International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

Agricultural Land Carrying Capacity and Its Implications for Local Food Security in Patilanggio District, Pohuwato Regency, Gorontalo Province

Fitria S. Bagu[1], Yunnita Rahim[2], Rahmiyati Modjo[3], Irma Abdulrahman[3]

[1] Head Lecturer of Agrotechnology Study Program, Faculty of Agriculture, Gorontalo State University, Gorontalo, Indonesia

[2] Lecture of Agrotechnology, Faculty of Agriculture, Gorontalo State University,Gorontalo, Indonesia

[3] Master's Student of Agrotechnology, Faculty of Agriculture, Gorontalo State University, Gorontalo, Indonesia

Corresponding Author: fitria.bagu@ung.ac.id

Abstract

Agricultural land carrying capacity is an important indicator for assessing the capacity of a region to provide space for food production, meet the needs of its population, and maintain the sustainability of land resources. Patilanggio Subdistrict, Pohuwato Regency, Gorontalo Province, has considerable agricultural potential in both food-crop and horticultural sectors. However, it also faces a range of challenges, including population growth, land-use change, increasing food demand, and environmental risks such as flooding and drought. This study aims to analyze agricultural land carrying capacity and its implications for local food security in Patilanggio Subdistrict. The study employed a descriptive quantitative method with a spatial approach. The analysis was conducted by calculating the land carrying capacity index, comparing land availability or agricultural production with population needs, and interpreting the results spatially using a Geographic Information System (GIS). The findings indicate that Patilanggio Subdistrict has relatively favorable spatial land carrying capacity due to its substantial land area and relatively low population density. Nevertheless, the sustainability of food-supporting capacity still requires strengthening through increased land productivity, protection of productive agricultural land, control of agricultural land conversion, development of agricultural infrastructure, and optimization of local commodities. This study confirms that land carrying

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

capacity is a strategic component in supporting local food security and sustainable agricultural development at the subdistrict level.

Keywords: Land carrying capacity; sustainable agriculture; local food security; Patilanggio; spatial analysis.

INTRODUCTION

Land carrying capacity is a key concept in regional planning, environmental studies, and agricultural development because it is directly related to the ability of a region to provide land resources that support human life in a sustainable manner. Yunita et al. (2021) state that land carrying capacity reflects the capacity of a region to meet the food needs of its population based on the available resource base. In the agricultural context, land carrying capacity is not limited to land availability in terms of area; it also includes land quality, productivity, land-use suitability, water access, climatic conditions, population pressure, and the sustainability of food-production systems. The greater the pressure from population growth and food demand, the greater the demand placed on land to produce sufficient, safe, and sustainable food.

In regional development planning, land carrying capacity analysis serves as an instrument for determining whether current land use remains within environmental limits or has exceeded the capacity of the region. Widodo et al. (2024) explain that land carrying capacity can provide a basis for determining sustainable regional development directions. A region with a surplus land carrying capacity has production capability or land availability that exceeds the needs of its population. Conversely, a region with a deficit land carrying capacity indicates that the population demand for food or land has exceeded the capacity of available land resources. Such a deficit may increase dependence on food supplies from outside the region, intensify pressure on productive land, and create ecological risks if land expansion is undertaken without considering land suitability and environmental carrying capacity (Wijaya et al., 2024).

Patilanggio Subdistrict is one of the subdistricts in Pohuwato Regency, Gorontalo Province, characterized by agricultural and rural landscapes. Geographically, the area occupies a strategic position, bordered by Taluditi Subdistrict to the north, Buntulia Subdistrict to the east, Tomini Bay to the south, and Randangan Subdistrict to the west. The area of Patilanggio Subdistrict is approximately 232.37 km2. This spatial structure indicates that Patilanggio has potential space for agricultural development, particularly when supported by appropriate spatial planning policies, production infrastructure, irrigation systems, market access, and land management aligned with the biophysical characteristics of the area.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

From a demographic perspective, Patilanggio Subdistrict had a population of 10,802 in the first semester of 2025. Population distribution among villages is uneven, with relatively large population concentrations in Ilo Heluma and Manawa Villages. Population growth and rising food consumption needs will have implications for increasing demand for land and agricultural production. According to Suryani and Pratama (2024), population growth that is not accompanied by improved land productivity can reduce regional carrying capacity and increase the risk of food deficits.

The main problem in the study of agricultural land carrying capacity in rural areas is the imbalance among land availability, agricultural productivity, and community food needs. On the one hand, agricultural regions may possess extensive land resources. On the other hand, land-use change, soil-quality degradation, limited water access, climate change, flooding, drought, and suboptimal cultivation technologies may reduce the capacity of land to support food production. Wijaya et al. (2024) emphasize that the conversion of agricultural land is one of the major challenges in maintaining food security in Indonesia.

Patilanggio Subdistrict also has considerable horticultural commodity potential. BPS data show that cayenne pepper was the annual vegetable crop with the largest harvested area in 2024, reaching 70 hectares, with production of 1,853 quintals. In addition, mango was recorded as the annual fruit crop with the highest production, reaching 1,851 quintals. These data indicate that agriculture in Patilanggio Subdistrict is important not only in the context of staple food, but also in supporting farm-household economies, commodity diversification, and local food availability based on horticulture. Putri and Rahman (2024) argue that agricultural commodity diversification can enhance food security while strengthening farm-household income.

Previous studies demonstrate that agricultural land carrying capacity is closely associated with regional food security. Yunita et al. (2021) found that population growth and limited productive land can place pressure on local food systems. In addition, Miswar et al. (2023) showed that GIS-based approaches are highly effective in mapping land carrying capacity and identifying priorities for agricultural land management. However, studies that specifically analyze agricultural land carrying capacity and its implications for local food security at the subdistrict scale, particularly in Patilanggio Subdistrict, remain limited.

The novelty of this study lies in integrating agricultural land carrying capacity analysis, socio-demographic data, local commodity potential, and a spatial approach to assess the implications for local food security in Patilanggio Subdistrict. This study does not merely assess the productive capacity of land; it also positions land carrying capacity as a basis for regional planning, strengthening local food systems, and promoting sustainable agricultural

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

development, as recommended by Widodo et al. (2024).

Based on the foregoing discussion, this study aims to identify the general regional conditions, land-use characteristics, and agricultural potential of Patilanggio Subdistrict; to analyze agricultural land carrying capacity based on the relationship between land availability or agricultural production and population needs; to classify areas based on their land carrying capacity status; and to formulate the implications of the analysis for local food-security policy and sustainable agricultural land management.

METHOD

Research Location and Period

The research location was determined using a purposive method (Mukhlis et al., 2019; Mukhlis et al., 2024; Asgaf et al., 2025). This research was conducted in Patilanggio Subdistrict, Pohuwato Regency, Gorontalo Province. The subdistrict consists of several villages, namely Ilo Heluma, Balayo, Manawa, Suka Makmur, Dudepo, and Dulomo. The study was carried out over three months, covering data collection, field observation, data processing, spatial analysis, interpretation of findings, and preparation of the scientific manuscript.

Research Type and Approach

This study employed a descriptive quantitative design with a spatial approach (Sugiyono, 2022; Mukhlis et al., 2022; Ogari et al., 2026). According to Miswar et al. (2023), a GIS-based spatial approach can provide a more accurate depiction of land-resource distribution and the level of regional carrying capacity. The descriptive approach was used to explain regional conditions, population characteristics, land use, and agricultural potential. The quantitative approach was used to calculate the land carrying capacity index based on land or food availability and demand.

Data Types and Sources

The data used in this study consisted of primary and secondary data (Sugiyono, 2020; Mukhlis et al., 2023; Sidayat et al., 2026). Primary data were obtained through field observations and interviews with agricultural extension officers, village officials, and farmers. Secondary data were obtained from Statistics Indonesia (BPS), the Agriculture Office, the Regional Development Planning Agency (Bappeda), the Spatial Plan (RTRW) of Pohuwato Regency, and relevant scientific publications.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

Data Collection Techniques

Data were collected through literature review, field observation, documentation, and secondary-data compilation. The literature review involved examining recent studies on land carrying capacity and food security, including those conducted by Putri and Rahman (2024), Suryani and Pratama (2024), and Widodo et al. (2024).

Data Analysis Techniques

Data analysis was conducted through descriptive analysis, land carrying capacity analysis, and spatial analysis. The calculation of land carrying capacity followed the approach used by Suryani and Pratama (2024), namely comparing land availability or food production with population needs.

RESULT AND DISCUSSION

General Conditions of Patilanggio Subdistrict

Patilanggio Subdistrict covers an area of approximately 232.37 km2 and consists of six villages. These geographical conditions provide opportunities for agricultural-sector development because of the relatively extensive land availability. Widodo et al. (2024) note that regions with adequate land availability have greater opportunities to maintain environmental carrying capacity and food security over the long term.

Compared with various rural regions in Indonesia that are experiencing rapid urbanization and land conversion, Patilanggio still exhibits relatively strong agrarian characteristics. This constitutes an important asset for maintaining the function of food production. Studies published in Land Use Policy and Sustainability over the past five years indicate that regions with relatively low pressure from non-agricultural development have greater opportunities to maintain food-production capacity than regions undergoing massive expansion of built-up areas.

The Scopus-indexed study by Zhang et al. (2022) shows that land carrying capacity is strongly influenced by the balance among land resources, population size, and the intensity of spatial use. The study demonstrates that regions with low population density tend to have greater flexibility in maintaining both ecological functions and land-production functions. This finding is relevant to Patilanggio Subdistrict, which has relatively low population density and therefore experiences less pressure on land resources than urban areas.

Furthermore, Liu et al. (2023), in their study of agricultural regions in Asia, showed that extensive land availability does not automatically guarantee high regional carrying capacity if it

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

is not accompanied by effective management. Therefore, the extensive land area of Patilanggio should be understood as a potential resource that must be optimized through sustainable land-management policies.

Land-Use Characteristics

Land use in Patilanggio Subdistrict is dominated by agricultural areas, settlements, and open spaces. Agricultural land is an important component of the regional spatial structure because it functions as a source of community livelihoods as well as a support system for local food availability. Wijaya et al. (2024) explain that the sustainability of agricultural land use is a determining factor in the capacity of a region to maintain food security.

From a sustainable-development perspective, land use is associated not only with economic aspects but also with ecological and social dimensions. Recent studies published in Land, Agriculture, and Environmental Development indicate that land-use change is one of the major factors affecting global food-production capacity. The conversion of agricultural land into settlement and infrastructure areas reduces the area of productive land and therefore weakens the capacity of regions to meet the food needs of their populations.

Chen et al. (2021) found that the loss of 1% of productive agricultural land can cause a significant reduction in food-production capacity if it is not offset by increased productivity. This finding reinforces the importance of protecting agricultural land in Patilanggio Subdistrict. Although development pressure has not yet reached the level observed in urban areas, anticipatory measures are still required to prevent uncontrolled land conversion.

From a spatial perspective, land-use patterns that are integrated with irrigation systems, road networks, and food-distribution centers can improve the efficiency of agricultural production. García et al. (2022) demonstrate that accessibility to agricultural infrastructure has a positive relationship with land productivity and farmer welfare. Therefore, land-use development in Patilanggio should consider the connectivity between production areas and service centers.

Area and Distribution of Agricultural Land

The distribution of agricultural land in Patilanggio varies among villages. Villages with large territorial areas, such as Dudepo, Ilo Heluma, and Balayo, have greater opportunities for agricultural development. Nevertheless, Suryani and Pratama (2024) emphasize that the size of an area does not necessarily indicate high land carrying capacity unless it is supported by optimal productivity and good land suitability.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

The findings of this study show that the distribution of agricultural land is an important factor in determining regional food-production capacity. Ahmed et al. (2023), in their study of tropical agricultural regions, found that evenly distributed land supported by good infrastructure access can increase production efficiency by more than 20%. Conversely, areas with extensive but fragmented land tend to face constraints in farm management and the distribution of agricultural outputs.

In the context of Patilanggio, its large land area provides opportunities for the development of integrated farming systems. Integrated farming approaches that combine food crops, horticulture, livestock, and agroforestry have been widely recommended in international research as strategies for increasing land carrying capacity. A study published in Agricultural Systems in 2024 indicates that integrated farming systems can improve land-use efficiency while strengthening household food security.

In addition, Wang et al. (2022) show that regions with good land distribution have a greater capacity to withstand climatic disturbances than regions that depend heavily on a single type of land use. This finding suggests that land-use diversification in Patilanggio can serve as an important strategy for strengthening the resilience of the agricultural system.

Potential of Major Commodities

Cayenne pepper is the main horticultural commodity in Patilanggio Subdistrict, with a harvested area of 70 hectares and production of 1,853 quintals in 2024. In addition, mango is the annual fruit commodity with the highest production. According to Putri and Rahman (2024), the development of horticultural commodities can enhance food diversification and strengthen the economic resilience of farm households.

The findings of this study show that the horticultural sector plays a strategic role in supporting local food security. In various international studies over the past five years, horticulture is no longer viewed merely as an economic commodity but also as a key component of sustainable food systems. Research by FAO and various academics published in the journal Food Security indicates that increased horticultural production contributes to improvements in the nutritional quality of communities.

Kumar et al. (2023) found that regions with diversified horticultural commodities tend to be more resilient to food-price fluctuations than regions that depend on a single major commodity. Commodity diversification also increases the stability of farmer income, thereby strengthening household capacity to access food.

In the context of Patilanggio, the presence of cayenne pepper and mango as leading

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

commodities can serve as a foundation for the development of the local agricultural economy. Nevertheless, the development of leading commodities must be accompanied by strengthened supply chains, market access, postharvest technologies, and efficient marketing systems. Recent research in the Journal of Rural Studies shows that supply-chain weaknesses are among the causes of low value added in agricultural products in rural areas.

Population and Land/Food Requirements

The population of Patilanggio Subdistrict reached 10,802 in 2025. Population growth will increase both food demand and spatial demand. Yunita et al. (2021) state that population growth that is not accompanied by an increase in food-production capacity can place pressure on land carrying capacity and regional food security.

In the theory of regional carrying capacity, the relationship between population size and food-production capacity is a key indicator of development sustainability. Studies conducted by the United Nations Environment Programme (UNEP) and various international academics show that population growth is one of the main factors increasing pressure on land resources, food systems, and regional environmental capacity.

Areas with High, Medium, and Low Carrying Capacity

The classification of land carrying capacity among villages shows variation based on area size, population size, water access, and land productivity. According to Miswar et al. (2023), spatial mapping of land carrying capacity can assist local governments in identifying priority areas for agricultural development and land-resource conservation.

The information obtained from carrying capacity analysis generally concerns the capacity of a region to support the processes of development and regional advancement by comparing the amount of land available with the existing population. The concept used to understand the critical threshold of land carrying capacity is based on the assumption that there is a limited population size that can be supported without reducing the quality of the natural environment, allowing the ecosystem to remain maintained. Bagu, (2012).

This study demonstrates that the land carrying capacity in Wanggarasi Sub -district is classified within the moderate category, indicating an imbalance between population demands particularly the high proportion of the farming population—and the limited availability of productive agricultural land and land suitable for living. Although the area remains capable of supporting agricultural activities and local livelihoods, the current condition reflects emerging socio-ecological pressures that may lead to land carrying capacity deficits if land use change and

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

population growth are not managed appropriately. These findings highlight the vulnerability of the study area to unsustainable land utilization practices in the absence of adaptive land management strategies. Bagu, et al. (2026)

The results of land carrying capacity analysis in Pohuwato Regency, particularly in Patilanggio Subdistrict, are presented in Table 1.

Table 1. Land Carrying Capacity Classification in Pohuwato Regency

LCC Classification	Farmers' Income from Non-Agricultural Activities (a)	Farming Population (f)	Cultivated Agricultural Land (b)	Land Area Required for a Decent Livelihood (z)	Subdistrict
High	0.420	0.548	0.548	0.492	Patilanggio
High	0.367	0.633	0.010	0.301	Randangan
Medium	0.268	0.732	0.107	0.301	Wanggarasi

Source: Analysis results, 2012.

The spatial analysis of land carrying capacity in Patilanggio Subdistrict, Pohuwato Regency, Gorontalo Province, is presented in Figure 1.

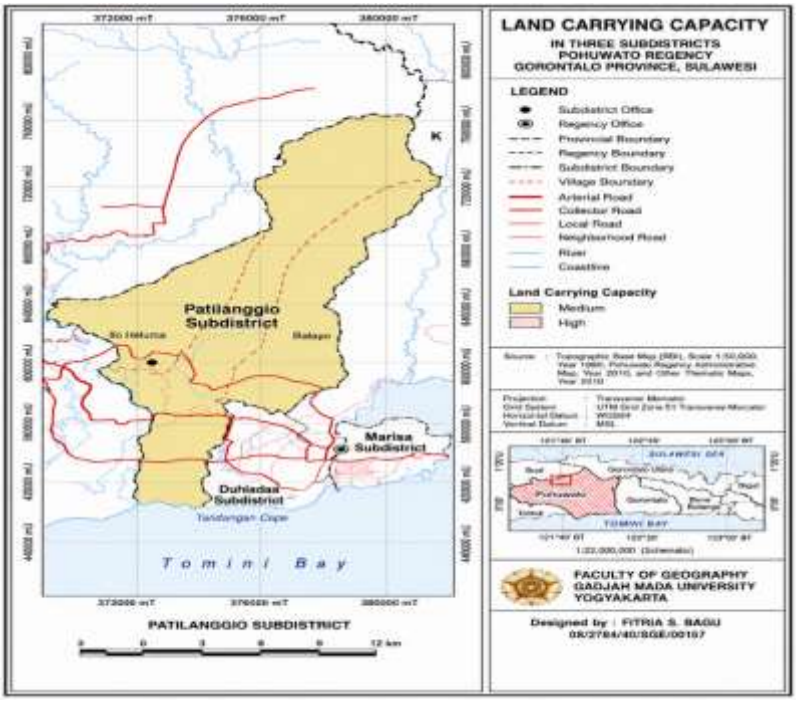


Figure 1. Map of land carrying capacity analysis in Patilanggio Subdistrict, Pohuwato Regency, Gorontalo Province.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

International Journal of Technology and Education Research

https://e-journal.citakonsultindo.or.id/index.php/IJETER

E-ISSN: 2986-0733

Factors Affecting Land Carrying Capacity

Several major factors affecting land carrying capacity in Patilanggio Subdistrict include the area of productive land, agricultural productivity, land conversion, regional biophysical conditions, water access, and population pressure. Wijaya et al. (2024) identify agricultural land conversion as one of the main factors causing a decline in food-production capacity across various regions of Indonesia. In addition, Suryani and Pratama (2024) emphasize that increasing land productivity is the most effective strategy for improving regional carrying capacity without requiring large-scale land expansion.

Implications for Regional Planning and Sustainable Agriculture

The results of the analysis indicate that land carrying capacity should serve as a basis for spatial-planning policy and agricultural development. Widodo et al. (2024) emphasize that integrating land carrying capacity into regional planning can prevent environmental degradation and maintain the sustainability of food production.

The development of local food security should also be pursued through productivity improvement, food diversification, and the strengthening of farmer institutions. Putri and Rahman (2024) state that these strategies can improve food security while strengthening the welfare of rural communities.

CONCLUSION

Patilanggio Subdistrict has considerable spatial potential for agricultural land carrying capacity because of its relatively large area and low population density. This potential is supported by leading horticultural commodities such as cayenne pepper and mango. The findings of this study are consistent with those of Widodo et al. (2024), which show that regions with adequate land availability have greater opportunities to support sustainable agricultural development.

Nevertheless, the carrying capacity status of staple-food production cannot yet be determined with certainty in the absence of complete data on major food-crop production. Therefore, further research is needed to integrate production data for rice, maize, and other food commodities, as recommended by Putri and Rahman (2024) and Suryani and Pratama (2024).

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

REFERENCES

Ahmed, M., Rahman, S. and Islam, T. (2023) 'Agricultural land distribution and infrastructure accessibility for sustainable food production in tropical regions', Agricultural Systems, 210, 103684. Available at: https://doi.org/10.1016/j.agsy.2023.103684.

Asgaf, K., Hifizah, A., Astati, Ananda, S., Jamili, M. A., & Mukhlis. (2025). Application of Fermented Feed Technology to Improve Beef Cattle Business Efficiency and Student Agribusiness Learning. Jurnal Penelitian Pendidikan IPA, 11(5), 604–610. https://doi.org/10.29303/jppipa.v11i5.11135

Badan Pusat Statistik Kabupaten Pohuwato (2025) Kecamatan Patilanggio dalam angka 2025. Pohuwato: BPS Kabupaten Pohuwato.

Bagu, F. S. Spatial Ecological Model for Optimizing Maize (Zea mays L.) Land Use in Patilanggio Subdistrict, Pohuwato Regency, Gorontalo Province. KF DOKTOR, 153.

Fitria S. Bagu, Zulzain Ilahude, & Laode Muhamad Irsan. (2026). Spatial Analysis of Land Carrying Capacity in Wanggarasi District, Pohuwato Regency. International Journal of Technology and Education Research, 4(01), 228-240. https://doi.org/10.63922/ijeter.v4i01.2875

Chen, Y., Li, X. and Zhang, H. (2021) 'Impacts of agricultural land conversion on food production and sustainability: Evidence from developing regions', Land, 10(11), 1187. Available at: https://doi.org/10.3390/land10111187.

Food and Agriculture Organization (2023) The state of food security and nutrition in the world 2023. Rome: FAO.

García, J., Martínez, P. and López, R. (2022) 'Infrastructure accessibility and agricultural productivity: A spatial analysis approach', Land Use Policy, 114, 105987. Available at: https://doi.org/10.1016/j.landusepol.2021.105987.

Kementerian Negara Lingkungan Hidup Republik Indonesia (2009) Peraturan Menteri Negara Lingkungan Hidup Republik Indonesia Nomor 17 Tahun 2009 tentang pedoman penentuan daya dukung lingkungan hidup dalam penataan ruang wilayah. Jakarta: Kementerian Negara Lingkungan Hidup Republik Indonesia.

Kumar, R., Singh, P. and Sharma, V. (2023) 'Horticultural diversification and food security resilience in rural communities', Food Security, 15(4), pp. 987-1002. Available at: https://doi.org/10.1007/s12571-023-01345-8.

Liu, Y., Wang, J. and Zhao, X. (2023) 'Agricultural land management and carrying capacity in Asian farming systems', Sustainability, 15(8), 6542. Available at: https://doi.org/10.3390/su15086542.

Miswar, D., Sugiyanta, I.G. and Fadilah, N. (2023) 'Geospatial modeling of environmental carrying

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

capacity for sustainable agriculture using GIS', International Journal of Sustainable Development and Planning, 18(1), pp. 59-67. Available at: https://doi.org/10.18280/ijsdp.180106.

Mukhlis, Hendriani, R., Sari, N., Firsta Wisra, R., Fitrianti, S., & Lutfi, U. M. (2023). Analisis Pendapatan Petani Model Usahatani Terpadu Jagung-Sapi Di Kecamatan Payakumbuh. Jurnal Penelitian Pertanian Terapan, 23(2), 254–261. https://doi.org/http://dx.doi.org/10.25181/jppt.v23i2.2953

Mukhlis, Hendriani, R., Sari, R. I. K., & Sari, N. (2022). Analisis Produksi dan Faktor Produksi Usaha Tani Terpadu Tanaman Padi dan Ternak Sapi di Nagari Taram Kecamatan Harau. Jurnal Penelitian Pertanian Terapan, 22(2), 104–110. https://doi.org/10.25181/jppt.v22i2.2581

Mukhlis, M., Ismawati, I., Sillia, N., Fitrianti, S., Ukrita, I., Wisra, R. F., Raflis, H., Hendriani, R., Hanum, L., Ibrahim, H., Nofianti, S., Marta, A., & Sari, N. (2024). Characteristics of Production Factors and Production of Zero Tillage System Rice Farming. Jurnal Penelitian Pendidikan IPA, 10(8), 6013–6019. https://doi.org/10.29303/jppipa.v10i8.8542

Mukhlis, Noer, M., Nofialdi, & Mahdi. (2019). Analysis of income and feasibility of rice-cattle integration system farming based on enterprises scale. Journal of Advanced Research in Dynamical and Control Systems, 11(7), 544–553. https://www.jardcs.org/abstract.php?id=2678

Muta'ali, L. (2019) Daya dukung dan daya tampung lingkungan hidup berbasis jasa ekosistem. Yogyakarta: Badan Penerbit Fakultas Geografi Universitas Gadjah Mada.

Ogari, P. A., Lastinawati, E., Ritonga, U. S., Oktarina, Y., Sari, R. N., & Mukhlis. (2026). Evaluating Tiered Facilitation as a Contextual Learning Approach for CPPOB Adoption in Food MSMEs. Jurnal Penelitian Pendidikan IPA, 12(1), 593–599. https://doi.org/10.29303/jppipa.v12i1.13882

Putri, A.R. and Rahman, T. (2024) 'Analisis daya dukung lahan pertanian terhadap ketahanan pangan wilayah', Jurnal Penataan Ruang, 19(1), pp. 1-12.

Sidayat, M., Syafi, S., Dewi, E. K., & Mukhlis. (2026). Factors Influencing Shift of Livelihoods from the Agricultural to Non-Agricultural Sector in the Nickel Mining Area of Central Halmahera Regency. Jurnal Penelitian Pendidikan IPA, 12(4), 936–941. https://doi.org/10.29303/jppipa.v12i4.14832

Sugiyono. (2020). Metode Penelitian Kuantitatif, Kualitatif dan Kombinasi (mixed methods). ALFABETA.

Sugiyono. (2022). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Alfabeta.

Suryani, E. and Pratama, R.A. (2024) 'Analisis daya dukung lahan berdasarkan kebutuhan dan

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.

ketersediaan lahan pertanian dan perkebunan', Paspalum: Jurnal Ilmiah Pertanian, 13(1), pp. 45-57.

United Nations Environment Programme (2023) Global environment outlook 7: Sustainable food systems and resource management. Nairobi: UNEP.

Wang, L., Chen, Z. and Huang, Y. (2022) 'Land-use diversity and climate resilience in agricultural landscapes', Environmental Development, 44, 100756. Available at: https://doi.org/10.1016/j.envdev.2022.100756.

Widodo, E.K., Soemarno, Rachmansyah, A. and Adiyoso, W. (2024) 'Mapping the future: Predicting the carrying capacity of agricultural land for sustainable development', Journal of Agricultural Systems and Spatial Planning, 55(8), pp. 112-126.

Wijaya, M., Santoso, P.B. and Lestari, D. (2024) 'Agricultural land use dynamics and food security challenges in Indonesia', Land, 13(12), 2030. Available at: https://doi.org/10.3390/land13122030.

Yunita, R., Nugroho, A. and Sari, M. (2021) 'The profile of land carrying capacity and food security in Gunungkidul Regency', Media Komunikasi Geografi, 22(2), pp. 145-158.

Zhang, Q., Li, Y. and Sun, W. (2022) 'Population pressure, land resources, and regional carrying capacity: A spatial assessment approach', Sustainability, 14(18), 11542. Available at: https://doi.org/10.3390/su141811542.

Copyright to the author of some rights reserved This work is licensed under aCreative Commons Attribution-ShareAlike 4.0 International License.