THE CARRYING CAPACITY ANALYSIS FOR FOOD AGRICULTURE: CASE STUDY IN DONGGALA REGENCY, CENTRAL SULAWESI.

1st Irwan Lakani, Agriculture Faculty, Tadulako University, lakani15@untad.ac.id

2nd Muhd Nur Sangadji, Agriculture Faculty, Tadulako University, muhdnursangadji@gmail.com

3rd Selvy Mozin, Faculty of Animal Husbandry and Fishery, Tadulako University, selvymozin68@gmail.com

4th Zulkifli, Agriculture Faculty, Tadulako University, zulkiflymachmud@gmail.com

5thHauris Pati, Agriculture Faculty, Tadulako University haurispati68@gmail.com

6th Rostiati, Agriculture Faculty, Tadulako University, rostiatirahmatuh@untad.ac.id

7th Reinal Putalan, Departement of Fish Product Processing Technology, reinalputalan@gmail.com

Corresponding Author: Muhd Nur Sangadji

ABSTRACT

This study aims to analyze the carrying capacity of agricultural food land, which will help determine rice sufficiency in Donggala Regency. That information can also be used for evaluating and planning sustainable management of agricultural food land in Donggala Regency. The research was carried out throughout the rice farming area. The method used was a descriptive quantitative approach. The analysis carried out was the capacity of agricultural land and the optimal population. The result showed that the carrying capacity of rice food based on the carrying capacity of the agriculture area in 2021 was 1,8. It meant that Donggala regency could be self-sufficient in rice food, based on the low optimum population number. Among sixteen districts in the regency, five were classified as capable of self-sufficiency in food with a value of agriculture area carrying a capacity of more than 1.00. The five areas were North of Sojol District (4,50), Sojol District (3,33), Dampelas District (2,43), Balaesang District (1.28), and South of Banawa District (1,10). If the number of agricultural areas is stable, Donggala Regency will be able to be self-sufficient in rice food until 2030.

Keywords: Carrying capacity, Population, Self-sufficiency, and Sustainable agriculture.

I. INTRODUCTION

Environmental carrying capacity is the ability of the environment to support human life and other living things [1]. Determination of environmental carrying capacity is done by knowing the capacity of the natural environment and resources to support human/population activities that use space for survival [2]-[4]. The amount of capacity in a place is influenced by the conditions and characteristics of the resources in the expanse of space [5]. The capacity of the environment and resources will be a limiting factor in determining the appropriate use of space.

Supply and demand are directly correlated with carrying capacity. According to Muta'ali [6], supply is typically constrained while demand is limitless. The environmental carrying capacity of an area with an unstable nature reflects the strong interaction between the environment, natural resources, and population in development. Although technical advancements can affect carrying capacity, changes in overwhelming population pressure frequently cause those adjustments. The agricultural industry is vital and strategically important since it meets food demands and creates employment possibilities for farmers in rural areas [7]. The community's inability to meet its rice food needs is impacted by inflation and social unrest. In development planning efforts, the food-carrying capacity must be considered because it is an indicator of fulfilling people's livelihood [8].

Planning to fulfill food needs was listed in the Sustainable Development Goals in the second goal of zero hunger. This goal includes indicators concerning, among others, food insufficiency, nutrition, food insecurity, and stunting [9]-[11]. Therefore, in policies, plans, and programs, food sufficiency can be fulfilled by efforts to increase food production, which can be carried out with

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various programs from regional apparatus organization agencies in Donggala Regency. In food production efforts, the environment's carrying capacity needs to be examined so that the planning carried out can be more precise. It can achieve the target and not exceed the environment's carrying capacity.

Donggala Regency is one of the regions in Central Sulawesi Province. Administratively, this area is divided into 16 sub-districts which are geographically located at 0^o, 30" N, 2^o, 20" S and 119^o, 45"-121^o, 45" E with an area of 5,275.69 km2 [12]. This area has excellent potential to be developed, among others, in the agricultural sector, with commodities produced in the form of cocoa, coconut, robusta coffee, cloves, pepper, cashew, and cloves. For agricultural activities in this area, the main agricultural products are food crops in the form of rice, horticultural crops, and secondary crops. Food crops, of course, with rice as the prima donna in addition to corn, beans, and tubers, are the spearhead of overall economic activity [13].

This study aims to analyze the carrying capacity of agricultural food land, which will help count the sufficiency of rice in Donggala Regency. That information is also can be used for evaluating and planning sustainable management of agricultural food land in Donggala Regency

II. METHODOLOGY

In the district of Donggala, this study was carried out. The study begins in August and runs through November 2021. Quantitative descriptive research is what was done. Secondary data are the sort of data used in this study. The carrying capacity of agricultural land and the level of food self-sufficiency are examined using secondary data. Data on the population, harvest areas, and rice output in the Donggala district are the secondary data required for this study.

2.1 Population growth calculations using the geometric method to obtain population growth rates with the equation:

$$Pn = Po\ (1 + r)^n$$

2.2 The process occurs in this study's data analysis to calculate the carrying capacity of crops is based on the notions of Odum's, Christeiler's theory, Ebenezer Howard and Issard, [14], namely:

$$\sigma = X / K \qquad (1)$$

Where:

σ = Level of carrying capacity of agricultural land

X = Per capita food crop harvest area, with the following formula:

X = (Harvest Area)/(Population Amount) (2)

K = Area of land for food self-sufficiency, with the following formula:

K = (Minimum Physical Requirement) / (Food Crop Production) (3)

Or:

σ = (Harvest Area x production per hectare per year) / (Total Population x KFM) (4)

2.2. Food Self-Sufficiency Status Analysis Using an estimate of the agricultural land's carrying capacity. The classification specified is:

Class, I $\sigma > 2.47$: Areas capable of self-sufficiency in food and can provide a decent life for the population.

Class II $1 \leq \sigma \leq 2.47$: Areas that are capable of self-sufficiency in food but have not been able to provide a decent life for the population

Class III $\sigma < 1$: Regions that have not been able to be self-sufficient in food

2.3. Based on data from the calculation of agricultural land's carrying capacity, the optimum population that can be accommodated in the sub-district and district can also be calculated. The optimum population can be calculated using the formula:

$$ó = \frac{Lp/Pr}{KFM}$$

where :

ó = Optimum population
Lp = Harvest Area
Pr = production per hectare per year
KFM = Minimum Physical Requirement

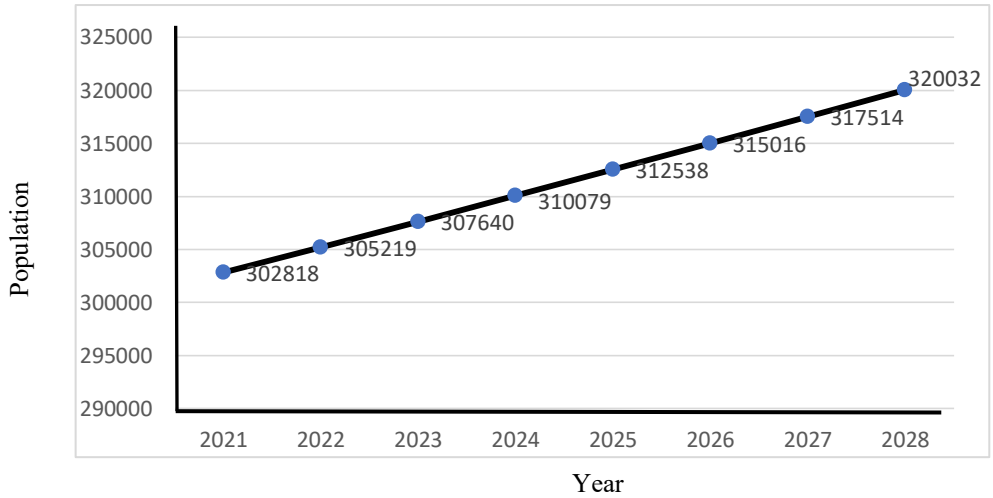
III. RESULTS AND DISCUSSION

A. Population Growth

Based on the results of the population census, it was known that the population of Donggala Regency in 2020 reached 300436 people. Along with the increasing population, the population density level has also increased. Until the end of 2020, the population density was recorded at 56,95 people / km², with an area of 5.275,69 km² in Donggala Regency. The population of Donggala

Regency in 2028, based on the projection results, is expected to amount to 320.032 people (Fig. 1)

FIGURE 1. POPULATION PROJECTION OF DONGGALA DISTRICT IN 2021-2028



B. Analysis of Agricultural Land Carrying Capacity

Analysis of the carrying capacity of agricultural land is carried out by calculating the area of rice harvest per capita and the area of land for food self-sufficiency. The rice harvest area per capita is obtained by dividing the rice harvest area by the total population. In contrast, the determination of the land area for food self-sufficiency is obtained by dividing the minimum physical consumption rate by the productivity of paddy fields for rice. The Minimum Physical Requirement (KFM) used in this calculation is 320 kg/capita/year, according to Sayogyo[15], based on calorie equivalent needs.

From the above table, it is possible to analyze the crop harvest area per capita obtained by dividing the harvested area by population and analysis of land area for food self-sufficiency obtained by dividing the minimum physical consumption (KFM) with rice productivity, to assess the carrying capacity of agricultural land and the status of food self-sufficiency in Donggala District. The results are as follows (table 1).

TABLE 1. CLASSIFICATION OF AGRICULTURAL LAND SUPPORT LEVELS IN DONGGALA DISTRICT IN 2020

Class	Carrying Capacity of Agricultural Land	Total	Sub District Location
I	$\sigma > 2.47$	2	Sojol, Sojol Utara
II	$1 \leq \sigma \leq 2.47$	3	Banawa Selatan, Balaesang, Dampelas
III	$\sigma < 1$	11	Rio Pakava, Pinembani, Banawa, Banawa Tengah, Labuan, Tanantovea, Sindue, Sindue Tobata, Sindue Tombusabora, Sirenja Balaesang Tanjung

The sub-districts of Sojol and Sojol Utara, Banawa Selatan, Balaesang, and Dampelas, are the primary rice producers because they can produce more than they need. The calculation results show that the other 11 sub-districts are at risk of food insecurity if they do not have other food alternatives or their financial ability to meet food needs is disrupted. It is necessary to print new rice fields in areas with suitable land availability to maintain food security in Donggala Regency. Rice production in Donggala Regency is dominantly produced in the North region while rice deficits occur more in the Banawa and Sindue regions. Therefore, planning efforts are made to diversify food in the rice deficit area.

TABLE 2. AGRICULTURAL LAND CARRYING CAPACITY DONGGALA REGENCY IN 2021-2027

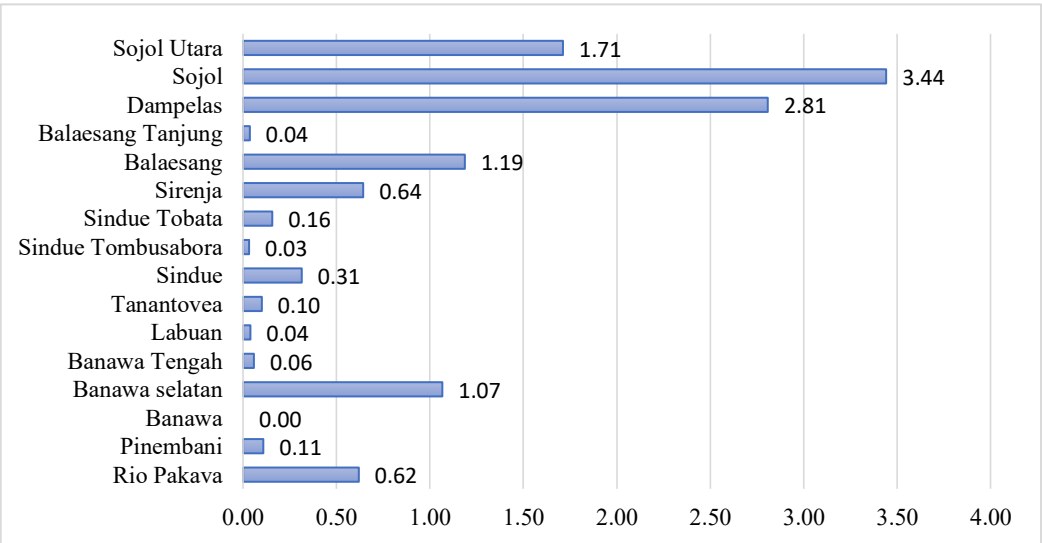
No	Sub District	Harvest Area	Crop Production	Agricultural Land Carrying Capacity year..						
				2021	2022	2023	2024	2025	2026	2027
1.	Rio Pakava	1.032	5.376,72	0.79	0.79	0.79	0.79	0.80	0.80	0.80
2.	Pinembani	180	937,80	0.46	0.46	0.46	0.45	0.45	0.45	0.44
3.	Banawa	0	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.	Banawa selatan	1.777	9.258,17	1.13	1.12	1.11	1.11	1.10	1.09	1.08
5.	Banawa Tengah	96	500,16	0.14	0.13	0.13	0.13	0.13	0.13	0.13
6.	Labuan	65	338,65	0.07	0.07	0.07	0.07	0.07	0.07	0.07
7.	Tanantovea	167	870,07	0.17	0.17	0.17	0.17	0.17	0.17	0.17
8.	Sindue	523	2.724,83	0.40	0.39	0.39	0.38	0.38	0.37	0.37
9.	Sindue Tombusabora	53	276,13	0.07	0.07	0.07	0.07	0.07	0.07	0.07
10.	Sindue Tobata	260	1.354,60	0.42	0.42	0.41	0.41	0.40	0.40	0.39
11.	Sirenja	1.071	5.579,91	0.79	0.79	0.78	0.78	0.77	0.76	0.76
12	Balaesang	1.978	10.305,38	1.27	1.26	1.25	1.24	1.23	1.21	1.20
13	Balaesang Tanjung	60	312,60	0.08	0.07	0.07	0.07	0.07	0.07	0.07
14	Dampelas	4.680	24.382,80	0.00	2.33	2.31	2.28	2.26	2.24	2.22
15	Sojol	5.736	29.884,56	3.69	3.69	3.69	3.69	3.69	3.69	3.69
16	Sojol Utara	2.853	14.864,13	5.04	5.04	5.05	5.06	5.06	5.07	5.08
17	**Donggala**	**20.531**	**106.966,51**	1.10	1.10	1.09	1.08	1.07	1.06	1.05

For the environment's carrying capacity to be maintained, it is necessary to carry out development planning by taking into account aspects of sustainability and environmental sustainability. Increase in rice production with extensification and intensification, as well as population control efforts. Then the rice surplus in Donggala Regency can only last until 2032.

C. Optimum Populatioan

Based on the formulation of the agricultural land environment's carrying capacity, the number of people the region can accommodate can be calculated. The optimum population (ȯ) value is used as an indicator of the ability to supply land for paddy crops that produce rice to the population in a region. If the number of agricultural areas is stable, Donggala Regency will be able to be self-sufficient in rice food until 2032.

FIGURE 2. THE OPTIMUM POPULATION OF DONGGALA DISTRICT



Based on Figure 2, it can be seen that only five sub-districts have an optimum population value above 1. The sub-districts with ó > 1 values are North Sojol, Sojol, Dampelas, Balaesang, and

South Banawa. A value of more than 1 indicates that the paddy land in the area can

Considering the value of the optimum population calculation results, alternative problem solving so that the value of ó > 1 is : (a) expand the paddy planting area for areas where the percentage of harvested land per planted area is small (extensification), (b) increase productivity (intensification) (c) suppress population growth [6].

IV. CONCLUSION

Among sixteen districts in the regency, five were classified as capable of self-sufficiency in food with a value of Agriculture Area Carrying Capacity of more than 1.00. The five areas were North of Sojol District (4,50), Sojol District (3,33), Dampelas District (2,43), Balaesang District (1.28), and South of Banawa District (1,10). Donggala regency can be self-sufficient in rice food based on the low optimum population number. If the number of agricultural areas is stable, Donggala Regency will be able to be self-sufficient in rice food until 2032.

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