Analysis of Indonesia national rice availability towards self-support with a dynamic model approach

D Pratiwi *
*IPB University, Bogor, Indonesia
*ditaliu@gmail.com

Received : 4 August 2022
Revised : 6 August 2022
Accepted : 10 August 2022

ABSTRACT: The purpose of this paper is to find out and project the effect of expansion of planting area or the effect of intensification and addition of production credit on increasing rice production so that it can be used as one of the recommendations in achieving and maintaining national rice self-sufficiency. The research was conducted using a qualitative descriptive method. The data used is secondary data, namely data on production and prices of Indonesian rice in 1993 – 2015. The data analysis method used is dynamic model analysis by producing price and production policies. The research was conducted with the help of IThink software. Based on the results of the processing and analysis of the existing data, it can be concluded that: (1) Variables that affect the yield of rice production and the achievement of self-sufficiency are extensification, intensification, and per capita consumption of rice per year; (2) Rice self-sufficiency can be achieved by Indonesia in 2024 or 2025 with a production target of 40 million tons if changes are made to these key factors; (3) The policy that needs to be done is to increase extensification and intensification by absorbing technology and adding inputs or capital through production credit and reducing rice consumption by 8% through the one day no rice program in one week.

Keywords: dynamic model, production, rice, simulation

INTRODUCTION

Rice is the main food commodity that affects the welfare of the Indonesian people which is difficult to replace by other food commodities. Around 98% of the Indonesian population consumes rice as a staple food, even in some areas that traditionally have corn or sago as the main food, some of the population has switched to consuming rice (Puspanegara et al., 2020). The high consumption of Indonesian rice also triggers the increase in rice prices. The dependence of the Indonesian population on rice consumption also affects the achievement of food self-sufficiency (Suryana, 2014). Food self-sufficiency, as outlined in Indonesia’s agricultural development program since the beginning of independence, has always received a high priority (Salim & Darmawaty, 2016). Indonesia seeks to be self-sufficient in food, especially rice. Rice self-sufficiency can be done by encouraging national rice production through intensification and extensification. Intensification is pursued by the introduction of rice cultivation technology accompanied by the discovery of superior varieties of seeds (Haryanto & Rijanta, 2018). Extensification, although in limited quantities, is carried out by printing paddy fields and expanding irrigation networks. Viewed from the perspective of the agribusiness system, Indonesia’s efforts to increase rice production are carried out in full, starting from the upstream agribusiness subsystem (procurement and distribution of rice inputs) to the downstream subsystem (rice processing and distribution), accompanied by the development of supporting institutions (research, financing, counseling, and education)(Yama, 2022)(Natalia et al., 2022).

The efforts made by the government above are efforts to be self-sufficient in rice from the supply side. We know that the success of rice self-sufficiency is also determined by the demand side. The success of increasing production if it is not balanced with a decrease in consumption, the goal of self-sufficiency in rice is not easy to achieve (Chaterine Yolandika, 2022). However, until now rice is positioned by the
government as the staple food of the Indonesian population. Therefore, the policy adopted by the government is to provide cheap food (rice) (cheap food policy). The goal is to protect rice consumers (Hardiyanti, 2022). The policy of protecting consumers of rice at low prices will theoretically increase or at least maintain rice demand. In line with population growth, the national demand for rice remains high. Indonesia’s population has now reached 270 million people with an average consumption of rice per capita per year of 124 Kg (Yama & Unteawati, 2022). This population has increased from 2014 which only reached 250 million people. The increasing population of Indonesia will certainly increase the consumption of rice per capita. This situation certainly makes it difficult for Indonesia to achieve food self-sufficiency, plus rice is a source of staple food in Indonesia (Wulandari & Warningsih, 2022)(Cahyati et al., 2022)(Hutasoit, 2022). The balance between the availability and the need for rice consumption is strongly influenced by the population. If the availability of rice is greater than the need for rice consumption, then the area is said to have a rice surplus, whereas if the availability of rice is less than the need for rice consumption, the region is said to be in a rice deficit (Anggara et al., 2022). The pattern of rice consumption is not easy to change, towards food diversification. For centuries, Indonesian people have been consuming rice for generations. The habit of diversifying food is difficult for adult consumers, but it can be started for children. Therefore, several efforts must be made to achieve rice self-sufficiency by taking into account several key factors that will determine the achievement of self-sufficiency and determining appropriate policies related to achieving and maintaining rice self-sufficiency (Nuni Anggraini, Anggara, et al., 2022).

The demand for rice in Indonesia is increasing every year so that the gap between production and consumption is getting bigger. This increase is due to the increasing population growth of Indonesia. Then the Indonesian consumption pattern that makes rice as a staple food is a hereditary problem that is difficult to change because it is related to habits (Clara Yolandika et al., 2017b)(Nuni Anggraini, Yolandika, et al., 2022). This situation makes Indonesia the highest ASEAN country in terms of rice consumption which reaches 124 kg per capita per year. The current level of consumption that exceeds rice production has prompted the government to import through world rice trade. Excess demand is covered by imports causing domestic rice prices to respond to global rice price movements which are detrimental to producers and consumers (Clara Yolandika et al., 2015)(Utoy & Yolandika, 2018a)(Utoy & Yolandika, 2018b). Especially in 2018, the government imported when farmers were about to harvest, this caused domestic rice prices to decline and harmed farmers from the producer side. So, policy instruments that can reduce dependence on imported rice and provide benefits to rice producers and consumers are urgently needed (Clara Yolandika et al., 2017a). Dependence on imports is slowly being eliminated with several efforts made by the government through agricultural extensification and intensification programs. With this program, it is expected to increase national rice production (Sofyani & Yolandika, 2021)(Utoy et al., 2018)(Clara Yolandika et al., 2021)(Sutarni et al., 2019)(Handayani et al., 2018)(C Yolandika et al., 2021). The purpose of this paper is to find out and project the effect of expansion of planting area or the effect of intensification and addition of production credit on increasing rice production so that it can be used as one of the recommendations in achieving and maintaining national rice self-sufficiency.

METHOD

The research was conducted using a qualitative descriptive method (Hendrik et al., 2021)(Bathara et al., 2021)(Clara Yolandika et al., 2016)(Clara Yolandika, 2016). The data used is secondary data (N Anggraini, Berliana, et al., 2022)(Hendri et al., 2022)(Handayani et al., 2017)(Berliana et al., 2018), namely data on production and prices of Indonesian rice in 1993 – 2015. The data analysis method used is dynamic model analysis by producing price and production policies. The research was conducted with the help of IThink software.

RESULT AND DISCUSSION

Availability of National Rice Towards Self-Sufficiency with Dynamic Model Approach
Problem Articulation

The problem that always arises from rice production in Indonesia is that Indonesian rice production has not been able to meet domestic food needs due to increased consumption and production that has not been able to meet the demand for rice. This will lead to dependence on imports which will harm producers and consumers. So, one way that can be done is to increase rice production by utilizing abandoned land through extensification or intensification with the addition of superior varieties or the absorption of new technologies. The first step in modeling a dynamic system is to determine the goals to be achieved, at this stage it becomes the basis for modeling activities so that forecasting becomes focused. Then a needs analysis is carried out regarding the variables that will be used in the modeling. The variables used include harvested area, rice production, rice production, productivity, consumption per capita, target, gap, birth rate, death rate, imports, extensification, intensification and population. Forecasting activities are carried out by looking at rice production and the achievement of predetermined targets in order to achieve self-sufficiency.

Formulation of Dynamics Hypothesis

a. Causal Loop Diagram (CLD)

Causal loop diagrams are made to describe the effect of each variable used, and in this diagram only variables that have a relationship and influence each other (have feedback) on the system are drawn. In Figure 1 below you can see a causal loop diagram consisting of 21 variables, namely abandoned land, extensification, land printing, harvested area, harvest, intensification, rice production, productivity, production credit, rice prices, HPP rice, rice imports, rice prices, demand, supply, rice consumption per capita, population, orange birth and death rates. These variables are the key variables that are considered to affect the national rice production. When the harvested area increases, the harvest will also increase which will increase production and productivity. When production increases, consumption needs increase and demand is met. Consumption itself is influenced by the positive population, and the population is influenced by the birth and death rates.

b. Stock Flow Diagrams (SFD)

The following are the results of the analysis using the Stock Flow Diagram approach using the iThink 9.0.3 software regarding rice production using BPS data on rice productivity in 1993 to 2015.
Analysis of Indonesia national rice availability towards self-support with a dynamic model approach

D Pratiwi

Figure 2. Stock and Flow Diagram

Information:
- Stock variables: Harvested Area, Rice Price and Population
- Endogenous variables: paddy field printing, land addition, harvesting, rice production, rice production, imports, supply and demand balance, price elasticity, births, deaths, rice prices, gaps, rice demand and rice supply
- Exogenous variables: Abandoned Land, Extensification, Intensification, Production Credit, Productivity, Import Policy, Production Target, Rice Consumption Per Capita And Rice HPP.

The stock flow diagram in Figure 2 can be seen that the harvested area is affected by extensification carried out by utilizing abandoned land which will be printed into rice fields so that there is an increase in land which will have an impact on increasing the harvested area. The increase in harvested area will certainly increase crop yields. Another effort that can be made to increase crop yields is through intensification in the form of additional inputs such as fertilizers, superior seeds, to the absorption of technology. Production credit is considered to be able to increase crop yields through additional capital obtained by farmers. However, the population that continues to grow will affect the demand for rice and the level of consumption per capita per year. Until 2018, it is estimated that the rice consumption per capita per year in Indonesia is 124 kg with a population of 270 million people. Through this stock flow diagram, the influence of these variables will be simulated on the achievement of national rice self-sufficiency.

Formulation and Simulation Model

a. Formulation Simulation Model Actual
The actual data used in this paper is data on the average productivity of rice according to (BPS 2018).

\[ \text{Price}_{\text{rice}}(t) = \text{Price}_{\text{rice}}(t - dt) \]

\[ \text{INIT} \text{rice}_{\text{price}} = 10000 \]

\[ \text{Population}_{\text{Number}}(t) = \text{Population}_{\text{Number}}(t - \text{sec}) + (\text{Births} + \text{Deaths}) * \text{sec} \]

\[ \text{INIT Population} = 270 \ \text{{MILLION PEOPLE}} \]

INFLOWS:
Birth = 0.0149
Death = 0.002827
Harvest_Areal(t) = Harvest_Areal(t - sec) + (Land_Addition - Harvest) * s
INIT Area_Areal_Harvest = 14 {MILLION HA}

Table 1. Average rice productivity in Indonesia 1993-2015

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Productivity (Ton/Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1993</td>
<td>4.4</td>
</tr>
<tr>
<td>2</td>
<td>1994</td>
<td>4.3</td>
</tr>
<tr>
<td>3</td>
<td>1995</td>
<td>4.4</td>
</tr>
<tr>
<td>4</td>
<td>1996</td>
<td>4.4</td>
</tr>
<tr>
<td>5</td>
<td>1997</td>
<td>4.4</td>
</tr>
<tr>
<td>6</td>
<td>1998</td>
<td>4.3</td>
</tr>
<tr>
<td>7</td>
<td>1999</td>
<td>4.5</td>
</tr>
<tr>
<td>8</td>
<td>2000</td>
<td>4.4</td>
</tr>
<tr>
<td>9</td>
<td>2001</td>
<td>4.5</td>
</tr>
<tr>
<td>10</td>
<td>2002</td>
<td>4.5</td>
</tr>
<tr>
<td>11</td>
<td>2003</td>
<td>4.5</td>
</tr>
<tr>
<td>12</td>
<td>2004</td>
<td>4.5</td>
</tr>
<tr>
<td>13</td>
<td>2005</td>
<td>4.5</td>
</tr>
<tr>
<td>14</td>
<td>2006</td>
<td>4.5</td>
</tr>
<tr>
<td>15</td>
<td>2007</td>
<td>4.5</td>
</tr>
<tr>
<td>16</td>
<td>2008</td>
<td>4.8</td>
</tr>
<tr>
<td>17</td>
<td>2009</td>
<td>4.7</td>
</tr>
<tr>
<td>18</td>
<td>2010</td>
<td>5.0</td>
</tr>
<tr>
<td>19</td>
<td>2011</td>
<td>4.9</td>
</tr>
<tr>
<td>20</td>
<td>2012</td>
<td>5.1</td>
</tr>
<tr>
<td>21</td>
<td>2013</td>
<td>5.1</td>
</tr>
<tr>
<td>22</td>
<td>2014</td>
<td>5.1</td>
</tr>
<tr>
<td>23</td>
<td>2015</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Source: (BPS 2018)

INFLOWS:
Land_addition = paddy_printing

OUTFLOWS:
Harvest = INTENSIFICATION+PRODUCT_CREDIT

UNATTACHED:
Rice_Price = PADI_HPP+(0.3*RICE_HPP)
EXTENSIFICATION = 100 {HA}
elasticity_price = balance_S__D*rice_price
gap = TARGET_PRODUKSI-production_rice
HPP_PADI = 4100
import = (POLICY_IMPORT*gap)-request_rice
INTENSIFICATION = RANDOM(0,3)
IMPORT_POLICY = 0.2
balance_S__D = demand_rice-supply_rice
KONSUMSI_BERAS_PERKAPITA = 124 {Kg}
CREDIT_PRODUCTION = RANDOM(0,3)
Abandoned Land = 250 {HA}
supply_rice = import+production_rice
printing_sawah = LAND_TERLANTAR-EXTENSIFICATION
Analysis of Indonesia national rice availability towards self-support with a dynamic model approach
D Pratiwi

\[
\text{rice\_demand} = \text{total\_population} \times \text{CONSUMPTION\_BERAS\_PERKAPITA}
\]
\[
\text{population\_growth} = \text{Birth} - \text{Death}
\]
\[
\text{rice\_production} = \text{rice\_production} \times 0.6274
\]
\[
\text{rice\_production} = \text{SMTH3(Harvest} \times \text{PRODUCTIVITY,5)}
\]
\[
\text{TARGET\_PRODUCTION} = 40000 \{000\text{TON}\}
\]
\[
\text{PRODUCTIVITY} = \text{GRAPH(TIME)}
\]
\[(1.00, 4.40), (2.00, 4.30), (3.00, 4.40), (4.00, 4.40), (5.00, 4.40), (6.00, 4.30), (7.00, 4.50), (8.00, 4.40), (9.00, 4.50), (10.0, 4.50), (11.0, 4.50), (12.0, 4.50), (13.0, 4.58), (14.0, 4.52), (15.0, 4.54), (16.0, 4.80), (17.0, 4.74), (18.0, 5.00), (19.0, 4.90), (20.0, 5.10), (21.0, 5.10), (22.0, 5.10), (23.0, 5.34)\]

Based on the table, the range of rice productivity in Indonesia is 4 to 5 tons/ha. This amount will affect the amount of national rice production to the demand and supply of rice in the market whose impact will affect the price and consumption of rice per capita. The above productivity data serve as basic data for projecting Indonesia’s rice production towards the national rice self-sufficiency target. After inputting into the i-think software, a simulation of the Indonesian rice production model with a projected year of 2018 to 2038 is obtained as follows.

A. Graphic

The graphic simulation above explains the relationship between Indonesia’s rice production and the rice production target to be achieved so that Indonesia can be self-sufficient in rice. The production...
target used is 40 million tons due to the national rice consumption needs, which according to (BPS, 2012) reaches 34.97 million tons. So if we want to meet the needs of national rice consumption, we must increase production to 40 million tons. According to the simulation model above, the target will never be achieved if no changes or efforts are made.

B. Testing
After we make an actual simulation of the condition of the rice economy in Indonesia, we will test and compare it with the simulation that we will make by increasing agricultural extensification and intensification. The target used in this simulation is rice production of 40 million tons. The following are graphs and tables of test results with efforts to increase extensification and intensification.

Table 2. Comparison of Actual and Simulation Data with a production target of 40 million tons

<table>
<thead>
<tr>
<th></th>
<th>Extensification</th>
<th>Intensification</th>
<th>Consumption Per Capita Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Data</td>
<td>100 Ha</td>
<td>Random 0.3</td>
<td>124 Kg</td>
</tr>
<tr>
<td>Simulation 1</td>
<td>110 Ha</td>
<td>Random 0.7</td>
<td>114 Kg</td>
</tr>
<tr>
<td>Simulation 2</td>
<td>110 Ha</td>
<td>Random 0.7</td>
<td>124 Kg</td>
</tr>
</tbody>
</table>

The three variables above are the key variables or determinants of achieving rice self-sufficiency, so that in the following simulation, it is done by changing the three key factors above.

In simulation 1, Indonesia can achieve rice self-sufficiency in 2024 by increasing land extensification by 10%, so that there will be a decrease in abandoned land, then reducing rice consumption per capita per year by 8% and increasing agricultural intensification through technology absorption or adding seeds. superior. If these efforts are carried out, it will increase rice production and achieve rice self-sufficiency.

In simulation 2, Indonesia can achieve rice self-sufficiency in 2024 or 2025 by increasing land extensification by 20%, so that there will be a decrease in abandoned land, but without reducing rice consumption per capita per year and increasing agricultural intensification through technology absorption or the addition of superior seeds. If these efforts are carried out, it will increase rice production and achieve rice self-sufficiency with a production target of 40 million tons.
B. Policy Design and Evaluation

Policy and evaluation can be decided after seeing the comparison of actual data and simulation data that has been tested. Based on the two simulations above, rice self-sufficiency can be achieved by increasing extensification by 10% and intensification and reducing rice consumption per capita per year by 8%. However, in the second simulation, the reduction of rice consumption per capita per year was not carried out and increased extensification by 20%. Reducing rice consumption can be done by diversifying food, but reducing the habit of consuming rice in Indonesia is not easy to do. Because consuming rice has become a hereditary habit in Indonesia. These habits can be applied to children, because basically, habits can be more easily changed from an early age. Diversification can be done by replacing rice with substitute foods such as corn, potatoes, and other tubers. Reducing rice consumption is also carried out with the one day no rice program in one week. So just one day a week we are asked not to consume rice and replace it with other staple foods. If this is done by at least half of the Indonesian people, it will reduce the consumption of rice per capita. However, lately the one day no rice program tends not to be applied in daily life, many people refuse to replace rice with other staple foods, so that if this happens, self-sufficiency can still be done by further increasing extensification by 20% followed by agricultural intensification.

CONCLUSION

Based on the results of the processing and analysis of the existing data, it can be concluded that: (1) Variables that affect the yield of rice production and the achievement of self-sufficiency are extensification, intensification, and per capita consumption of rice per year; (2) Rice self-sufficiency can be achieved by Indonesia in 2024 or 2025 with a production target of 40 million tons if changes are made to these key factors; (3) The policy that needs to be done is to increase extensification and intensification by absorbing technology and adding inputs or capital through production credit and reducing rice consumption by 8% through the one day no rice program in one week.

REFERENCE

Analysis of Indonesia national rice availability towards self-support with a dynamic model approach
D Pratiwi


Analysis of Indonesia national rice availability towards self-support with a dynamic model approach
D Pratiwi


RICE-MARKET-CHAIN.pdf
