RICE BALANCE SIMULATION IN ORDER TO SUPPORT SUSTAINABLE RICE SELF-SUFFICIENCY PROGRAM IN NORTH SUMATERA

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Abstract: The UPSUS program for food self-sufficiency launched by the government has succeeded in increasing national rice production, including in North Sumatera, by increasing the additional embedded area (LTT). However, the aspect of rice supply and distribution is still a problem, so rice imports are still carried out. This study aims to determine the rice balance by comparing the value of rice production to consumption every month throughout the year. The method used is a dynamic system approach using secondary data to build a simulation model. The simulation results show that, in general, the demand for rice has been fulfilled, although in certain months there is a deficit because the planting area in that month is not as large as in other months. Likewise, for some rice production centers, there are regions that experience rice deficits throughout the year. Therefore, efforts to improve supply chain management are an alternative solution to supporting sustainable rice self-sufficiency in North Sumatera.

Keywords: simulation, balance, rice, self-sufficiency, sustainability

Abstrak: *Program UPSUS swasembada pangan yang dicanangkan oleh pemerintah telah berhasil meningkatkan produksi padi nasional, termasuk di Sumatera Utara melalui peningkatan luas tambah tanam (LTT). Meskipun demikian, aspek penyediaan dan distribusi beras masih menjadi masalah, sehingga impor beras masih dilakukan. Penelitian ini bertujuan untuk mengetahui neraca perberasan dengan membandingkan nilai produksi beras terhadap konsumsi disetiap bulan sepanjang tahun. Metode yang digunakan adalah pendekatan sistem dinamik dengan menggunakan data sekunder, untuk membangun model simulasi. Hasil simulasi menunjukkan bahwa secara umum kebutuhan beras telah tercukupi, meskipun pada bulan tertentu mengalami defisit dikarenakan luas tanam pada bulan tersebut tidak sebesar bulan lainnya. Demikian pula untuk beberapa daerah sentra produksi beras dimana terdapat daerah yang mengalami defisit beras sepanjang tahun. Oleh karena itu, upaya perbaikan manajemen rantai pasok menjadi alternatif solusi dalam mendukung swasembada beras berkelanjutan di Sumatera Utara.*

Kata kunci: *simulasi, neraca, beras, swasembada, berkelanjutan*

Article history:

Received
14 September 2022

Revised
18 November 2022

Accepted
21 November 2022

Available online
30 November 2022

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INTRODUCTION

During the 2014-2019 period, the government launched a special effort (UPSUS) to increase rice production nationally. These efforts are in the form of input facilities such as fertilizers, seeds, and agricultural machinery to boost the additional embedded area or commonly referred to as LTT. The LTT report is generated daily to monitor the area of rice cultivated in an area. In fact, the report was validated by using satellites to determine the exact area of land planted with rice.

Along with the UPSUS program, the Ministry of Agriculture collaborates with stakeholders such as local governments, the Indonesian National Military (TNI), and field extension officers to oversee the distribution of aid and the achievement of the LTT targets that have been set. As the agency authorized to publish official data, the Central Bureau of Statistics (BPS) is also involved in validating LTT data.

The collaboration of these institutions produced positive results. Data on national rice production increased significantly between 2014 and 2019. According to the data, rice production in 2017 totaled 81.38 million tons of GKG, an increase of 3.72% year on year (Sulaiman et al. 2018). North Sumatera Province had a rice planting area of 727,103 hectares at the time of the declaration of a special effort for rice self-sufficiency. In 2018, this value increased by 61%, to 1,174,571 hectares.

Based on data compiled by the Data and Information Center, Ministry of Agriculture, North Sumatera's rice production has continued to increase since 1990 (Figure 1). The highest increase occurred in 1995, when rice production reached 3.9 million tons, an increase of 900 thousand tons over the previous year. Although it fell back to 3.1 million tons the following year.

Rice production could be said to have been stable in the range of 3 to 3.5 million tons per year from 1996 to 2006. Then production experienced a high positive trend increase after 2005 to 2016. The highest slope's peak was reached after 2014, when the UPSUS program began.

Based on data from the BPS, there were five major rice supplier districts in North Sumatera from 2010 to 2016, namely Simalungun Regency (14%), Deli Serdang Regency (12%), Langkat Regency (10%), Serdang Bedagai Regency (8.6%), Mandailing Natal Regency (5%), and Batubara Regency (4.5%).

Several studies on the factors influencing rice production in North Sumatera have been conducted. Rahayu (2019) reported that rice production has an inverse relationship with imports: the higher the import, the lower the production. Meanwhile, Hilalullaily et al. (2021) suggested that the increase in productivity and production was due to an increase in agricultural input use and agricultural land area.

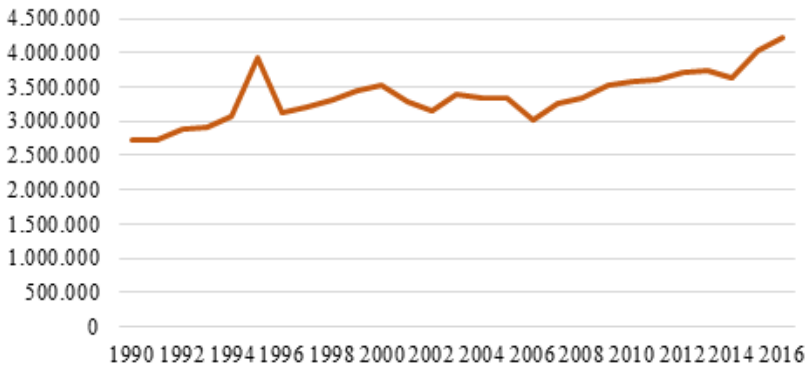

Figure 1. Rice Production in North Sumatra 1990 - 2016 (Pusdatin, 2019).

Although the UPSUS program is said to be successful in increasing rice LTT, there are several things that need to be improved in its implementation, including distribution issues, particularly in terms of rice distribution. Provinces experiencing a rice surplus, such as East Java, Central Java, West Java, and South Sulawesi, tend to have no food stock problems (Pratama et al. 2019). However, this is not the case in large cities, particularly Jakarta, which relies on food from surrounding buffer areas, which have serious food stock issues. Prices are very sensitive to changes in stock, and because rice is a basic necessity, it is still purchased even if the price is high. This can occur when the emphasis on production overrides distribution and consumer preferences. According to Kusumaningrum et al. (2021), an area with a food production value that is still lower than its needs tends to focus on efforts to achieve aggregate production and lacks a policy on consumer preferences, including commodity distribution.

Rice stock fluctuations are caused by different rice production patterns and rice needs. Although it appears that currently most of them have a year-round planting season, as evidenced by the presence of LTT values in each month, the proportion in each month is still different. Because rice production remains reliant on the rainy season, the LTT is higher during that season than during the dry season.

On the consumption side, national demand for rice is relatively constant and does not vary with the seasons. This is because the amount of rice consumed in each area is directly influenced by the population. Although the overall value of rice consumption is said to be declining. Rice consumption reached 9 Kg/capita/month in 2009 (BPS, 2018b) but it is expected to fall to 7.56 Kg/capita/month in 2020. However, the decline was only observed in major cities. Meanwhile, consumption in both rural and urban areas remains higher than the national average.

The two different production and consumption patterns will at least lead to two conditions, namely, the need for rice warehouses to accommodate rice when production is higher than consumption. Second, conditions at the time of production are lower than consumption, so that consumption uses stock supplies from previous production. Therefore, it is necessary to study the rice balance that compares the value of rice production to consumption every month throughout the year. This will provide early information on the shortage of rice supply so that the presence of rice can be ascertained to meet the needs of the community.

METHODS

This study uses a dynamic system approach using secondary data from the Ministry of Agriculture and the Central Bureau of Statistics. The use of dynamic systems in the analysis will use some basic instruments to build the model and operate the model.

In general, the stages of analysis in the systems approach are problem formulation, dynamic hypothesis formulation, model formulation, testing, and developing scenarios to be evaluated (Fristovana et al. 2019; Krisdayanti et al. 2017; Irfangi et al. 2020). The main advantage of simulation using the dynamic system method is that it can describe processes, behavior, and complexity in systems that are uncertain and in accordance with actual conditions after going through the validation and verification process, compared to other forecasting or simulation methods. The drawback is that if an actual system is more complex, then it takes quite a lot of variables and time in the preparation of the model.

The dynamic system model of the rice balance in this study was built on a relationship in the form of a Causal Loop Diagram (CLD), which was equipped with a feedback loop mechanism. The CLD rice balance system for each district and city in Sumatera Province, as shown in Figure 2, includes two sub-systems, namely the sub-system of rice production and rice consumption.

Figure 2 is then used to identify the rice balance of 33 districts in North Sumatera. The rice center districts are predicted to fulfill rice needs evenly throughout the year so that they can contribute to the non-rice center districts. This is reinforced by data on crop yields and the additional embedded area of rice from the Central Bureau of Statistics.

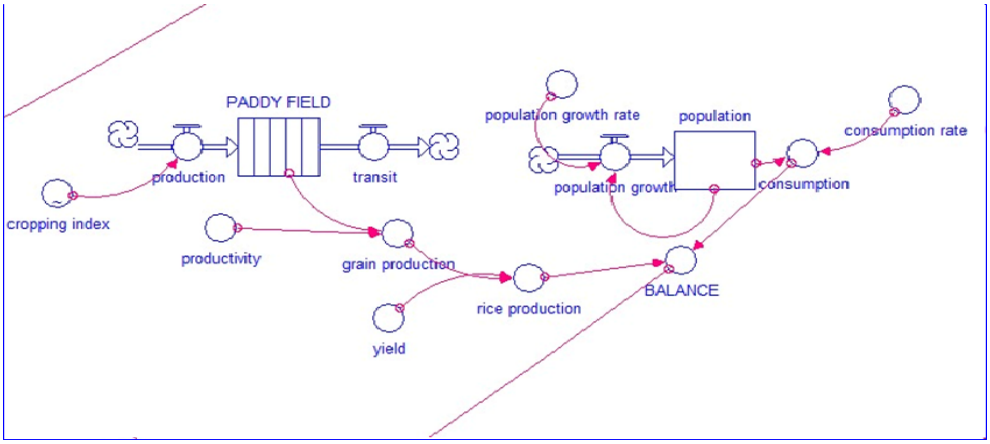

Figure 2. Stock Flow diagram of rice balance model scenarios for districts/cities in North Sumatra

RESULTS

Consumption Rate and Consumer Preference

This study's model preparation still assumes that all rice can meet consumer preferences. In fact, there is a tendency to increase consumer preferences for rice quality, especially medium rice. In fact, consumer preferences for rice quality, particularly medium rice, are increasing. As a result, even if the aggregate supply of rice is sufficient, rice prices may rise, and a rice shortage may occur because consumers cannot find rice that meets their preferences. This can be seen in urban consumers, who prefer to buy rice in branded packaging rather than bulk rice from the market.

Preference is influenced by a variety of factors. Some consumers choose rice based on price, while others choose based on the commodity's attributes, such as taste, fluffier, color, size, and others. A small percentage are loyal to certain premium rice brands even though the type or variety of rice is not always the same from time to time.

According to Yunita and Arbi (2019), consumers are divided into three groups when choosing rice preferences. First, low-income consumers rank rice quality as the highest in general. In addition, when selecting the quality of rice, consumers consider the location of purchase. Second, middle-income consumers prioritize a more specific quality of rice, namely the durability and aroma of rice, as the main considerations in determining the decision to consume rice. Third, consumers with higher incomes are more loyal to the type of rice that is ranked higher than other attributes. This consumer group is unconcerned about the characteristics of rice advertisements or promotions.

Rice is a commodity that affects inflation because it is a staple food. Because of large harvest activities in rice production centers such as Langkat, Simalungun, Serdang Bedagai, Deli Serdang, and Batubara, the inflation rate fluctuated, particularly in the first quarter (Wijaya et al. 2020).

Despite the fact that rice is a commodity that contributes to inflation, rice stocks in North Sumatera are stable. Several studies on food security, supply and demand, and the ratio of food consumption availability conclude the same thing: rice is a safe commodity in terms of stock in North Sumatera. These studies were carried out, among others, by (Sari et al. 2020; Saragih et al. 2021; Napuku et al. 2021; Pratama et al. 2021). Rice stock, rice harvest area, land productivity, rice consumption, and rice price are all factors that influence rice availability. This value, however, varies greatly across North Sumatera Province. Pematang Siantar and Binjai have the lowest consumption, with 6 kg/capita/month. Meanwhile, North Padang Lawas Regency had the highest consumption, with 11.08 kg/capita/month.

As a direct factor that affects the amount of rice consumption, the population in North Sumatera is predicted to increase by 11.38 percent within ten years (BPS, 2015). North Sumatera's population in 2015 was 13,961,440 people, with a projected increase to 15,550,460 people. This indicates that as the population grows, so will the demand for rice for consumption. Rice production has increased in tandem with GKG rice production, with various programs such as intensification, extensification, and swamp land optimization implemented.

North Sumatera Rice Balance Simulation

Food security, particularly rice in North Sumatera, can be said to have met consumption needs. In terms of production, rice production in 2016 totaled 4.2 million tons of GKG. If this figure is converted into rice at an 83.12 percent conversion rate (BPS, 2018a), it will produce at least 3.5 million tons of rice. This amount exceeds the consumption value, which is only about 1.3 million tons for an 8 kg/capita/month consumption value.

This value, however, does not necessarily describe the condition of safe rice stocks because the value of rice imports in North Sumatera remains. Imports cannot be used as a general indicator of food supply shortages, but they can be an alternative policy in certain (situational) circumstances. This is also due to the fact that rice production has not been distributed evenly across the seasons.

A dynamic simulation of the system, as shown in Figure 3, can be used to describe the situation of the rice production and consumption balance in each month of the current year. The graph above shows how the level of consumption on the demand side and production on the supply side influence the rice balance. Rice production is determined by the conversion of grain production from agricultural land through planting area. A planted area has a single planting period or planting season that causes a production delay. The planted area itself can be fulfilled by farmers based on the price they receive as a source of income. Furthermore, government programs can influence the additional embedded area by increasing the Planting Index (IP) or optimizing dry land and swamps.

On the consumption side, rice output can be said to be constant every month. Even though there are major holidays at the end of the year, the increase is primarily due to temporary migration or migration of people from cities to rural areas. The rice balance reflects the supply and demand sides, which in turn affects rice prices due to stock conditions.

Using a dynamic simulation system, Figure 4 depicts the state of the rice balance in North Sumatera Province. The figure shows that, in general, the need for rice has been met. From March to August, the balance sheet continued to improve. However, there was a deficit in August, October, and November, owing to higher consumption than higher production. The deficit in that month can be explained by the fact that the planting area in April and May is not as large as in other months. Although total rice demand can be met, it is important to remember that farmers do not typically store large amounts of grain. To earn money, most farmers sell their harvested grain at the same time. This indicates that rice stocks are in the hands of traders and Bulog.

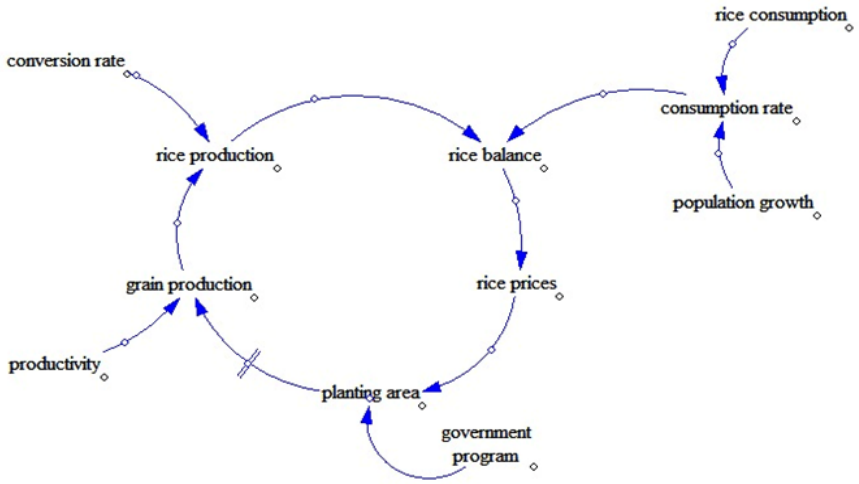

Figure 3. North Sumatra rice balance model

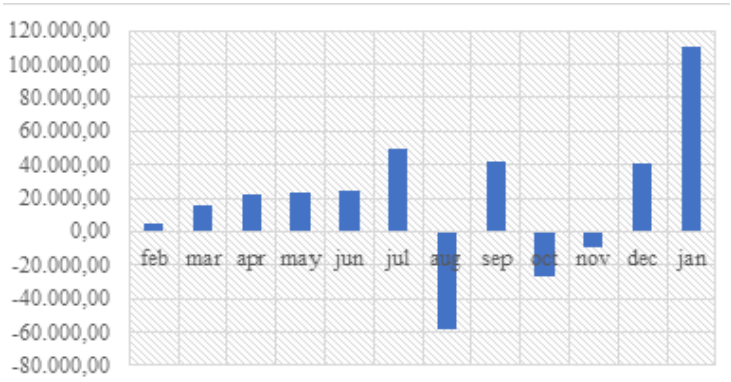

Figure 4. North Sumatra rice balance

The rice balance can be seen in more detail in Figure 5, which tells about each rice production center in North Sumatera. The three major rice production areas, namely Simalungun, Deli Serdang, and Langkat, have similar average rice production, namely 500 thousand tons of GKG rice. However, Deli Serdang has the largest population, with 2.2 million people, followed by Langkat with one million, and Simalungun with around 880 thousand people. This results in a monthly rice surplus in the Simalungun Regency area. Meanwhile, Deli Serdang experienced a rice shortage from April to June, August, October, and December. While there is a surplus in Langkat Regency, the remaining stock is not too large in the middle of the year, until there is a large harvest from September to February.

The next production centers are Serdang Bedagai, Mandailing Natal, and Batubara. Serdang Bedagai has the highest population of the production centers in this group, with 615 thousand people. Thus, even though Serdang Bedagai ranks fourth in terms of rice contribution, the district's rice balance is always negative throughout the year.

Managerial Implication

The study assumes that the resulting rice production is completely consumed by consumers. Consumers, in fact, have preferences for the type of rice produced. Rice is classified as premium, medium, or bulk based on its quality. Even when there is a sufficient supply, rice prices can rise when there is a shortage of premium and medium rice among certain consumers.

Supply chain management entails organizing the flow of commodities, goods, and services from the time raw materials are provided until they reach the final consumer. In practice, the supply chain not only regulates the flow of goods, but it also organizes stock to meet product needs in the coming days. This can be done when a certain quantity, namely the cost of product storage, is lower than the cost of shipping goods. In addition to anticipating high transportation costs, stock management is also needed to deal with spikes in demand during peak seasons such as holidays, school holidays, and others. Masyitha (2018) stated that the optimum supply of Perum Bulog in North Sumatera is 43,698 tons. When compared to the monthly consumption of the North Sumateran population, this value only allows for consumption for 12 days. This is understandable given that Bulog is not the only actor in the rice supply chain and operates only when certain conditions exist, such as price increases and large harvests.

However, agricultural commodity supply chain management differs from that of non-agricultural commodities. Agricultural commodities are vulnerable to organism attack during storage, causing commodities to be easily damaged. According to Wahyuni (2013), carbohydrates, fat, and energy in rice will decrease over a 7-9 month storage period. The flow of rice in a warehouse should not exceed the shelf life so that the quality of the content does not deteriorate.

Looking at the storage age limit, North Sumatera's rice needs should be able to be met without importing because production in the same year has exceeded consumption needs. Imports, however, are not solely determined by a region's rice surplus or deficit. According to Sari (2022), rice imports in North Sumatera are influenced by the rice production, the price of North Sumatera rice, and the amount of rice stock. This suggests that North Sumateran rice should be more competitive in the local market when compared to imported rice. Increased competitiveness will result in lower production costs, lowering the market price of rice.

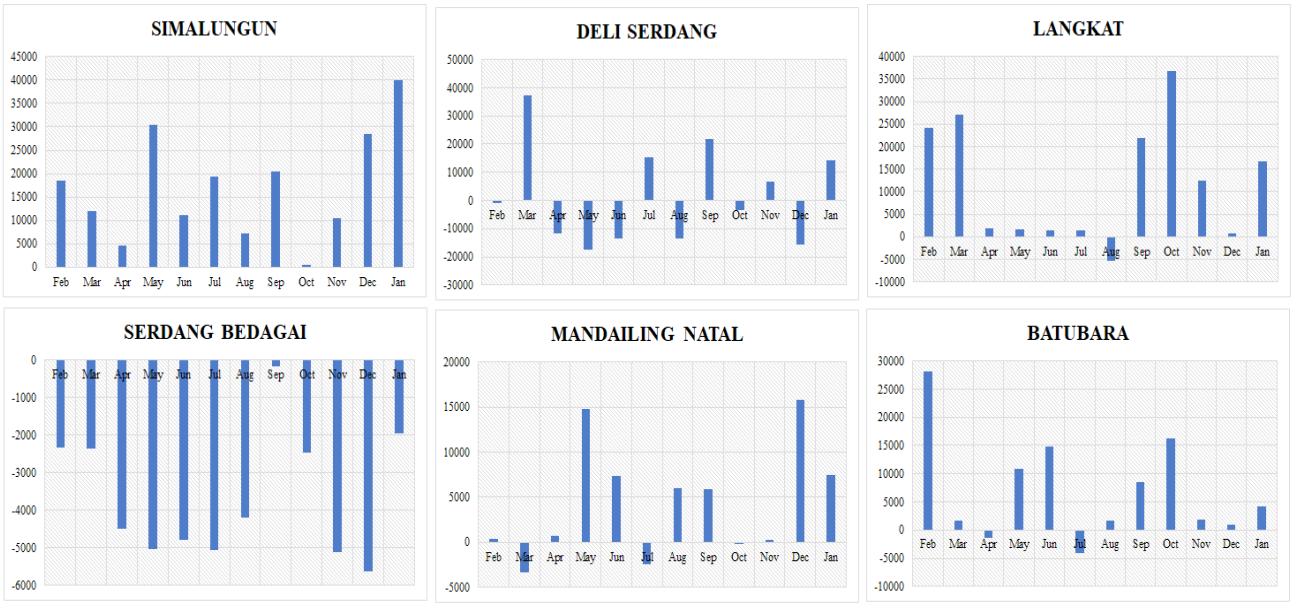

Figure 5. Rice balance in production centers

Efforts to improve rice supply chain management can also be made by increasing planted area in April and May in order to avoid a rice balance deficit in August. Although the deficit can be filled with stock from the previous month, distributing production throughout the month improves supply chain efficiency because it has a shorter chain and lowers storage costs in the supply chain. However, given the importance of climate and water resources in agriculture, this is not an easy task. Utilization of dry land and swamp land may be an option for meeting rice demand. As a result, the expansion of dry land or swamp land is planned in such a way that it does not coincide with paddy fields or existing land. A well-managed supply chain will clearly describe the flow of commodities, both inflows and outflows. Commodity weighing on major highways that connect provinces and cities will assist the government in monitoring commodity flows, including seasonal data. The data can then be input into a more comprehensive information system.

Information systems can improve the effectiveness of rice supply chain actors from upstream to downstream (Pudjiarti et al. 2019; Tasril et al. 2019). Communication and coordination related to the rapid movement of information and data will be facilitated by information systems. The information system will accommodate farmers' needs to market their products based on the type of rice and will assist consumers in finding rice specifications that suit their preferences. The improvement of the information system, combined with an increase in rice competitiveness, will cause North Sumatera's rice production to be consumed first, before importing rice from elsewhere in the country.

As policy makers, local governments can improve the achievement of sustainable self-sufficiency by paying attention to the balance of rice demand and production. The managerial implementations that can be done include; first, determining commodities in accordance with resource support. North Sumatera is an area that has equatorial type rainfall (Santoso et al. 2022). This can be addressed by selecting upland rice commodities because they have good potential, equalizing rainfall in drylands. Second, determining the minimum target of planting area every month. The determination of the minimum target is based on the level of community needs and population which is then converted into how much planting area needs to be provided every month. Third, disseminate technology to reduce the impact of climate change, especially the increase in pests and drought conditions. Technology can also assist in planning the fulfillment of needs in the form of a minimum target planting area so that the need and supply of rice become more measurable.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The simulation model of the rice balance in North Sumatera shows that consumption from the demand side and production from the supply side influence the rice balance. In general, the simulation results show that the demand for rice has been met, even though there is a deficit in certain months due to a decrease in planted area in those months. Furthermore, several rice production centers require attention, as even though they have a surplus, the remaining rice stocks are not excessive. There are even rice production centers that have a year-round deficit. Therefore, efforts to improve supply chain management are an alternative solution for supporting North Sumatera's sustainable rice self-sufficiency.

Recommendations

Equitable food fulfillment can be achieved through the improvement of production-increasing programs such as LTT. One of the suggested improvements is to plan the planting season based on specific conditions to ensure rice availability. Production fulfillment targets are not only cumulative throughout the year, but are also part of specific monthly plans, which include the distribution of supporting facilities such as seeds and fertilizers. Production fulfillment targets are not only cumulative throughout the year, but are also part of specific monthly plans, which include the distribution of supporting facilities such as seeds and fertilizers. Technology, such as water harvesting or the construction of reservoirs to hold back water flow, is required to overcome the reduction in added planting area during the dry season.

FUNDING STATEMENT: This research did not receive any specific grant from funding agencies in the public, commercial, or not - for - profit sectors.

CONFLICTS OF INTEREST: The authors declare no conflict of interest.

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