Agro Bali : Agricultural Journal
Vol. 7 No. 2: 390-398, July 2024
e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

Multi-aspect Analysis of Rice Sustainability in the Improvement of Rice Production in North Sumatra Province, Indonesia

Lindawati[1♥], Ida Zulfida[2], Siti Khadijah Hidayati Nasution[1], Sri Handayani[3]

[1]Department of Agribusiness, Faculty of Agriculture, University of Sumatera Utara, Medan, Indonesia
[2]Department of Agrotechnology, Faculty of Agriculture, Universitas Pembinaan Masyarakat Indonesia, Medan, Indonesia
[3]Department of Agribusiness, Faculty of Agriculture, Universitas Teuku Umar, Meulaboh, Indonesia
♥Corresponding author email: lindatan84@usu.ac.id

Article history: submitted: February 2, 2024; accepted: July 22, 2024; available online: July 31, 2024

Abstract. North Sumatra's food security highly depends on rice supply from rice fields in rice-producing districts, namely Deli Serdang, Serdang Bedagai and Simalungun. The decrease in rice field area impacts the North Sumatra region's rice supply. This research aims to analyze the sustainability status and sensitive factors that cause the sustainability of rice fields based on economic, ecological, social, technological, legal, and institutional dimensions using Multi-aspect Sustainability Analysis software. The research results show that, in aggregate, the sustainability of rice fields is in the quite good category with a score of 62. Apart from the less sustainable economic aspect with a score of 59.09, there are four other aspects, such as environmental, social, infrastructure and technology, laws and regulations, and institutions, declared sustainable with a score greater than 62. The research also found 15 sensitive key factors that can improve the sustainability status of rice fields in North Sumatra to become very sustainable

Keywords: multi-aspect; rice fields; sustainability

INTRODUCTION

North Sumatra is one of the rice-producing centers in Indonesia. In 2022, North Sumatra's milled dry grain production will reach 3,942,774 tons, equivalent to 2,327,419 tons of rice from a harvest area of 751,885 hectares (ha). With rice production reaching 2.3 million tons, while the demand for rice in North Sumatra is around 1.8 million tons, North Sumatra is a rice surplus area so it can reduce rice imports by 2023. This high production achievement ranks North Sumatra seventh in the national rice production center (Kementan RI, 2023)

However, the fairly high increase in production is thought to have come from other factors such as improvements in cultivation technology, fertilizer and seed subsidies, irrigation (Muliarta & Purba, 2020; Purba, 2011; Tehulie et al., 2021), and credit assistance, not from increasing land area in North Sumatra. This is based on BPS data that every year there is a decrease in the area of rice fields. Data shows that there is a decrease in the area of rice fields every year from 2003 to 2021. A fairly high decline occurred from 2003 to 2005, when the area of rice fields decreased at a rate of --16.9 % from 538,180 ha to 462,767 ha, then from 2011 to 2021. 2012 amounted to 467,138 ha to 448,722 ha with a decline rate of -4.1%, and the highest decline with a decline rate of -73.8% from 2017 to 2018 amounted to 427,262 ha to 245,801 ha. In 2019, there was an increase in the area of rice fields by 20.4% in North Sumatra to 308,668 ha. Meanwhile, in 2020 to 2021, there was no significant change in the area of rice fields, from 308,830 ha to 309,398 ha (BPS, 2020; Dinas Tanaman Pangan dan Hortikultura, n.d.; Kementan RI, 2023). With an average decrease in paddy field area of -4.3% per year, in the long term, it is predicted that rice production will decrease, resulting in a rice shortage problem in North Sumatra (Nurmalina, 2023; Pratama et al., 2018; Saiki et al., 2020; Zhong, 2016). For this reason, the decline in paddy field area must be addressed and anticipated because it is an obstacle in increasing rice production and is counter-productive in increasing competitiveness through the agricultural sector, which is a priority for the 2018-2023 Regional Medium Term Development Plan (RPJMD).

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

It is feared that the decline in the area of rice fields that occurs almost every year at a fairly high rate will affect rice production and the availability (supply) of rice in the following year. Based on Badan Pusat Statistik (BPS) data, North Sumatra has experienced several declines in rice production, namely (1) 2000-2002 with a growth rate of -6.90% and - 3.99% (2) 2005-2006 with a growth rate of -12.7% (3) 2009-2010 with a growth rate of -4.29% (Badan Pusat Statistik, 2022). Rice shortages will cause the government to adopt import policies that drain regional government revenues and budgets.

Rice fields are an important factor in rice cultivation to maintain food security. Until now, in general, rice production in the world still uses land (rice fields) as a medium for sustainable rice production. The phenomenon of decreasing paddy field area is a complex problem so more in-depth research is needed to look at the real issue from a multi-aspect perspective systematically. Based on the description above, this research aims to analyze the sustainability status of rice fields in existing conditions based on environmental, economic, social, technological, as well as legal and institutional aspects (Firmansyah et al., 2016; Widiatmaka et al., 2015).

METHODS

Location and Method of Sample Determination

The research location was purposively in North Sumatra Province in 3 districts, namely Deli Serdang, Serdang Bedagai, and Simalungun, considering that these three regions are rice production centers and have extensive rice fields in North Sumatra.

Respondents are stakeholders in the three (3) Deli Serdang, Serdang Bedagai and Simalungun districts: the government/policymakers, environmental experts, economic experts, social experts, farmers/relevant communities, academics, and NGOs. There were thirty-three (33) respondents interviewed; eighteen (6) came from the Simalungun agricultural and environmental service, seven (7) from the Deli Serdang agricultural service, five (5) from Serdang Bedagai and fifteen (15) farmers from three research area.

Types of Data

Primary data obtained directly in the field or by filling out the questionnaire online by recording the respondent's name and email to be invited to fill out the questionnaire on the MSA website. Secondary data is data from Deli Serdang, Serdang Bedagai and Simalungun districts regarding area, population, socio-economic population, area of rice fields, GRDP, inflation, and rice prices at the producer and consumer levels.

Analysis Methods

Data analysis using Multi-aspect Sustainability Analysis (MSA) online. MSA analysis can explain an object's sustainability in a multi-aspect manner from environmental, economic, social, infrastructure, and technological as well as legal and institutional aspects (Santoso et al., 2023; Widiatmaka et al., 2015). Each element has factors or attributes that are characteristics inherent in that dimension. Factors in each aspect are expected to increase and differ in each region.

The stages of analyzing the sustainability of rice fields using MSA software (**Figure 1**) are 1) Preparing the MSA questionnaire, 2) Expert assessment, 3) Sustainability assessment of selected respondents, 4) Assessment using data processing on the MSA website 5) Status assessment and leverage factors, 6) Scenario analysis, 7) Policy analysis based on scenarios 8) Implementation (Pusat Sains, 2023; Sukwika, 2020).

The factors used in each aspect are presented in **Table 1**. These factors are derived from references discussing development in rural areas (Alder J., Pitcher T.J., Preikshot D., Kaschner K., 2010; Fauzi,

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

2019; Fauzi & Oxtavianus, 2014; Nijkamp & Ouwersloot, 1998), as well as from the results of field observations. Factors in each dimension are classified based on criteria into "good" and "bad" using concepts from the Fisheries Center (2002). Each factor in good condition is given a score of 3 or 2, depending on the range defined for each factor, while the worst is given a score of 0, in the range of 0 to 3 or 2. The definitive score is the mode value, which is then analyzed to determine the correct point. Reflects the relative position of sustainability against "good" and "bad" points using multidimensional statistical ordination techniques (Mawarsari & Noor, 2000; Widiatmaka et al., 2013, 2014).

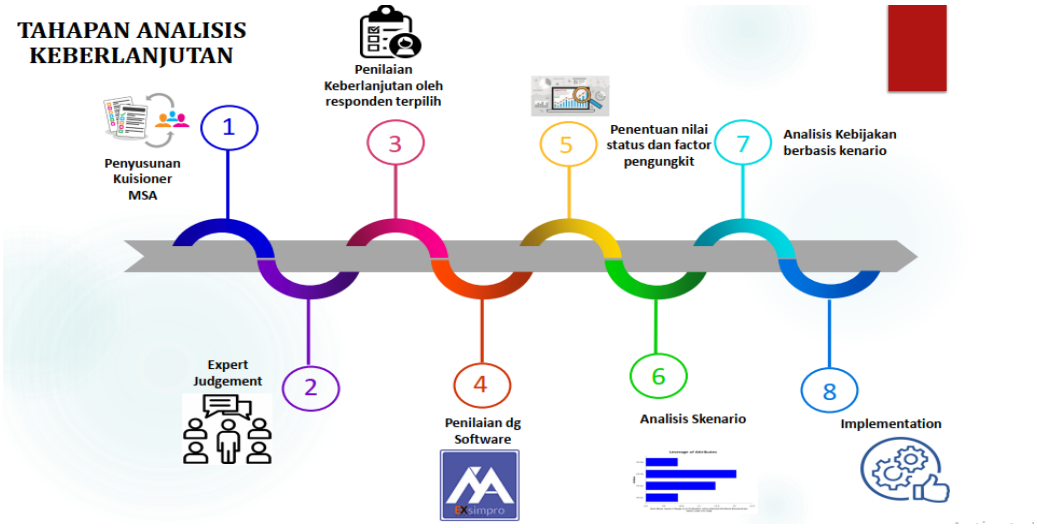

Figure 1. Stages of sustainability analysis (Multi-aspect Sustainability Aspect, 2023)

The estimator score for each aspect is expressed on a scale of 0% (bad) and 100% (good), which is then grouped into four (4) categories, 0-20% is classified as unsustainable; >20-40% is classified as low sustainable; >40-60% classified as moderate sustainable; and >60-80% is classified sustainable; and >80-100% is classified very sustainable (Nurmalina, 2023; Syakir et al., 2021).

RESULTS AND DISCUSSION

Validation and Sustainability Status in Existing Conditions

The average validation status of environmental, economic, social, infrastructure and technological aspects as well as legal and institutional is three. This shows that overall the analysis results are quite good because the results of random iteration for ten repetitions are less than 5. The validation results show that the research activities are quite good (**Table 2**).

The overall sustainability score for environmental, economic, social, infrastructure, and technological aspects, as well as legal and institutional aspects, is 62 or sustainable and shows quite good performance. The lowest sustainability value was 59.09, and the highest was 64.43. Only the economic aspect shows a less sustainable because the value is 59.09 or less than 60, while the other four aspects have relatively good values. In the financial aspect, several attributes show less sustainability with low indicator measurements, such as marketing access showing a value of 0, where the marketing chain or marketing actors after harvest are intermediaries.

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

Table 1. Classification of factors from environmental, economic, social, infrastructure and Aspects of technology as well as law and institutions (Firmansyah et al., 2016)

	Factors	Class			Factors	Class	
		Bad	Good			Bad	Good
Ecology				**Social**			
1	Level of pollution in irrigation canals	0	3	1	Health	0	3
2	Water availability (Rainfall and Irrigation)	0	2	2	Pendidikan	0	4
3	Soil fertility	0	4	3	Family participation in managing rice fields	0	2
4	Seasonal pattern forecast	0	2	4	Agricultural Extension	0	3
5	Superior seeds	0	2	5	Conflict Events	0	3
6	Use of fertilizer	0	3	6	Paddy field management patterns	0	2
7	Suitability of land	0	4	7	Mutual Cooperation Habit	0	3
8	Flood events	0	2	8	Community empowerment	0	3
9	Waste utilization	0	3	**Infrastructure and Technology**			
Economy				1	Adoption of technology	0	3
1	Farmers' income	0	2	2	Site-specific fertilization	0	2
2	Mechanism for sharing the results of cultivated land	0	3	3	The relevance of technology to farmer habits	0	3
3	Land ownership status	0	2	4	Farmers' response to new technologies	0	2
4	Marketing Access	0	3	5	The recommended technology is appropriate to the farmer's capabilities	0	3
5	Market Reach	0	4	6	The existing technology base includes those that have not yet been adopted	0	2
6	Money savings in the form of farmer savings	0	4	7	Availability of appropriate agricultural technology	0	2
7	Government Assistance	0	2	**Law and Institutions**			
8	Price Stability	0	1	1	Microfinance and cooperative institutions	0	2
9	Feasibility of agricultural business	0	3	2	The existence of farmer groups	0	3
10	The level of consumer dependency on agricultural products	0	3	3	Customary rules/customs	0	2
				4	Counseling on land conversion control	0	3
				5	Law enforcement	0	3
				6	Consistency of land use with RTRW	0	3
				7	Clarity of the General Spatial Planning Plan (RUTR)	0	3

Other attributes include farmers still complying with the indicators for implementing the government's purchasing price for harvested dry grain, namely IDR 6,000, even though the selling price of rice for consumers has reached IDR 14,000 to IDR 17,000 per kg. With the cost of rice increasing relatively high, reaching an average of 60 percent in early 2024, the price of grain at the farmer level should also increase.

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

Table 2. Validation and sustainability status

Aspect Name	Validation Status	Sustainability Status
Environment	2	62
Social	2.5	62.5
Economy Aspects	3.09	59.09
Infrastructure and Technology	2.43	64.43
Law and Institutions	5	62
Average	**3**	**62**

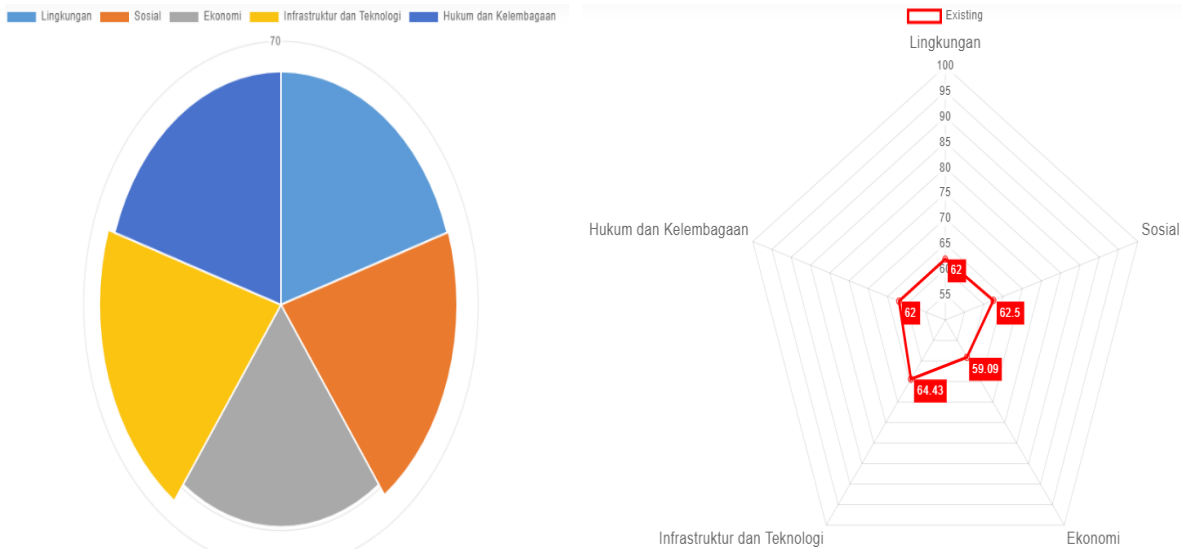

Figure 2. Polar and flying diagrams on environmental, economic, social, aspects of infrastructure and technology, law and institutions

Table 3. Sensitive factors that influence sustainability status

No	Sustainable Aspects	Sensitive factor
1	Environmental Aspects	Quality seeds
		Fertilizer use
		Flood incident
2	Social Aspects	Family participation in managing rice fields
		Paddy field management patterns
		Mutual Cooperation Habit
3	Economic Aspects	Mechanism for sharing the results of cultivated
		Marketing Access
		Feasibility of farming
4	Infrastructure and Technology	Location-specific fertilization
		Farmers' response to new technology
		The available technology base includes those that
5	Legal and institutional aspects	Counseling on controlling land conversion
		Law enforcement
		Consistency of land use with Regional Spatial

This phenomenon shows that the transmission of price increases from the market does not reach farmers. Indicators of the feasibility of lowland rice farming are

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

also low, namely an average of less than 1 hectare. BPS data shows that the land ownership of the majority of farmers in Indonesia is minimal, on average less than 0.3 hectares. The average productivity of agricultural products is 5 tons/ha. The results of the MSA analysis are shown in the kite diagram and polar diagram (**Figure 2**).

Determining key factors through sensitivity analysis on each aspect

Agriculture, in general, and food supply, in particular, need to apply the concept of sustainable development. Sustainable development is a development that can meet the needs of the present without compromising the ability of future generations to meet their needs. In the substance of this concept, ecological, social, and economic aspects must be fulfilled simultaneously so that there is no trade-off between different interests (Firmansyah et al., 2016; Widiatmaka, 2015)

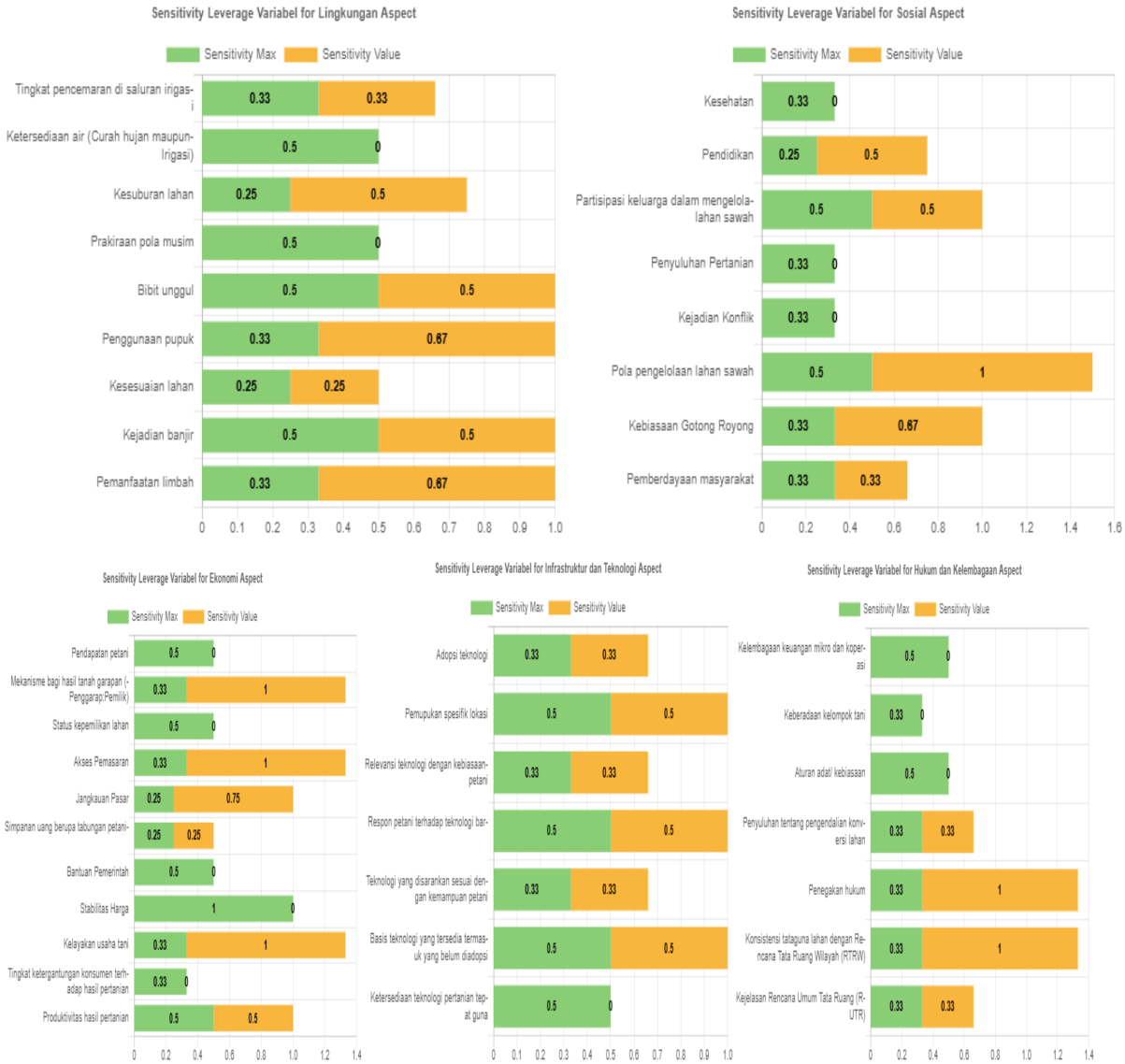

Figure 3. Sensitivity analysis on environmental, economic, social, and infrastructure aspects and technology, law, and institutions

Based on the results of the MSA analysis, factors sensitive to existing conditions are key or leverage factors that can be described and applied if the sustainability value

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

experiences a continuous decline. The analysis results show that some attributes act as sensitive factors (leverage factors) that are present in each aspect partially (**Table 3**). The five sensitive aspects include environmental, economic, social, infrastructure, technology as well as legal, and institutional (Figliana et al., 2021; Gairhe et al., 2021). To improve the sustainable status of paddy land use in the research area, it is necessary to intervene in these fifteen (15) factors (**Figure 3**).

CONCLUSION

The current condition of land use for rice fields in North Sumatra is at sustainable status. Environmental, social, infrastructure technological, legal, and institutional aspects have entirely sustainable performance, while economic aspects show less sustainable performance. Several factors are considered sensitive (leverage attributes) for the sustainability of rice field use in North Sumatra. Increasing the sustainability of paddy land use can be done by intervening, improving performance, and prioritizing sensitive factors. There are fifteen (15) sensitive factors, including superior seeds, use of fertilizer, flood events, family participation in managing rice fields, rice field management patterns, cooperation habits, mechanisms for sharing the results of cultivated land, marketing access, the feasibility of farming, location-specific fertilization, farmer response regarding new technologies, available technology bases including those that have not yet been adopted, counseling on land conversion control, law enforcement and consistency of land use with regional spatial planning.

ACKNOWLEDGEMENTS

The research was funded by DRTPM Ministry of Education, Culture, Research and Technology (Decree of the Minister of Education Culture, Research and Technology Grant Number: 167/E5/PG.02.00.PL/2023 on 19 June 2023).

REFERENCES

Alder J., Pitcher T.J., Preikshot D., Kaschner K., dan F. B. (2010). How Good Is Good?: A Rapid Appraisal Technique For Evaluation of The Sustainability Status of Fisheries of The North Atlantic. In *Sea Around Us Methodology Review* (pp. 136–182).

BPS. (2020). *Provinsi Sumatera Utara Dalam Angka*.

Dinas Tanaman Pangan dan Hortikultura. (n.d.). *Statistik Hortikultura 2022*. 2022. Retrieved April 10, 2023, from https://www.bps.go.id/id/publication/2023/06/09/03847c5743d8b6cd3f08ab76/statistik-hortikultura-2022.html

Fauzi, A. (2019). *Teknik analisis keberlanjutan*. Gramedia Pustaka Utama.

Fauzi, A., & Oxtavianus, A. (2014). Pengukuran Pembangunan Berkelanjutan di Indonesia. *Jurnal Mimbar*, *30*(1), 42–52.

Figliana, N. P. B., Sudarma, I. M., & Widianthini, W. (2021). Analisis Keberlanjutan Lahan Sawah di Subak Yeh Sumbul, Desa Yeh Sumbul, Kecamatan Mendoyo, Kabupaten Jembrana. Jurnal Agribisnis dan Agrowisata. *Jurnal Agribisnis Dan Agrowisata*, *12*(2), 46–59. https://doi.org/https://doi.org/10.24843/JAA.2023.v12.i02

Firmansyah, I., Pramudya, B., & Budiharsono, S. (2016). Sustainability status of rice fields in the rice production center of Citarum Watershed. *Advances in Agriculture & Botanics*, *8*(1), 13–25.

Gairhe, S., Gauchan, D., & Timsina, K. P. (2021). *Temporal Dynamics of Rice Production and Import in Nepal*. *7*(April), 97–108. https://doi.org/10.3126/jnarc.v7i1.36932

Kementan RI, D. S. dan P. P. (2023). *Produksi Beras Capai 2,3 Juta Ton, Sumut Siap Penuhi Kebutuhan Saat*

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

Nataru. https://psp.pertanian.go.id/berita/produksi-beras-capai-23-juta-ton-sumut-siap-penuhi-kebutuhan-saat-nataru

Mawarsari, A., & Noor, T. I. (2000). Sustainability Level of Paddy Field in Setianagara, Cibeureum District, Tasikmalaya City, West Java. *MIMBAR AGRIBISNIS Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, *6*(1), 388–400.

Muliarta, I. N., & Purba, J. H. (2020). Potential of Loss of Organic Fertilizer in Lowland Rice Farming in Klungkung District, Bali. *Agro Bali: Agricultural Journal*, *3*(2), 179–185. https://doi.org/10.37637/ab.v3i2.567

Nijkamp, P., & Ouwersloot, H. (1998). *Multidimensional sustainability analysis: the Flag model* (pp. 255–273). Springer. https://doi.org/10.1007/978-94-017-3511-7_13

Nurmalina, R. (2023). Analysis of Sustainability Index and Status of Rice Availability System in Several Regions in Indonesia. *Jurnal Agro Ekonomi*, *26*(1), 47–79.

Pratama, A., Amin, M., Asmara, S., & Rosadi, B. (2018). Analisis Spasial Lahan Pertanian Pangan Berkelanjutan (Lp2b) di Kabupaten Pesawaran. *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering)*, *7*(1), 41. https://doi.org/10.23960/jtep-l.v7i1.41-50

Purba, J. H. (2011). Kebutuhan dan Cara Pemberian Air Irigasi untuk Tanaman Padi Sawah (Oryza Sativa L.). *Widyatech: Jurnal Sains Dan Teknologi*, *10*(3), 145–155. https://jurnalwidyatech.files.wordpress.com/2012/02/jhon-hardy-purba.pdf

Pusat Sains. (2023). *Pelatihan Online MDS (Multi Dimensional Scalling)*. https://pusatsains.com/

Saiki, M., Nguyen, T. P. M., Shindo, J., & Nishida, K. (2020). Nitrogen balance in paddy fields under flowing-irrigation condition. *Nutrient Cycling in Agroecosystems*, *116*(1), 19–30. https://doi.org/10.1007/s10705-019-10019-y

Santoso, A. B., Manurung, E. D., Siagian, D. R., Purba, H. F. P., & Sembiring, P. (2023). Sustainability Study of Horticultural Development in Mandailing Natal District With RAPFISH-MDS Analysis. *Agro Bali : Agricultural Journal*, *6*(2), 286–302. https://doi.org/10.37637/ab.v6i2.1170

Sukwika, T. (2020). *Fungsi dan Pemahaman Aplikasinya (MDS)*. Pusatsains.

Syakir, M., Haryono, Y., Sodikun, A., Rahmantyo, A., Mahmud, L., & others. (2021). Growth rate study of mangrove using hydroponic installation system with mol nutrient at Central Processing Plant (CPP) Senoro Banggai Regency-Central Sulawesi. *IOP Conference Series: Earth and Environmental Science*, *860*(1), 12006.

Tehulie, N. S., Fikadu, T., & Purba, J. H. (2021). Response of Mungbean [Vigna radiata (L.)Wilczek] Varieties to Plant Spacing under Irrigation at Gewane, Northeastern Ethiopia. *Agro Bali: Agricultural Journal*, *4*(1), 1–14. https://doi.org/10.37637/ab.v0i0.613

Widiatmaka, W., Ambarwulan, W., Firmansyah, I., Munibah, K., Santoso, P. B. K., & Sudarsono, S. (2014). Land suitability and dynamic system modelling to define priority areas of soybean plantation in paddy fields in Karawang, West Java. *Agrivita*, *36*(3), 235–248.

Widiatmaka, W., Ambarwulan, W., & Munibah, K. (2013). *Land use Change During A Decade As Determined By Landsat Imagery Of A Rice Production Region and Its Implication to Regional Contribution toRice Self Sufficiency: Case Studyof Karawang Regency, West Java,Indonesia*.

Widiatmaka, W., Munibah, K., Sitorus, S. R. P., Ambarwulan, W., & Firmansyah, I. (2015). Appraisal Keberlanjutan Multidimensi Penggunaan Lahan Untuk

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i2.1741

Sawah di Karawang - Jawa Barat. *Jurnal Kawistara*, *5*(2), 36–46. https://doi.org/10.22146/kawistara.7591

Zhong, C. (2016). A review on effects and regulation of paddy alternate wetting and drying on rice nitrogen use efficiency. In *Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering* (Vol. 32, Issue 19, pp. 139–147). https://doi.org/10.11975/j.issn.1002-6819.2016.19.020