SINTA Journal – *Science, Technology and Agriculture Journal*
Available online at : ***http://journal.pdmbengkulu.org/index.php/sinta***
DOI: https://doi.org/10.37638/sinta.6.2.553–574

Analysis of the Carrying Capacity of Rice Commodity Agricultural Land Management in North Kolaka Regency

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How to Cite :
Ainuddin, A., Arzam, A.R.T.S., Yasmin. (2025). Analysis of the Carrying Capacity of Rice Commodity Agricultural Land Management in North Kolaka Regency. *Sinta Journal*, 6 (2), 553–574. DOI: https://doi.org/10.37638/sinta.6.2.553–574

ARTICLE HISTORY
Received [21 October 2025]
Revised [28 November 2025]
Accepted [05 December 2025]

KEYWORDS
land carrying capacity
land protection
food security
climate change

ABSTRAK

Pertanian merupakan sektor utama yang menopang perekonomian pedesaan di Kabupaten Kolaka Utara, dengan padi sebagai komoditas pangan pokok masyarakat. Namun, pertumbuhan penduduk, perubahan iklim, serta alih fungsi lahan sawah menjadi tantangan serius terhadap ketersediaan pangan beras lokal. Penelitian ini bertujuan untuk menganalisis ketersediaan pangan beras, kebutuhan lahan persawahan, serta status daya dukung lahan pertanian di Kabupaten Kolaka Utara, sekaligus memproyeksikan kebutuhan lima tahun mendatang. Metode penelitian menggunakan pendekatan kuantitatif deskriptif dengan data sekunder dari BPS, Bappeda, dan Dinas Tanaman Pangan dan Hortikultura, serta observasi primer untuk verifikasi lapangan. Analisis meliputi perhitungan ketersediaan pangan beras berdasarkan produktivitas lahan, kebutuhan pangan berdasarkan konsumsi per kapita, serta Indeks Daya Dukung Lahan (IDDL) dengan rumus Odum, Howard, dan Issard. Hasil penelitian menunjukkan bahwa rata-rata ketersediaan pangan beras mencapai ±7.000 ton/tahun, dengan distribusi yang timpang antar kecamatan. Beberapa wilayah seperti Ranteangin dan Batu Putih berada pada kondisi surplus, sedangkan kecamatan lain cenderung defisit atau tidak memiliki produksi signifikan. IDDL menunjukkan kecenderungan menurun akibat berkurangnya luas panen sekitar 2,1% dalam lima tahun terakhir, sementara kebutuhan pangan meningkat seiring pertumbuhan penduduk. Proyeksi lima tahun ke depan memperlihatkan

risiko defisit semakin besar jika tidak ada intervensi kebijakan. Temuan ini menegaskan perlunya strategi penguatan ketahanan pangan daerah melalui intensifikasi pertanian (peningkatan indeks tanam, benih unggul, efisiensi irigasi), perlindungan lahan sawah berkelanjutan (LP2B), serta diversifikasi pangan lokal. Hasil penelitian diharapkan menjadi rujukan bagi pemerintah daerah dalam perencanaan tata ruang, pengendalian alih fungsi lahan, dan perumusan kebijakan ketahanan pangan berkelanjutan.

ABSTRACT

Agriculture is the main sector that supports the rural economy in North Kolaka Regency, with rice as a staple food commodity for the community. However, population growth, climate change, and the conversion of rice fields are serious challenges to the availability of local rice food. This study aims to analyze the availability of rice food, the need for rice fields, and the carrying capacity status of agricultural land in North Kolaka Regency, as well as projecting the needs of the next five years. The research method uses a descriptive quantitative approach with secondary data from BPS, Bappeda, and the Food Crops and Horticulture Service, as well as primary observations for field verification. The analysis included the calculation of rice food availability based on land productivity, food needs based on per capita consumption, and the Land Carrying Capacity Index (IDDL) with the Odum, Howard, and Issard formula. The results of the study showed that the average availability of rice food reached ±7,000 tons/year, with an uneven distribution between sub-districts. Some areas such as Ranteangin and Batu Putih are in surplus conditions, while other sub-districts tend to have deficits or do not have significant production. The IDDL shows a downward trend due to a reduction in harvest area of about 2.1% in the last five years, while food needs increase as the population grows. Projections over the next five years show that the risk of deficit is even greater if there is no policy intervention. These findings confirm the need for strategies to strengthen regional food security through agricultural intensification (increasing planting index, superior seeds, irrigation efficiency), sustainable rice field protection (LP2B), and diversifying local food. The results of the research are expected to be a reference for local governments in spatial planning, land conversion control, and sustainable food security policy formulation.

INTRODUCTION

Agriculture is still the main focus of the economy of rural communities in Indonesia, including in North Kolaka Regency. As a major commodity, rice makes a great contribution to local and national food security (Sukmawati et al., 2025). However, increasing population, climate change, and land conversion are serious threats to the availability of productive rice fields. This condition raises concerns about the ability of existing agricultural land to meet the community's rice consumption needs. Therefore, it is important to know the extent to which the currently available land carrying capacity is able to support sustainable rice production in North Kolaka.

One of the important efforts in maintaining a balance between needs and availability is to analyze the carrying capacity of rice farming land systematically and based on data. The carrying capacity of the land can be calculated through a comparison between the availability of land and the food needs of the population. If the carrying capacity is low, then the area is at risk of experiencing a food deficit and dependence on other regions (Food and Agriculture Organization, 1996).

The carrying capacity of agricultural land is not only determined by the area of physical land, but also by the level of productivity, water availability, microclimate conditions, and farming practices. In the context of North Kolaka, the potential of land resources is quite promising, but problems such as the conversion of rice fields into non-agricultural land, limited irrigation infrastructure, and low utilization of agricultural technology are serious obstacles to increasing rice production. Therefore, a carrying capacity analysis needs to be carried out to assess whether rice production is currently able to meet the consumption needs of the local community (Wang, 2022).

A recent study by (Widayati et al., 2021)) shows that the carrying capacity of agricultural land in several districts in Southeast Sulawesi is starting to experience pressure, especially due to population growth and infrastructure development policies that do not consider the sustainability of food land. In addition, according to the (Kementrian Pertanian, 2024), there is a tendency for agricultural land conversion to be quite high in Southeast Sulawesi, including North Kolaka, especially in areas near urban areas or areas with high economic value. This phenomenon can disrupt regional food security and have an impact on increasing regional dependence on food supplies from outside.

Through the analysis of land carrying capacity management, it will be known the extent of a region's ability to provide food independently. If the results of the analysis show that the carrying capacity is below the

consumption needs, then appropriate policy interventions are needed, such as agricultural intensification, rice field conservation, and food diversification. This research is expected to be a scientific and practical reference for local governments in making decisions related to the management and protection of agricultural land in North Kolaka in a sustainable manner.

RESEARCH METHODS

The research method used in this study is a quantitative research method based on the philosophy of positivism with survey research procedures. The data sources in this study are primary and secondary data. The data analysis technique used is a descriptive analysis technique in which data is processed through arithmetic calculations, and then a description or description of the results of data processing is carried out. Arithmetic calculations are used to calculate analyses related to the carrying capacity of agricultural land in North Kolaka Regency. The analysis used in this study consisted of food availability analysis; analysis of agricultural land needs and projected rice field needs; Analysis of the Carrying Capacity of Agricultural Land.

1. Food Availability Analysis

The analysis of food availability can be calculated by the variables of land productivity (kg/ha), the area of land planted with rice (ha), and the rice-to-rice conversion index. Food, in this case, is rice, as the main food of the Indonesian people. To calculate the availability of food, the formula is used, namely: (Rietbergen, 1990)

$$KT = (PL(kg/ha \times LP(ha)) \times JKPM \quad \text{.....(1)}$$

Information:

KT = Food Availability
PL = Land Productivity (Kg/ha)
LP = Harvest Area (ha)
JKPMB = Rice to Rice Conversion Index

2. Analysis of Agricultural Land Needs and Projections of Rice Field Land Needs

a. Agricultural Land Needs Analysis

The analysis of agricultural land needs can be calculated from the food needs of the population, which are converted to agricultural land. From food needs, the area of rice field agricultural land needed is sought. This can be calculated by

variables such as the size of the population, the standard of rice needs per person per day, and the average land production per hectare. To calculate food needs, the following formula is used:

$$\mathrm{KP} = \mathrm{JP(jiwa)} \times \mathrm{SKP(Beras)} \quad \text{.....(2)}$$

Information:

KP = Kebutuhan Pangan
JP = Jumlah Penduduk (Jiwa)
SKP = Standar Kebutuhan Pangan (Beras)

$$\sum \mathrm{KP} = \frac{\mathrm{KP(Jumlah\ Penduduk \times KFM)}}{\mathrm{PLR/ha \times KPB(0.63)}} \quad \text{.....(3)}$$

Keterangan:

∑KP = Total Food Requirement
KP = Food Needs
KFM = Minimum Physical Requirements
PLR = Average Land Production
KPB = Conversion of Rice to Rice (0,063)

b. Analysis of Rice Field Land Projections

Agricultural land carrying capacity projection is an analysis to estimate the extent to which agricultural land can support the needs of the human population in a certain period, considering aspects of land productivity, population growth, and potential land use changes. To calculate the basis of land carrying capacity projections, a formula according to is used, as follows:

$$\mathrm{KRPL} = \frac{\mathrm{(KBP \times PO)(1+rN)}}{\mathrm{Pr \times 0.632}} \quad \text{.....(4)}$$

Information:

KLPR = Agricultural land needs
KPB = Per capita rice food requirement is 154.1 kg/capita/year (According to the Food Security Agency)
Po = Population at the beginning of the base year
r = Early year population growth (%)
Pr = Average land production per hectare (kg/ha)
N = Projected year

0,632 = Konstanta perubahan padi menjadi beras (badan ketahanan pangan).

3. Agricultural Land Carrying Capacity Analysis

The analysis of the carrying capacity of agricultural land using the concept of the carrying capacity of agricultural land uses the formula according to Lutfi Muta'ali (2015) as follows:

$$\tau = (\mathrm{Lp}/\mathrm{Pd})/(\mathrm{KFM}/\mathrm{Pr}) \quad \text{.....(5)}$$

Information:

T = Carrying Capacity of Agricultural Land
Lp = Harvest area (for food crops)
Pd = Population
KFM = Minimum Physical Requirements
Pr = Average Land Production/Hectare

RESULTS AND DISCUSSION

Availability of Rice Food

When an area has a safe and nutritious amount of food for everyone in a certain period, it is called food availability (Kristiawan, 2021; Majuanna, 2024). Local harvest area multiplied by average land production per hectare, or self-production, can increase food availability. This can be calculated by multiplying the local harvest area by the average land production per hectare (Muta'ali, 2015).

In this analysis, rice must be converted into rice. This is given that rice is a food that people consume, and that rice has undergone a significant decline in its form into rice. An analysis conducted by the Central Statistics Agency of Indonesia (Badan Pusat Statistik, 2015) shows that in 2018 the conversion rate from Harvested Dry Rice (GKP) to Ground Dry Rice (GKG) was 83.38%, which shows that dry grain obtained with a condition of ready to grind from dry grain when harvested was 83.38%, and the conversion rate from Dry Ground Rice to rice was 64.02%. The following are the results of the analysis of the availability of rice food in North Kolaka Regency described in Table 1.

Table 1. Food Availability in North Kolaka Regency in 2022-2024

No	District	Food Availability in North Kolaka Regency (Tons)			
		2022 (Ton/GKP)	2023 (Ton/GKP)	2024 (Ton/GKP)	%
1	Totala	0.00	0.00	0.00	0
2	Porehu	0.00	42.05	93.64	1,30
3	Batu Putih	1743.82	1837.56	2018.07	27,53
4	Pakue Utara	891.83	455.61	554.82	7,57
5	Pakue Tengah	769.50	1056.75	1343.01	18,32
6	Pakue	0.00	0.00	0.00	0,00
7	Watunohu	0.00	0.00	0.00	0,00
8	Ngapa	8.04	31.82	36.30	0,49
9	Tiwu	0.00	0.00	0.00	0,00
10	Kodeoha	274.62	199.67	288.93	3,94
11	Katoi	0.00	0.00	0.00	0,00
12	Lasusua	102.01	66.53	104.30	1,40
13	Lambai	0.00	0.00	0.00	0,00
14	Ranteangin	1456.75	2272.86	2012.36	27,46
15	Wawo	901.80	1111.40	1105.70	15,00
	Sum	**6148**	**7074**	**7329**	**100,00**

Source: Primary Data After Processing, 2025

Based on the data presented in Table 1, the availability of rice food in North Kolaka Regency in the last three years has increased every year. Food availability is above the average of 7000 tons/year. The highest food availability is in Rante Angin District in 2023, with 2018.07 tons of harvested dry grain or 27.53%. The lowest availability is in Ngapa District at 36.30 tons of GKP or 0.49% while the sub-districts that do not have food availability are Tolala, Pakue, Watunohu, and Katoi Districts. The availability of rice food in North Kolaka Regency in the last three years has averaged around 6,850.33 tons/year.

Source: analysis data, 2025

Figure 1. Rice Food Availability Chart in North Kolaka Regency in 2022-2024

The graph of rice food availability presented in Figure 1 shows that in North Kolaka Regency, in the last three years, there has been a linear increase. From 2022 to 2024, there will be a significant increase in food availability. One of the factors that causes the increase in land area due to the transfer of commodities, namely from plantation land to rice fields. In addition, the existence of residential land is sourced from plantation land, which has been converted into residential land due to the increase in population. In 2022 and 2023, there will be an increase in food availability in North Kolaka Regency 2022 to 2024. However, the availability figure is not as high as in 2022. So, it can be concluded that there are differences in the trend of food availability in North Kolaka Regency in the last three years, namely in 2022, 2023, and 2024. To find out the availability of food, especially rice, is presented in Table 2.

Table 2. Food Availability in North Kolaka Regency in 2024

No.	District	Harvest Area (ha)	Land Production (kg/ha)	Food Availability (Harvest Area (ha) X Land Production (kg/ha)	GKP to GKG conversion 83.38% (Kg)	GKG to Rice Conversion 64.02% (Kg)
1	Totala	0	0000	0	0	0
2	Porehu	20	4682	93.640	78.077.03	49.984.92
3	Batu Putih	394	5122	2.018.068	1.682.665.10	1.077.242.20
4	Pakue Utara	105	5284	554.820	462.608.92	296.162.23
5	Pakue Tengah	267	5030	1.343.010	1119801.738	716.897.07
6	Pakue	0	0000	0	0	0
7	Watunohu	0	0000	0	0	0
8	Ngapa	8	4538	36.304	30.270.28	19.379.03
9	Tiwu	0	0000	0	0	0
10	Kodeoha	57	5069	288.933	240.912.34	154.232.08
11	Katoi	0	0000	0	0	0
12	Lasusua	20	5215	104.300	86.965.34	55.675.22
13	Lambai	0	0000	0	0	0
14	Ranteangin	362	5559	2.012.358	1.677.904.10	1.074.194.21
15	Wawo	201	5501	1.105.701	921..933.50	590.221.83
	Sum	1434	5.111	7.557.134	6.301.138.33	4.033.988.76
	Average					

Source: Analysis Results, 2025

Based on the results of the analysis shown in Table 2, it can be concluded that the availability of food in North Kolaka Regency is food availability in 2024 will reach 4,033,988.76 kg of rice.

Food and Rice Farming Land Needs

The definition of food needs is food that humans need to consume per person within one year (Sadiyah et al., 2020). To find out the food needs in North Kolaka Regency, you must first know the number of residents. The population of North Kolaka Regency from 2022 to 2024 is presented in Table 3.

Table 3. Number of Population of North Kolaka Regency in 2022-2024

No	District	Total Soul Population		
		2022	2023	2024
1	Totala	3692	3940	6131
2	Porehu	6733	7006	7087
3	Batu Putih	8739	6957	7047
4	Pakue Utara	8264	28240	29224
5	Pakue Tengah	7773	7207	7345
6	Pakue	10481	11212	11470
7	Watunohu	6804	4700	4800
8	Ngapa	17341	16613	16985
9	Tiwu	4652	7025	7210
10	Kodeoha	11365	10558	10712
11	Katoi	7171	8019	8234
12	Lasusua	28418	7532	7605
13	Lambai	6589	8841	9125
14	Ranteangin	6077	6578	6708
15	Wawo	3692	3940	3921
	Kolaka Utara	141151	140488	143604

Source: BPS, 2025

Table 4. Food Needs of North Kolaka Regency in 2022-2024

		Food Needs in North Kolaka Regency (kg)		
No	**District**	**2022**	**2023**	**2024**
1	Totala	394674.8	421186	419154.9
2	Porehu	719757.7	703188.2	717085.2
3	Batu Putih	934199.1	945102.9	975462.5
4	Pakue Utara	883421.6	857231.1	880214.6
5	Pakue Tengah	830933.7	805170.8	812974.5
6	Pakue	1120418.9	1128650.2	880214.6
7	Watunohu	727347.6	750972.5	770749
8	Ngapa	1853752.9	1775929.7	1815696.5
9	Tiwu	497298.8	502430	513120
10	Kodeoha	1214918.5	1198562.8	1226143
11	Katoi	766579.9	770428.3	785180.5
12	Lasusua	3037884.2	3018856	3.124.045.6
13	Lambai	704364.1	748941.4	757600.3
14	Ranteangin	649631.3	647814	655403.9
15	Wawo	753858.8	743703.3	753324.3
Sum		15.089.041.9	15018167.2	15351267.6
Average		**15.152.825,57**		

Source: Researcher Analysis, 2025

The community's food needs are calculated based on the number of people and the minimum physical consumption per capita of the population (Muta'ali, 2015). The number of people in North Kolaka Regency in 2024 will reach 143,604 people. Meanwhile, the minimum physical consumption is based on the latest study by the Central Statistics Agency on the 2024 Staple Consumption book. Based on BPS, the per capita rice consumption per year in 2024 for the Indonesian people is 106.9 kg. To find out the food needs of the residents of North Kolaka Regency, it is described in Table 4.

Food needs in East Kolaka are presented in Table 5. North Kolaka's food needs in the last three years have continued to increase. It can be concluded that in three years, there was an increase of 15351267.6 kg/year. The average food demand in three years is around 15,152,825.57 kg/year. Furthermore, to see the level of food demand for 2024, it is outlined in the following:

Table 5. Food Needs of North Kolaka Regency in 2024

No	District	Sum Inhabitant	KFM (106,90 Kg/capita/year)	Necessity Food (kg)
1	Totala	3921	106,90	419154.9
2	Porehu	6708	106,90	717085.2
3	Batu Putih	9125	106,90	975462.5
4	Pakue Utara	8234	106,90	880214.6
5	Pakue Tengah	7605	106,90	812974.5
6	Pakue	10712	106,90	1145112.8
7	Watunohu	7210	106,90	770749
8	Ngapa	16985	106,90	1815696.5
9	Tiwu	4800	106,90	513120
10	Kodeoha	11470	106,90	1226143
11	Katoi	7345	106,90	785180.5
12	Lasusua	29224	106,90	3.124.045.6
13	Lambai	7087	106,90	757600.3
14	Ranteangin	6131	106,90	655403.9
15	Wawo	7047	106,90	753324.3
	Sum	143604		15351267.6

Source: Data processed, 2025

Rice Field Land Needs

Analysis of field land needs requires a comprehensive approach to determine the area of land needed to meet food demand, especially rice. Factors that need to be considered in this analysis are: (1) Population Data: obtaining data on the number of people and their projections for the next few years; (2) Rice Consumption Data: collecting data on rice consumption per capita; (3) Productivity Data: information about rice yield per hectare; (4) Land Data: data on the area of land available and used for rice fields; (4) Climate and Weather Data: data on rainfall, temperature, and climate patterns affecting agriculture (Mulyani et al., 2016).

Analysis of rice field land needs requires a multi-disciplinary approach that includes demographic, agronomic, ecological, and technological aspects. The goal is to ensure food security through effective and sustainable land planning and management. To find out the needs of rice fields in North Kolaka Regency, Table 6 is summarized as follows:

Table 6. Rice Field Land Needs in North Kolaka Regency in 2025

No	District	Food Needs	Average Land Production (Kg/ha)	Rice to Rice Conversion	Rice Field Land Needs (Ha)	Rice Field Area of North Kolaka Regency (2024)
1	Totala	419154.9	0	0.64	128.14	0
2	Porehu	717085.2	5111	0.64	219.22	< 133.87
3	Batu Putih	975462.5	5111	0.64	298.21	< 283.71
4	Pakue Utara	880214.6	5111	0,64	269.09	< 168.24
5	Pakue Tengah	812974.5	5111	0,64	248.54	> 308.05
6	Pakue	1.145.112.8	5111	0,64	350.08	< 56.21
7	Watunohu	770749	5111	0,64	235.63	0
8	Ngapa	1.815.696.5	5111	0,64	555.08	< 9.52
9	Tiwu	513120	0	0.64	156.87	0
10	Kodeoha	1226143	5111	0.64	374.85	< 58.41
11	Katoi	785180.5	5111	0.64	240.04	< 26.81
12	Lasusua	3.124.045.6	5111	0.64	955.06	< 41.18
13	Lambai	757600.3	5111	0.64	231.61	< 0
14	Ranteangin	655403.9	5111	0.64	200.37	>228.87
15	Wawo	753324.3	5111	0.64	230.30	< 110.97
Sum		15.351.267,6			4.693.08	

Source: Data analysis, 2025

Based on Table 6, it can be seen that from the calculation of food needs in North Kolaka Regency, the area of land needed for rice fields is obtained, the average sub-district in North Kolaka Regency does not have a rice field area that has sufficient food needs, namely a standard rice field area of 1,425.8 ha where the need for rice fields is around 4,693.08 (ha) with a total food need of 15,351,267.6 kg. There are only two sub-districts that have more than the required area of rice fields. The sub-districts are Pakue Tengah District and Rante Angin District, North Kolaka Regency.

This statement shows that of all the sub-districts observed in the study or study, only one sub-district has the availability of paddy fields that exceed the needs for agricultural activities, especially rice cultivation. This can be interpreted as the sub-district has the potential for excess rice fields, which can be a strategic opportunity in the development of the agricultural sector, such as increasing production, diversifying crops, or even conserving regional food reserves.

On the other hand, other sub-districts have less than the required area of rice fields, which can be an obstacle to achieving food production targets, local food independence, or agribusiness development. This shortage can be caused by various factors such as land conversion, limited water resources, or limited agricultural infrastructure. This condition also indicates the need for more optimal land use planning at the sub-district level, including land distribution following production needs, strengthening farmer institutions, and targeted agricultural counseling. Based on the results of the study, it is known that only one sub-district has a rice field area that exceeds the ideal needs for rice production. This shows that the distribution of rice fields in the study area is still uneven and has not fully supported the development of the agricultural sector optimally in all sub-districts.

This sub-district, which has an excess of rice fields, has the potential to become a rice production center or even a food buffer for other sub-districts that experience land shortages. This is in line with the research conducted by (Pastiniasih, 2023), which states that optimizing land use in areas that have a surplus of agricultural land can help cover the shortcomings of other regions through cooperation between regions. Meanwhile, sub-districts that experience a deficit of paddy fields need to receive more attention, both through land redistribution policies, the provision of new land (extensification), and increased productivity through agricultural intensification (the use of technology, fertilizers, superior seeds, and efficient irrigation). In terms of land needs, according to (Sukmawati et al., 2025), the importance of a spatial

approach in agricultural planning to identify priority areas for development.

In addition, massive land conversion is one of the main causes of the reduction in productive rice fields. This follows the results of research conducted by (Sudaryanto & Rusastra, 2016), which stated that the conversion of rice fields to non-agricultural land directly has an impact on reducing production capacity and regional food independence. The inequality in the availability of rice fields between sub-districts is a challenge in sustainable agricultural development. Therefore, a region-based land management policy and spatial data are needed to improve the efficiency and equitable distribution of agricultural development.

Carrying Capacity Status of Agricultural Land

The carrying capacity status of agricultural land is obtained from the calculation of the division between the harvest area and the population, then divided by the division between physical consumption and agricultural land productivity (Ayu et al., 2023; Purwantini et al., 2002; Sari et al., 2021). There are three indicators from the results of the calculation of the carrying capacity of agricultural land (Elsheikh et al., 2013). If the calculation results are less than one (1), then a region cannot carry out food self-sufficiency; on the other hand, if the calculation has more than one result, then a region is said to be able to carry out its food self-sufficiency. Meanwhile, if the calculation results show several 0, the status of the carrying capacity of agricultural land in an area is said to be in optimal condition. Table 7 presents the calculation of the carrying capacity of agricultural land in North Kolaka Regency.

Table 7. Carrying Capacity of Agricultural Land in North Kolaka Regency

No	District	Sum Inhabitant	Rice Harvest Area	KFM	Prodicivity (kg)	Value X	Value K	Supporting Capacity of Rice Fields
1	Totala	6131	0	106.9	0.00	0	0	0
2	Porehu	7087	20	106,9	4682	0.0023	0,02	0,15
3	**Batu Putih**	**7047**	**394**	**106,9**	**5122**	**0,050**	**0,02**	**2,50**
4	Pakue Utara	29224	105	106,9	5284	0.004	0,02	0,20
5	Pakue Tengah	7345	297	106,9	5030	0.0040	0,02	0,20
6	Pakue	11470	0	106,9	0.00	0	0	0
7	Watunohu	4800	0	106,9	0.00	0	0	0
8	Ngapa	16985	8	106,9	4580	0.0005	0,02	0,025
9	Tiwu	7210	0	106,9	0.00	0	0	0
10	Kodeoha	10712	57	106,9	5069	0.005	0,021	0,24
11	Katoi	8234	0	106,9	0.00	0	0	0
12	Lasusua	7605	20	106,9	5215	0.003	0,02	0,15
13	Lambai	9125	0	106,9	0.00	0	0	0
14	**Ranteangin**	**6708**	**362**	**106,9**	**5559**	**0.055**	**0,02**	**2,65**
15	Wawo	3921	201	106,9	5501	0.0051	0,02	0,255
	Sum							

Source: Data processed, 2025

According to (Rachman, 2010), areas that can be food self-sufficient are areas that can meet the minimum physical needs of the population of 1600 calories/person/day, or equivalent to 265 kg of rice/person/year or rice consumption of 106.9 kg/person/year. Areas that can provide a decent life for the population depend on food crop areas that are able to meet the needs of the population at a decent level, which is equivalent to 650 kg of rice/person/year or 2,466 times KFM. Based on this value, the carrying capacity of agricultural land is divided into 3 classifications, namely: a) Class I if the value of $\sigma>2.47$: the carrying capacity of agricultural land is high, meaning that the area can be food self-sufficient and provide a decent life for its residents, b) Class II if the value is $1\leq\sigma\leq2.47$: the carrying capacity of agricultural land is optimal, meaning that the area can be food self-sufficient, but has not been able to provide a decent life for its residents. The carrying capacity of rice fields in North Kolaka Regency is presented in Table 8.

Table 8. Status of Agricultural Land Carrying Capacity of North Kolaka Regency in 2024

No.	District	Carrying capacity Rice Fields	Information
1	Totala	0	Unable to Afford Food Self-Sufficiency
2	Porehu	0,15	Unable to Afford Food Self-Sufficiency
3	Batu Putih	2,50	Being able to afford food
4	Pakue Utara	0,20	Unable to Afford Food Self-Sufficiency
5	Pakue Tengah	0,20	Unable to Afford Food Self-Sufficiency
6	Pakue	0	Unable to Afford Food Self-Sufficiency
7	Watunohu	0	Unable to Afford Food Self-Sufficiency
8	Ngapa	0,025	Unable to Afford Food Self-Sufficiency
9	Tiwu	0	Unable to Afford Food Self-Sufficiency
10	Kodeoha	0,24	Unable to Afford Food Self-Sufficiency
11	Katoi	0	Unable to Afford Food Self-Sufficiency
12	Lasusua	0,15	Unable to Afford Food Self-Sufficiency
13	Lambai	0	Unable to Afford Food Self-Sufficiency
14	Ranteangin	2,65	Being able to afford food
15	Wawo	0,255	Unable to Afford Food Self-Sufficiency
	Jumlah	5,991	
	Kolaka Utara	0,40	Unable to Afford Food Self-Sufficiency

Source: Data analysis, 2025

The decline in the carrying capacity of agricultural land in 13 sub-districts in North Kolaka Regency is an important indicator of the imbalance between food availability and demand. This indicates that food production from the agricultural sector is no longer able to keep up with the increase in population and the increasing need for food consumption every year. In this context, the carrying capacity of agricultural land is an important measure that reflects the ability of a region to meet the community's food needs sustainably from local production.

Several studies support the findings of this study. According to (Chaireni et al., 2020) in their research, it is stated that land carrying capacity is closely related to productivity factors, land area, and land use changes. When the conversion of agricultural land to non-agricultural uses continues to increase, the ability of land to provide food will decrease. This is in line with what was shown by the (Badan Pusat Statistik, 2023), which reported that in various regions of Indonesia, there was a decrease in the food availability index due to a decrease in the productivity of rice fields and a decrease in the potential land that could be cultivated. In North Kolaka Regency, this phenomenon can be attributed to climate change, land degradation, agricultural land

conversion, and weak agricultural institutional systems that cause low production efficiency.

(Kementrian Pertanian, 2024)stated that the concept of food land carrying capacity is the basis for sustainable regional planning. If the carrying capacity decreases significantly, it is necessary to evaluate spatial planning policies, agricultural systems, and strengthen the capacity of farmers to be able to optimize the available land. Therefore, the decline in the status of land carrying capacity in 13 sub-districts in North Kolaka Regency must be a serious concern in regional development planning, especially in terms of food supply and strengthening regional food security sustainably.

Bearing Capacity Status of Rice

There is a significant difference in the carrying capacity of rice in each sub-district in North Kolaka Regency. Overall, the carrying value of rice in North Kolaka Regency will decrease in 2024 as presented in Table 9.

Table 9. Rice Carrying Capacity of North Kolaka Regency in 2024

No	District	Food Availability (GKG to Rice Conversion 64,02%)	Food Needs	Availability-Needs	Information
1	Totala	0	419154.9	419154.9	Defisit
2	Porehu	49.984.92	717085.2	667.100,28	Defisit
3	**Batu Putih**	**1.077.242.20**	**975462.5**	**101.779,7**	**Surplus**
4	Pakue Utara	296.162.23	880214.6	584.052,37	Defisit
5	Pakue Tengah	716.897.07	812974.5	967. 076,93	Defisit
6	Pakue	0	1145112.8	1145112.8	Defisit
7	Watunohu	0	770749	770749	Defisit
8	Ngapa	19.379.03	1815696.5	-1.796.317,47	Defisit
9	Tiwu	0	513120	-513.120	Defisit
10	Kodeoha	154.232.08	1226143	-1.071.911	Defisit
11	Katoi	0	785180.5	785.180.5	Defisit
12	Lasusua	55.675.22	3.124.045.6	-3.068.370,38	Defisit
13	Lambai	0	757600.3	-757.600.3	Defisit
14	**Ranteangin**	**1.074.194.21**	**655403.9**	**418.790,31**	**Surplus**
15	Wawo	590. 221.83	753 324.3	-163.102,47	Defisit
	Sum	4.033.988.76	15.351.267.6	-11.317.278,84	Defisit

Source: Data analysis, 2025

If viewed based on the comparison between the availability and needs of food in North Kolaka Regency, it is found that several sub-districts have a deficit status or are unable to provide food self-sufficiency for the sub-district itself. This comparison is called the carrying capacity of rice. The conversion of crops from harvested rice to ready-to-cook rice causes severe shrinkage. Based on the existing rice carrying capacity, overall, North Kolaka Regency has a deficit rice carrying capacity status or is unable to carry out its food self-sufficiency. However, if you look at each sub-district in North Kolaka Regency, there are two sub-districts that have surplus rice carrying capacity, namely Batu Putih District and Rante Angin District.

According to (FAO, 2009), there are four main pillars of food security: (1) Food availability; (2) Access to food; (3) Optimal use of food; (4) Stability of food supply. The deficit that occurs shows the weakness of the first and fourth pillars, namely availability and stability, where local food production is insufficient and distribution between regions is not optimal. As a result, there is a dependence on food from outside the region, which can trigger vulnerability to price fluctuations, natural disasters, and distribution disruptions.

Districts experiencing food deficits in North Kolaka need to be encouraged to: diversify local food commodities (not depend on one type of food such as rice alone), increase productivity through modern technology and production facilities, strengthen food distribution between sub-districts, management of abandoned land, and empower farmers and local institutions to create a sustainable and resilient food system. Furthermore, synergy is needed between local governments, agricultural extension workers, farmer groups, and the private sector in designing food policies based on regional data. This approach is in line with the concept of participatory agricultural development, where the planning and implementation of programs are tailored to local needs and potential.

Projected Rice Field Land Needs for the Next Five Years in North Kolaka Regency

Proyeksi kebutuhan lahan persawahan merupakan pendekatan kuantitatif untuk memperkirakan berapa luas lahan yang dibutuhkan untuk memenuhi kebutuhan konsumsi beras penduduk di masa depan. Konsep ini berkaitan erat dengan aspek ketahanan pangan, di mana kecukupan produksi pangan pokok seperti beras harus disesuaikan dengan pertumbuhan penduduk dan konsumsi per kapita.

According to the (Badan Ketahanan Pangan, 2018), the provision of sufficient agricultural land is one of the important components in realizing food security. Land is the main natural resource in rice production, so any decline or conversion of rice fields can have an impact on decreasing the availability of rice nationally and locally. There are several main factors in determining the projected need for rice fields, namely: Number of population (P): The larger the population, the greater the need for rice consumption. Rice consumption per capita (K): Varies between regions (influenced by eating culture, economic level, and food preferences). Land productivity (Y): The ability of rice fields to produce rice in tons/ha/year, influenced by technological inputs, rice varieties, and the yearly planting season. The projected demand for rice fields for the next five years in North Kolaka Regency can be calculated using the following formula:

$$\sum \mathrm{KLP} = \frac{\mathrm{P} \times \mathrm{K}}{\mathrm{Y}} \quad \text{.....(5)}$$

Information:

∑KLP = Rice Field Land Needs for Five Years
P = Projected population in year X (souls)
K = Per capita rice consumption per year (kg/person/year)
Y = Rice Field Productivity (Tons/Ha/Year)

The research using the land needs formula for the next five years results in the following that the population of North Kolaka Regency for the next five years (2030) = 165,000 people (BPS, 2024). Per capita rice consumption according to (Badan Pusat Statistik, 2015) = 98kg/person/year. Rice field productivity = 10,222 tons/ha/year. So, after calculating based on the land needs formula, the projected rice field land needs for the next five years are 1,581,882 hectares.

Based on the calculation of land potential, production, and population gives an idea that the adequacy of food availability in North Kolaka Regency is still not met locally. There are only two sub-districts that can meet their food sufficiency, namely Batu Putih District and Rante Angin District. The highest food needs are in the Lasusua and Pakue Districts. Food needs are influenced by the large number of people living in the area. The higher the population, the need for settlements also increases, which results in a decrease in the carrying capacity of agricultural land.

The carrying capacity of food agricultural land (rice fields) in

North Kolaka Regency has a low carrying value of agricultural land. The influencing factors are the physical condition of land use and the distribution of the population, which follows the fact that the evenly distributed sustainable food agriculture area is in North Kolaka Regency. The carrying capacity of agricultural land in North Kolaka Regency has not been able to achieve food self-sufficiency on its own. Of the 15 sub-districts in North Kolaka Regency, two sub-districts can carry out food self-sufficiency. The sub-districts with the largest carrying capacity are Batu Putih District, with a carrying capacity value of 2.50, and Rante Angin District 2.65. Overall, North Kolaka Regency does not have the status of carrying land for rice farming or surplus rice food. This follows the reality on the ground that there are only two sub-districts that have surplus status, and there are 13 sub-districts in deficit conditions.

Acknowledgments

The authors of this study state that they did not receive any grants from any funding agency in the public, private, or not-for-profit sectors before doing this research

Conflicting interests

The authors of the research have stated that they do not have any conflicts of interest to disclose concerning the current investigation.

Contributions by the authors

Each of the writers made an equal contribution to this article, and they were the primary contributors. Every author of the final paper reads it and gives their approval.

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