

The Carrying Capacity Analysis of Land for Food Agriculture: Case Study in Banjar Regency, South Kalimantan

Sri Setyati¹, Fadly H Yusran², Asmu'i³, Bambang J Priatmadi²

¹Doctorate Program of Agricultural Science, Lambung Mangkurat University, Banjarbaru (70714), Indonesia

²Soil Science Study Program, Faculty of Agriculture, Lambung Mangkurat University, Lambung Mangkurat University, Banjarbaru (70714), Indonesia

³Faculty of Social and Political Sciences, Lambung Mangkurat University, Banjarmasin (70123), Indonesia

Corresponding Author: Sri Setyati

ABSTRACT

This study aimed to analyze the carrying capacity of agricultural food land which will be useful for evaluating and planning sustainable management of agricultural food land in Banjar Regency. The research was carried out throughout rice farming area. Method used was a descriptive quantitative approach to describe the relationship between variables. The analysis carried out was a carrying capacity of agricultural land and the optimal population. The result showed that among twenty districts in regency, there were seven districts belonging to Class I which was classified as capable of self-sufficiency in food and capable of providing a decent life for its inhabitants. There were eleven districts classified as Class II which was capable of food-sufficiency but had not been able to support the population and Class III, two districts as not being able to be self-sufficient in food. On the average, Banjar Regency belonged to Class II with a land carrying capacity of 1.80. There were two districts, namely Martapura and Martapura Timur, where the optimal population was smaller than the recorded population. Overall, the optimal population of Banjar Regency was still above the recorded population.

Keywords: Sustainable agriculture, land carrying capacity, agricultural land, population

INTRODUCTION

The staple food of the people in Indonesia is mostly rice, this has resulted in the demand for rice commodity to increase

in line with the population. With a population growth rate of 1.31% and a rice consumption rate of 124.89 kg capita⁻¹ year⁻¹, this has resulted in an increase in population and demand for rice [1]. Rice commodity has considerable effect on the stability of the national economy. Rice also plays a role in food security, economic resilience and national political stability. Maintaining rice availability and the stability of affordable prices is the responsibility of the government [2,3].

Several things can be done to maintain food availability are the intensification and extensification of rice farming. Intensification is carried out to increase plant productivity such as good soil cultivation, regular irrigation, superior seeds, appropriate and balanced fertilization, integrated pest and disease control, efficient post-harvest handling and marketing [4]. Extensification is the expansion of agricultural land, with the establishment of new lands for food crops. Extensification is required to meet food needs because of the decline in agricultural production. Providing agricultural land becomes a challenge when faced with other economic interests such as urban development, industry, and housing. However, land which is a non-renewable resource, will influence management strategies in various sectors including food production, energy, forestry and climate change mitigation [5].

The problem of the sustainability of agricultural land for food crops at this time is the land conversion or land use change. This does not only occur in Indonesia but also becomes a world problem [6]. Land that was previously productive for food has changed its function to other activities such as housing, industrial areas such as warehousing, trading areas, public facilities and other economic development. The conversion in Indonesia has been going on for a long time. This has resulted in the narrowing of agricultural land, especially rice fields. The conversion in Indonesia is estimated at 100,000 ha year⁻¹ [7].

South Kalimantan is a rice buffer area nationally, because its production is quite large. Nationally, rice production in South Kalimantan reaches 2,140,276 tons, this number makes South Kalimantan the 12th out of 34 provinces in Indonesia, while Banjar Regency is the 3rd highest rice production contributor in South Kalimantan. Banjar Regency has agricultural land consisting of 15,090 ha of rain-fed rice fields 35,135 ha of tidal swamps and 11,868 ha of lowland swamps. The agricultural land of Banjar Regency is also characterized by local varieties of rice, which is a popular rice producer in South Kalimantan. Therefore, maintaining productive agricultural land is a necessity for local governments to maintain food security. Local governments make policies to protect food-agricultural land, namely Regional Regulation No.9/2012 regarding the protection of Sustainable Food Agricultural Land (SFAL).

Land protection policy needs attention in the implementation, one of which is the determination of land to be protected or has met the carrying capacity. The carrying capacity of agricultural land is the ability of the land to support the food needs of the people in an area [8,9]. Determination of carrying capacity can be used as a basis for policies or evaluating existing land designation. Several studies have been carried out on the carrying capacity of agricultural land in various

regions [10,11,12]. However, a study on the calculation of the carrying capacity of agricultural land in Banjar Regency has not been carried out. According to [13], carrying capacity for agricultural land is not a constant value but can change due to technology and culture of an area. Based on this, this study aimed to analyze the carrying capacity of agricultural food land which will be useful for evaluating and planning sustainable management of agricultural food land in Banjar Regency.

MATERIALS & METHODS

The research was conducted in Banjar Regency, South Kalimantan Province, Indonesia. This research applied a quantitative descriptive approach. The land for food crops in this study was rice farming as most of the land for food crops in the area is for rice. Secondary data was obtained from the Central Bureau of Statistics and related agencies/institutions. The data analyzed in this study were population, rice harvested area, rice production, and other supporting data for sustainability of agriculture land.

Carrying capacity was determined with analytical approach to describe the ability of land in a land unit to support human needs for food [13,14]:

$$\sigma = \frac{X}{K}$$

where: σ = level of carrying capacity of agricultural land

X = The area of harvest of food crops per capita

K = area of land for food self-sufficiency

With:

$$X = \frac{\text{harvest area (ha)}}{\text{Population (person)}}$$

$$K = \frac{\text{Minimum Physical Need (MPN)}}{\text{Productivity of food crops/ha/person}}$$

The minimum physical need for the population is 1600 calories person⁻¹ day⁻¹ or

equivalent to 265 kg rice person⁻¹ year⁻¹. Meanwhile, an area abled to provide a decent life for people who depend on food plants was an area that can meet the needs of the population at a decent level, which

was equivalent to 650 kg rice person⁻¹ year⁻¹ or 2466 times the MPN. Based on these values, the carrying capacity of the land was classified in (Table 1).

Table 1. Classification of Land Carrying Capacity

Class	σ value	Classification
I	$\sigma > 2.47$	An area capable of self-sufficiency in food and capable of providing a decent life for its inhabitants.
II	$1 \leq \sigma \leq 2.7$	An area capable of self-sufficiency in food but not yet able to provide a decent life for its inhabitants
III	$\sigma < 1$	Areas that are not yet able to be self-sufficient in food

The next analysis was the optimal population (OP) which can be supported by the results of food crops from agricultural land in the SFAL area.

$$OP = \sigma \times \text{Population}$$

RESULT

Banjar Regency is one of the regencies in South Kalimantan Province with an area of 4,668.50 km². Geographically, Banjar Regency is located between 2°49'55 "to 3°43'38" south latitude and 114°30'20 "to 115°35'37" east longitude. Banjar Regency is at an altitude between 0-1,878 m above sea level. The number of sub-districts in Banjar Regency is 20 districts, previously 19 districts, with an

area of 4,668.50 km². The population of Banjar Regency based on projections in 2018 is 580,026 people with an average population growth rate of 1.63% (Figure 1).

Most of the agricultural land in Banjar Regency mainly the non-irrigation system (90.77%). The rice farming system was one-time cropping system, which was 53,245 ha of rice fields. The district with the largest area of rice harvesting was Sungai Tabuk with 9,380 ha of rice fields and the second largest was the District of Gambut with 8,240 ha [15]. Based on Figure 1, the area of rice harvested in general has been decreased each year, for six years there has been a decline of 3,813 ha.

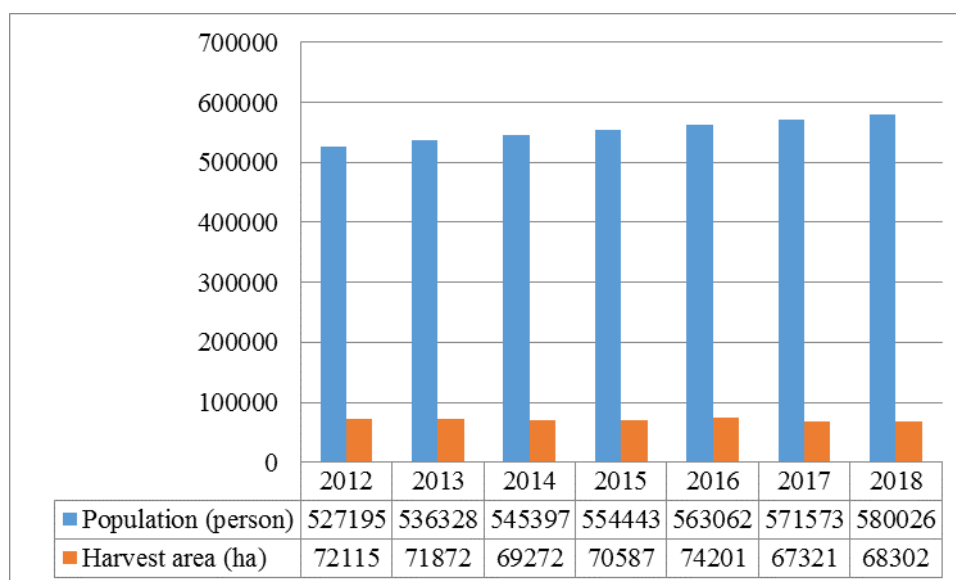


Figure 1. Graph of population and area of rice harvest

The results carrying capacity of paddy agricultural land from 2012-2018 showed that Banjar Regency produced a value of 1.80 which was included in class II

(Table 2). Class II was classified in areas capable of self-sufficiency in food but not yet able to provide feasibility for life for its residents (Table 3). Based on the results of

the analysis of twenty districts in Banjar Regency, there were seven districts belonged to Class I which was capable of self-sufficiency in food and able to provide a decent life for its residents. The seven districts were Aluh-Aluh, Beruntung Baru, Gambut, Tatak Makmur, Martapura Barat, Sungai Pinang, and Telaga Bauntung.

There were eleven districts classified as Class II, namely Kertak Hanyar, Sungai Tabuk, Astambul, Karang Intan, Sungai Pinang, Paramasan, Pengaron, Kontak Makmur, Mataraman, Simpang Empat, and Cintapuri Darusalam. Class III category consisted of two districts, namely Martapura and Martapura Timur, where the two districts are areas that were not yet self-sufficient.

Table 2. The carrying capacity of paddy farming land

No.	District	Average (2012-2018)		
		X	K	σ
1	Aluh-Aluh	0.2432	0.0676	3.60
2	Beruntung Baru	0.4247	0.0696	6.10
3	Gambut	0.2272	0.0669	3.39
4	Kertak Hanyar	0.0714	0.0684	1.05
5	Tatak Makmur	0.2061	0.0708	2.91
6	Sungai Tabuk	0.1444	0.0718	2.01
7	Martapura	0.0074	0.0711	0.10
8	Martapura Timur	0.0403	0.0660	0.61
9	Martapura Barat	0.3022	0.0646	4.68
10	Astambul	0.1311	0.0696	1.88
11	Karang Intan	0.0882	0.0718	1.23
12	Aranio	0.1552	0.0887	1.75
13	Sungai Pinang	0.2549	0.0836	3.05
14	Paramasan	0.2300	0.0872	2.64
15	Pengaron	0.1302	0.0821	1.59
16	Sumber Makmur	0.1048	0.0782	1.34
17	Mataraman	0.1006	0.0698	1.44
18	Simpang Empat	0.1432	0.0737	1.94
19	Telaga Bauntung	0.2500	0.0817	3.06
20	Cintapuri Darusalam	0.1715	0.0752	2.28
21	Banjar Regency	0.1275	0.0707	1.80

Table 3. Classification of land carrying capacity

No.	Class	Classification	Region (District)
1	I	An area capable of self-sufficiency in food and capable of providing a decent life for its inhabitants.	Aluh-Aluh; Beruntung Baru; Gambut; Tatak Makmur; Martapura; Sungai Pinang; Telaga Bauntung.
2	II	An area capable of self-sufficiency in food but not yet able to provide a decent life for its inhabitants	Kertak Hanyar; Sungai Tabuk; Astambul; Karang Intan; Sungai Pinang; Paramasan; Pengaron; Sumber Makmur; Mataraman; Simpang Empat; Cintapuri Darusalam.
3	III	Areas that are not yet able to be self-sufficient in food	Martapura; Martapura Timur

Based on the carrying capacity value, the optimal population can be calculated. The optimal population in Banjar Regency was 1,050,582 people or 181%

more of the recorded population. Districts that were at level III had optimum population below the total population recorded in 2018.

Table 4. The optimal population in Banjar Regency

No.	District	Total population (Person)	Carrying capacity Land	Total population optimal (Person)
1	Aluh-Aluh	30815	3.60	111401
2	Beruntung Baru	14742	6.10	90830
3	Gambut	41398	3.39	141508
4	Kertak Hanyar	45242	1.05	47497
5	Tatak Makmur	12638	2.91	36990
6	Sungai Tabuk	63863	2.01	129535
7	Martapura	117898	0.10	12359
8	Martapura Timur	32516	0.61	20202
9	Martapura Barat	18764	4.68	90351
10	Astambul	36720	1.88	70517
11	Karang Intan	34849	1.23	42585
12	Aranio	9578	1.75	16773
13	Sungai Pinang	1990	3.05	52167
14	Paramasan	5438	2.64	14805
15	Pengaron	17871	1.59	28451
16	Sumber Makmur	13315	1.34	17886
17	Mataraman	26282	1.44	38002
18	Simpang Empat	26819	1.94	52384
19	Telaga Bauntung	3538	3.06	10886
20	Cintapuri Darusalam	10750	2.28	24532
21	Banjar Regency	580026	1.80	1050582

DISCUSSION

The factors that influence the assessment of land carrying capacity are population, agricultural land area and crop productivity. If the population continues to increase while the area of agricultural land and plant productivity is not increased, it will reduce the carrying capacity of the land. In certain areas, expansion of agricultural land is not possible due to the need for land for the development of other non-agricultural sectors such as housing, industry, infrastructure, offices and so on [8].

Based on the results of the assessment, it was found that the average carrying capacity of food farming land shows that Banjar Regency is an area that is capable of food self-sufficiency but has not been able to provide the feasibility of life for its people. Districts that were classified as class I with a carrying capacity value above 2.7 were found in seven out of twenty sub-districts. The districts were Aluh-Aluh, Beruntung Baru, Gambut, Tatah Makmur, Martapura Barat, Sungai Pinang, and Telaga Bauntung. Currently, the regional government had designated six districts whose food-agricultural land was made into protected areas as sustainable food agriculture in Banjar Regency. These districts are Aluh-Aluh, Sungai Tabuk, Kertak Hanyar, Gambut, Tatah Makmur, and Beruntung Baru.

Of the six sub-districts that are the SFAL area, there are four districts that are in Class I and 2 districts in Class II. Of the six districts that have the lowest score was Kertak Hanyar District. The carrying capacity value was determined by the X value and the K value. Overall, the twenty districts had a K value that was not much different between 0.066 and 0.0887 with an average of 0.070. Meanwhile, the value of X had a wide range of differences, namely between 0.0074 and 0.4247 on average 0.1275. The low value of the carrying capacity of Kertak Hanyar compared to other districts in the SFAL area was because it had a small X value (0.074) (Table 2). This X value was obtained from the

harvested area of food crops in an area divided by the number of residents in that area [14].

Kertak Hanyar was an area that closed to urban areas so that to maintain its food agricultural land as a P2B area requires good management and strengthening of government policies in protecting agricultural land [16,17]. Apart from Kertak Hanyar, an area close to urban areas was Gambut District. Gambut was included in Class I which means that it had good land carrying capacity, therefore it was recommended that agricultural land in Gambut District be maintained, in addition to meeting food needs. The agricultural area also functions as a conservation area, ecological and environmental protection and maintains agricultural culture in Banjar Regency. According to [18] Agricultural land also had a social function for environmental education and farmer regeneration.

According to [19] the need to protect agricultural lands that have a high suitability value for agricultural production. In this study, the mainland is land that has a carrying capacity in Class I. To implement this protection, it is necessary to apply the principle of sustainable development. The main thing is that government policies in implementing land protection policies must be carried out seriously so that there is no change in land functions from agriculture to non-agriculture. The determination of the SFAL area to become a protected agricultural area in the Regional Spatial Plan is a step that needs to be maintained.

Population affects the value of the carrying capacity of the land. The population has two roles in the agricultural production process, namely from the factors of production that produce agricultural products and consumption to meet basic needs, therefore the population determines food needs [20,21]. In addition, population growth also plays an important role in accelerating the conversion of agricultural land functions [22]. According to [23] suppressing the rate of population growth can overcome the food crisis. Based on the

analysis of OP calculations, Banjar Regency is still a condition of a safe population or food sufficiency can still be met. Only a few districts have OP smaller than the recorded population, namely in Martapura and Martapura Timur District. The two districts were located in urban areas as trade centers in Banjar Regency.

CONCLUSION

Based on the results of the study, it could be concluded that the carrying capacity value of agricultural food land in Banjar Regency was 1.80 which was classified as able to be food self-sufficient but had not been able to provide decent living for its residents. Of the 20 districts, there were seven districts belonging to Class I which classified as capable of self-sufficiency in food and was able to provide a decent life for its residents. The seven districts were Aluh-Aluh, Beruntung Baru, Gambut, Tatah Makmur, Martapura Barat, Sungai Pinang, and Telaga Bauntung. Class II was classified of areas capable of self-sufficiency in food but had not yet able to provide eligibility for life for its inhabitants, 11 districts, and Class III was classified of had not been able to be self-sufficient in two districts.

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