The 2nd International Conference On Indigenous Knowledge For Sustainable Agriculture 2023
ISBN : 978-623-161-062-1

Food Security Study in North Kalimantan Province (Case Study: Availability of Rice in Bulungan District)

Mohammad Wahyu Agang[1*], **Deslima Simanjuntak**[1]

[1]Agribusiness, University of Borneo Tarakan, Indonesia
*email : wahyuagang@gmail.com

Keywords:

Dynamic system,
Rice availability,
Land availability

ABSTRACT

This study aims to answer questions related to the availability of rice in Bulungan District. is the availability of land as an important variable in increasing rice production in Bulungan District. Determining the location in this study was done purposively (purposive). The method of determining the sample in this study was a purposive sampling method with the criteria used to determine the sample for this study were the Bulungan Regency Agriculture Service, the Bulungan Regency Population and Civil Registry Service, the Food Security Service which has the data archives needed by researchers. Collecting data in this study is by interview and documentation. The data analysis used is a system dynamics approach to the causal loop diagram (cld) model and stock flow diagram (sfd) with Ventana system (Vensim) PLE 9.3.4x64 software. The results of the study show that the factor that influences the availability of rice is the population, where the population from 2022-2052 will increase significantly with an average increase of 2%. Rice production of rice from 2022-2052 has decreased by an average of 2.1%, a policy of simulating the availability of rice in Bulungan Regency has been carried out with a scenario of increasing the rice field production rate by 5%. However, rice consumption is not sufficient in 2022, 2024-2025, 2029, 2031-2035, 2039-2041, 2045 and 2050. In 2022 the availability of rice is 8,075.15 tons and rice consumption is 8,075.16 tons so that people still lack 100 kg of rice, so also happened in the following years. When carrying out a combined scenario of rice availability in Bulungan Regency with an increase in the rice field printing rate of 5% and 10% rice field productivity, it will be sufficient for the rice consumption of the people of Bulungan Regency from 2022 to 2052.

INTRODUCTION

Bulungan Regency is one of the regencies in North Kalimantan Province. Bulungan Regency is one of the largest contributors to rice production, namely in 2021, namely 8,075.69 tons by BPS North Kalimantan 2022. In the development of the agricultural sector one of them is to choose a commodity that must be considered with land suitability and socio-cultural conditions of the community. The leading commodity in the food sector in Bulungan Regency is rice. Because it has become a tradition for Indonesian people to make rice a staple food in various regions, tribes and others. This resulted in

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

rice consumption being the largest consumption of food commodities compared to other commodities [1].

One of the availability of food is the availability of rice. Rice is a staple food for people in Indonesia. Apart from being one of the most consumed food commodities in Indonesia, rice is also often associated with meeting basic human needs, therefore every human being has the right to obtain these basic needs [2]

Bulungan Regency strongly supports the development of food crop commodities, especially rice. This situation is also supported by agro-ecosystem conditions, varietal diversity and wide availability of land. The area of paddy harvested land in Bulungan Regency in 2021 will reach 3,954.32 hectares, and rice production will be 13,010.96 tons, where rice productivity in Bulungan in 2021 will be 32.90 ku/ha by BPS Kalimantan Utara 2022, which is still very far from the average. The average national productivity in 2021 is 54.42 tonnes/ha. besides that population growth is increasing significantly every year in 2021 the population of Bulungan Regency is 153,550 people by Department of Population and Civil Registry of Bulungan Regency 2022.

According to [2] The area of paddy fields and the population will affect the amount of rice availability, the more rice the area of paddy harvested land, the greater the rice production produced, apart from that the population cannot be separated from the need for rice consumption, because the more the population increases, the need for rice consumption will increase. increasing too. The problem of rice availability is caused by fluctuating rice, where rice production is limited and rice consumption increases with increasing population.

The system approach is a way of solving problems that starts with identifying the existence of a number of needs so that it can produce an operation of a system that is considered effective [4]. The rice availability system involves various sectors covering various aspects and is complex, so that solving the rice availability problem requires a more comprehensive and holistic approach, namely using a dynamic system.

System dynamics is a framework that focuses on systems thinking by means of feedback loops and takes several additional structural steps and tests them through computer simulation model [4]. Acording to [5] The development of a rice availability model is needed to support decision making in developing policies to ensure rice availability. Based on these tests and analysis, the productivity and availability of paddy fields are two important variables that can have a significant impact on the entire rice production system. Both of these variables can be used as a reference in studying the development of policy models in order to ensure the availability of rice. The aim of this is to analyze land area as an important variable in increasing rice production in Bulungan District.

METHOD

This research was carried out in Bulungan Regency, North Kalimantan Province and the implementation time started from October 2022-December 2022. In determining the location of this research, it was carried out purposively because the

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

location considerations are that Bulungan Regency has a vision, namely to realize Bulungan Regency which is food sovereign, advanced and prosperous. This study applies a dynamic system to determine the availability of rice in the next 30 years. The data used in this study are secondary data, namely a six-year time series from 2016 to 2021 rice production, rice land area, rice harvest area, land conversion, population growth. Data sources will be obtained from related literature data such as the Central Bureau of Statistics, the Agriculture Service, the Food Security Service, the Population and Civil Registry Service, previous research, and various sources relevant to this research. This study was analyzed using the system thinking method with the help of Ventana system (Vensim) PLE 9.3.4 x 64 software. Stages of making a dynamics system model

1) Creating a concept in a CLD model (Causal Loop Diagram)
2) Develop a system diagram. This diagram describes the subjects, objects, and alternative policy tools that can be used.
3) Development of a dynamic model for integration using statistical analysis and to find out the relationship between related variables by making a flow chart model or Stock Flow Diagram.
4) Model validation serves to ensure that the model that has been successfully created can represent actual conditions. The model is said to be valid if the deviation is less than 10%, in this study model validation is calculated using the mean absolute percentage error (MAPE) calculation approach, which is written mathematically in the formula (5)

$$\text{MAPE}= \left(\frac{100}{n}\right) \sum_{t=1}^{n} \left| \frac{Dt-Ft}{Dt} \right|$$

Information:

n : sample size
Dt : data in period t
Ft : forecasting in period t

5) The last stage is simulation. The end result of this research is to get some sensitive variables that can have a big impact on the rice supply system.

RESULT AND DISCUSSION

The development of population, rice production, rice harvest area and oil palm area in Bulungan Regency in the last 6 years.

Table 1. Population growth, rice production, rice harvest area and paddy field area in Bulungan Regency in the last 6 years.

Year	Number of Population	Rice Production (Tons)	Rice Harvested Area (Ha)	Palm area (Ha)
2016	150.656	9.345,06	17.370,7	2.245
2017	133.546	9.104,80	10.868,2	2.257
2018	136.204	9.424,03	4.365,7	2.245
2019	139.733	7.437,22	8.942,3	2.169
2020	148.452	9.079,62	4.606,0	2.371
2021	153.558	8.075,69	8.808,3	2.317

Note: Data will be processed in 2023

Based on table 1, it can be seen that the population of Bulungan Regency in 2017, namely 133,546 people, decreased compared to 2016. From 2017 to 2021 population growth in Bulungan Regency has increased significantly. The highest increase in population was in 2020 of 148,452 people.

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

Rice production and rice harvest area are factors that influence the availability of rice. With the fulfillment of the amount rice production, the availability of rice will also be fulfilled. it can be seen that rice production in the District Bulungan in the last six years has fluctuated. In 2019 rice production in Bulungan Regency experienced a significant decrease, namely in 2018 it was 9,424.03 tons and in 2019 it became 7,437.22 tons. 2019 was the year of the lowest rice production in Bulungan Regency in the last six years. The highest rice production in the last six years was in 2018 of 9,424.22 tonnes.

The same can be seen in the rice harvest area. The area of paddy harvested land in Bulungan Regency in 2018 has decreased significantly, namely in 2018 it was 4,365.7 hectares compared to 2017 which was 10,868.2 hectares. This happened in 2019 to 2021. One of the production factors that affect productivity is land or soil. The land is a place for planting paddy rice and upland rice. If the land or place is converted, rice productivity will also decrease, this will have an impact on rice availability. The area of oil palm land in Bulungan Regency has fluctuated over a period of six years. In 2019 the area of oil palm was 2,169 hectares, a decrease compared to 2018, which was 2,245 hectares. The highest area of oil palm land is in 2020, which is 2,371 hectares.

To analyze the availability of rice in Bulungan Regency, a simulation model is made that is in accordance with the problem model in the field as a policy direction in decision making. The development of a dynamic system model in this study is limited to matters relating to rice production systems, rice consumption and land conversion in Bulungan Regency. To facilitate the modeling of rice availability in the District Bulungan is divided into 3 sub-models (subsystems), namely rice production, rice consumption and land conversion sub-models.

To create a dynamic system for rice availability in Bulungan Regency, several assumptions are used, including: availability modeling built for Bulungan rice production only, rice productivity, fraction of field area with an average of 20 fraction/year (Data processed by the Bulungan District Agriculture Office 2016-2021) , the fraction of the harvested area of the fields with an average of 50 fraction/year (Data processed by BPS Bulungan Regency 2016-2021), the fraction of the area of paddy fields with an average of 0, the fraction of the harvested area of paddy rice with an average of 3 fraction/year (Data processed by BPS Bulungan Regency 2016-2021).

Food consumption, the average fraction of per capita consumption in 2021 is 79 kg per year or 0.079 (BPS Indonesia 2022), total population, (Data processed by Disdukcapil Bulungan Regency in 2016-2021), births, deaths. paddy field area, paddy field area increase, paddy field print fraction with an average of -1 (Data processed by the Bulungan District Agriculture Office 2016-2021), paddy field area, paddy field area reduction, paddy field area reduction rate, paddy field area increase fraction oil palm with an average of 1 fraction/year (Data processed by BPS Bulungan Regency 2016-2021), increase in oil palm area, oil palm land area, reduction in oil palm area, fraction of the rate of oil palm area reduction with an

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

average of 0 (Data processed by Bulungan Regency BPS 2016-2021). The simulation analysis period is limited to the period from 2022 to 2052.

The dynamic system model of rice availability in this study is built on the basis of a Causal Loop Diagram (CLD) relationship equipped with a feed back loop mechanism. This conceptual model is then transformed into a computer-based modeling tool, namely the Ventana System (Vensim) PLE 9.3.4x64 software or what is called Stock flow diagram. Causal Loop Diagram of rice availability in Bulungan Regency includes three subsystems, namely rice production, rice consumption and land conversion subsystems. the rice production subsystem consists of 5 variables including: rice productivity, field area, field harvest area, rice field area, rice field harvest area. Furthermore, the rice consumption subsystem consists of 5 variables including: food consumption, per capita consumption, population, births, deaths. The land conversion subsystem consists of 11 variables including: paddy field area, increase in paddy field area, print paddy field, paddy field area, reduction of paddy field area, reduction of paddy field area, rate of increase in oil palm area, increase in oil palm area, oil palm area, reduction area of oil palm, the rate of reduction of oil palm area. The causal loop diagram of rice availability in Bulungan Regency can be seen in the following figure.

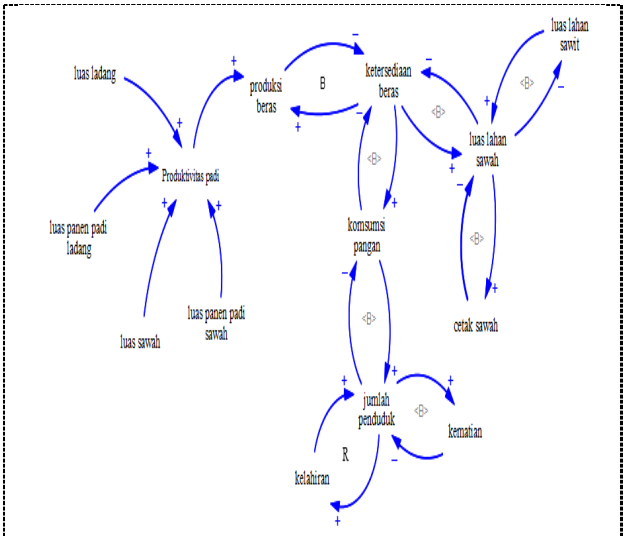

figure1. *Causal Loop Diagram of Rice Availability in Bulungan*

Based on the picture above, it shows a causal loop diagram of the availability of rice in Bulungan Regency. Where rice production is influenced positively (+) by rice productivity, besides that rice productivity will also increase with the positive influence of field area, rice harvest area, paddy field area, paddy rice harvest area which can increase rice production. Furthermore, the availability of rice is positively influenced by rice production and paddy field area and the availability of rice will decrease if food consumption increases so that it is negative (-). The area of paddy fields has a positive influence on the availability of rice but is negatively affected by the area of oil palm or is called land conversion. The population is positively influenced by birth and the population will decrease if there is death so that it is negative (-) to the population.

This model formulation connects the variables that have been identified in the conceptual model by using the symbolic language

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

of Vensim PLE 9.3.4x64. In preparing the Stock flow diagram of rice availability in Bulungan Regency, there are several sub-models, namely rice production, rice consumption and land conversion sub-models. Stock flow diagram can be seen in the following figure.

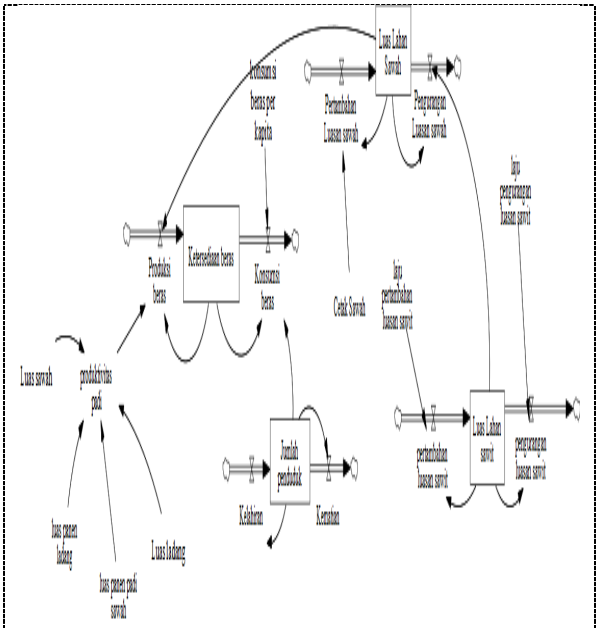

Figure 2. *Stock Flow Diagram of Rice Availability in Bulungan*

Stock flow diagram simulation of rice availability in Bulungan Regency, namely a dynamic model built based on real conditions in the field using a computer with Ventana System software as a model maker where the level/stock symbol consists of rice availability, paddy field area, population, oil palm area. The flow with rate symbol consists of rice production, food consumption, births, deaths, increase in paddy field area, reduction in paddy field area, increase in oil palm area and reduction in oil palm area. Furthermore, the auxliary symbol consists of rice productivity. Then for the constant symbol consists of paddy field area, field harvest area, paddy rice harvest area, field area, consumption per capita, paddy fields printing, rate of reduction of oil palm area and rate of increase of oil palm area.

To determine the validity level of the model, it is necessary to test the accuracy of the simulation model. The accuracy test is carried out by using a simple error test, namely the mean absolute percentage error (MAPE) between the variables of rice availability and land conversion (oil palm area) within the accuracy testing period adjusted to actual data, namely in the period 2016 to 2021. Because at the beginning of the simulation, you have to state a certain number, so in 2016 the actual data on the availability of rice and the simulation have the same value, namely 9,345 tonnes. The highest absolute percentage error value for the rice availability variable was in 2019, namely 19%. actual data on land conversion, in 2016 the actual data on land conversion and simulation have the same value, namely 2,245 Ha. The highest absolute percentage error value for the land conversion variable was in 2019, namely 7%. Model validation on the availability of rice shows that the MAPE value is 6% and for the land conversion variable, namely the area of oil palm land, has a MAPE value of 2%.

After the rice availability model has been verified and is valid, then a simulation is made to predict rice production, consumption, and availability. projections show that the increase in the number of residents in Bulungan Regency increases significantly, in 2022 is projected that the total population is 156,629 people and in 2052 the total population will reach 283,712 people. From the simulation results it is known that the increase in population in Bulungan Regency is an average

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

of 2% per year. Rice production from year to year has decreased in 2022 it is estimated that rice production in Bulungan Regency will be 7,839.96 tons and in 2052 rice production in Bulungan Regency will be 4,099.39 tons. Rice production is affected by land area, the simulation results show that the land area in Bulungan Regency decreases every year in 2022 the area of paddy fields is 36,858.9 hectares, a decrease compared to 2021, which is 3,723.1 hectares.

Projections show that the availability of rice in Bulungan Regency will decrease. The highest supply of rice is in 2021 of 8,075 tons while in 2052 the availability of rice in Bulungan Regency is projected to be 4,188.17 tons. Consumption of rice in Bulungan Regency and consumption of rice in Bulungan Regency in 2021 is 8,141.56 tons, exceeding the available rice stock. As seen in table 4, every year rice consumption in Bulungan Regency is higher than the availability of rice and rice production. The following is a graph of rice availability and rice consumption in Bulungan Regency in 2021-2052.

Policy scenario for simulating an increase in the rice field production rate in Bulungan Regency with an increase of -1% to 5% rice field production rate, namely this scenario aims to see an increase in rice production after being given a policy by increasing the rice field printing rate, so that the availability of rice can be sufficient for consumption rice in Bulungan Regency from 2021 to 2052 has increased.

Table 2. Policy results for simulating the area of paddy fields and the availability of rice in Bulungan Regency for 2021-2052.

Year	Availability of rice (tons)	Consumption of rice (tons)	Paddy Field Area (Ha)
2021	8.075	8.075,01	37.231
2022	8.075,15	8.075,16	39.092,7
2023	8.075,3	8.075,3	41.047,5
2024	8.075,43	8.075,44	43.100,1
2025	8.075,56	8.075,57	45.255,2
2026	8.075,69	8.075,69	47.518,2
2027	8.075,81	8.075,81	49.894,3
2028	8.075,92	8.075,92	52.389,2
2029	8.076,02	8.076,03	55.008,9
2030	8.076,13	8.076,13	57.759,6
2031	8.076,22	8.076,23	60.647,8
2032	8.076,31	8.076,32	63.680,4
2033	8.076,4	8.076,41	66.864,6
2034	8.076,48	8.076,49	70.208,1
2035	8.076,56	8.076,57	73.718,8
2036	8.076,64	8.076,64	77.405
2037	8.076,71	8.076,71	81.275,6
2038	8.076,78	8.076,78	85.339,6
2039	8.076,84	8.076,85	89.606,9
2040	8.076,9	8.076,91	94.087,6
2041	8.076,96	8.076,97	98.792,3
2042	8.077,02	8.077,02	103.732
2043	8.077,07	8.077,07	108.919
2044	8.077,12	8.077,12	114.366
2045	8.077,17	8.077,17	120.084
2046	8.077,21	8.077,21	126.089
2047	8.077,25	8.077,26	132.394
2048	8.077,29	8.077,3	139.014
2049	8.077,33	8.077,34	145.965
2050	8.077,37	8.077,37	153.264
2051	8.077,4	8.077,41	160.927
2052	8.077,44	8.077,44	168.974

Note: Data will be processed in 2023

Based on Table 2, the results of the policy scenario simulation of paddy field area, rice availability, rice consumption, with an increase in the paddy field printing rate of 5% show that the area of paddy fields increases so that the

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

availability of rice also increases in Bulungan Regency. However, an increase in the paddy field printing rate of 5% has not been able to meet rice consumption in 2022, 2024-2025, 2029, 2031-2035, 2039-2041, 2045 and 2050. In 2022 the availability of rice is 8075.15 tons and rice consumption is 8075 .16 tons so that the community still lacks 100 kg of rice, as will happen the following year. On the other hand, the very slow increase in the availability of rice in Bulungan Regency every year indicates that the availability of rice in Bulungan Regency cannot be sustainable.

CONCLUSION

1. From the results of the simulations carried out, the factor that influences the availability of rice is the population, where the population from 2022-2052 has increased significantly with an average increase of 2%. Rice production from 2022-2052 has decreased by an average of 2.1%
2. Development of a rice supply scenario simulation policy in Bulungan Regency that land area is an important variable in increasing rice production in Bulungan Regency based on the results of the simulation scenario of increasing the printing rate rice fields by 5% of rice production in 2022-2052 in Bulungan Regency has increased but has not been able to fully meet the needs for rice consumption in 2022, 2024-2025, 2029, 2031-2035, 2039-2041, 2045 and 2050. In 2022 the supply of rice is 8,075.15 tons and rice consumption of 8,075.16 tons so that people still lack 100 kg of rice, as will happen in the following years
3. The combined scenario of rice availability policies in Bulungan Regency with an increase in the printing rate of 5% rice fields and 10% rice productivity has been sufficient for the consumption of the people of Bulungan Regency from 2022 to 2052, but on the other hand the availability of rice in Bulungan Regency is not sustainable

ACKNOWLEDGMENTS

The author's thanks go to the Dean of the Faculty of Agriculture, University of Borneo Tarakan, Vice Dean 1, Vice Dean 2, and the Chairman and The Secretary of the Agribusiness Study Program who have helped and supported the authors during this. Futhermore, the writing team includes Deslima Simanjuntak who has contributed to the writing of this journal.

REFERENCES

[1] Gayatri NF. Analisis Faktor-Faktor yang Mempengaruhi Ketersediaan Beras di Kota Malang. Jurnal Ilmiah Mahasiswa Fakultas Ekonomi dan Bisnis Universitas Brawijaya. 2017;5(2).

[2] Fikram A, Imran S, Rauf A. Analisis

ISBN : 978-623-161-062-1
Managed By: Faculty Of Agriculture, University Of Borneo Tarakan

Ketersediaan Beras di Kabupaten Gorontalo Selang Tahun2021-2030. Agrinesia. 2021;6.

[3] Saputra Erlanda H, Karimuna L, Herdhiansyah D. Analysis Of The Availability Of Rice With A Dynamic System Approach In The Village Of Punggaluku, The District Of Laeya, The Regency Of South Konawe. Jurnal sains dan Teknologi Pangan. 2019;4(January 2019):2360–78.

[4] Forrester JW. System dynamics, systems thinking, and soft OR. System Dynamics Review. 1994;10(2–3):245–56.

[5] Wibowo AD. Dinamika Ketersediaan Beras : Sebuah Studi Kasus Di Kalimantan Selatan. Ziraa'ah Majalah Ilmiah Pertanian. 2016;41(2):242–9.