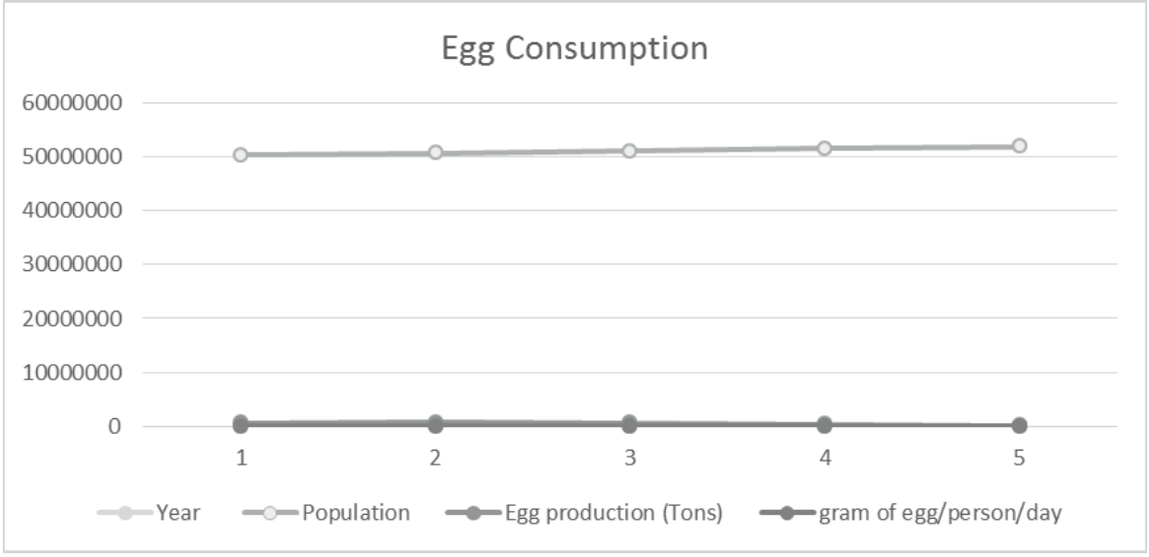

Figure 3. Projected Egg Consumption in West Java 2021-2025

According to Nutrition Adequacy figures of AKG of Indonesian people, the average protein intake should be 56.7 g of protein per person per day. In this case, the egg consumption contributes 4.2% to the protein consumed per person per day for the population in West Java (Headey, Hirvonen, 2018).

Based on the Figure 4, there is an increase in the population of West Java from 2021 to 2025 with an average increase of 1.3%. This study is further supported by a previous study conducted by Suryana and Sukandar about the forecasting of production and requirements of broiler chicken eggs for the consumption of animal protein in Aceh province which suggested that though nationally the production of broiler chicken eggs increased, the broiler chicken eggs produced in Aceh was still low to meet the needs of the Aceh people (Suryana & Sukandar, 2022 ; Sukandar, 2022). The production and consumption of eggs can be influenced by the various actors in the supply chain such as the government, breeding industry, breeders' farmers groups as discussed in the study by Saptana in the Management of *Ayam Kampong* egg supply chain (Saptana & Sartika, 2014).

Furthermore, a study by Kristiansen about the Entry barriers in rural business, the case of egg production in Eastern Indonesia, suggested that entry barriers like capital costs, technological development, limited knowledge, and market dominance by powerful business groups limited entry into the egg production business. Another study by Sukandar in the Discriminant Analysis to Determine the Poor Line Indicator reported that a farmer's poverty line gold standard is 2.2g of gold/per capita/per month and the frequency of egg consumption used.

Policy guidelines must be developed to meet food security and sovereignty and engage all the stakeholders. The six pillars of food security, including availability, access, utilization, stability, sustainability, and system agencies, should be considered. The government can endorse agricultural policies that can promote and support egg production. This may include giving subsidies, grants and loans, modern equipment, and adopting advanced technologies. In addition, it can assist the farmers in constructing or expanding poultry farms. Research and development in the poultry sector can lead to innovations that can enhance egg production, such as new breeds with higher egg-laying capacities (Yaman et al., 2020), improve feed formulations and develop disease prevention and control strategies (Akintunde et al., 2015).

The concerned institutions can also organise effective training and education (Palada, 2020) to provide technical assistance to farmers, especially the small-scale producers about best practises for increased egg production and disease management in the poultry farm. The government can invest in an improved infrastructure such as upgrading hatcheries, feed mills, transportation, and storage

facilities to ensure the eggs reach the market in good condition. The marketing and distribution of layer eggs can be improved by establishing market linkages between producers and consumers through cooperative networks, quality control standards and consumer protection. The authorities can also implement effective disease control measures such as surveillance systems to monitor and control diseases that affect egg production, vaccination programs, biosecurity protocols and disease outbreak response.

CONCLUSION

Through the time-series data approach to Secondary Data Analysis, West Java is projected to have an average increment of 51,070,714 in its population by 2025 according to the Geometric method used. However, the Layer Egg Production that has been forecasted for 2023-2025 using MA and WMA in this province, is low to match the population demand to meet its protein contribution towards the nutrition adequacy as needed from animal food sources to fight against stunting. The population can have 18.77 g of egg per person per day and which is averagely to 2.4 g of protein per person per day which is 4.2% of protein contributed from egg. There are factors that are contributing towards this trend which may include income, population demand, cost of production and the availability of other protein sources, including plant proteins like *Tempe* and Tofu. This research can be further used to guide the stakeholders and policymakers to formulate policies and guidelines that enhance and facilitate increased production in the livestock sector for animal source foods, particularly layer egg production. This is crucial as it can uplift the provision of adequate, equitable and sustainable food which meets the nutritional requirements of the population at an affordable cost.

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