Sustainability Of Rice Cultivation In Irrigated Paddy Fields In The Highlands Of Bengkulu, Indonesia

Muhammad Faiz Barchia[1*], Hesdianto Eko Mareja[2], Agus Susatya[3], Elsa Lolita Putri[1]
{faizbarchia@unib.ac.id}
[1]Dept. of Soil Science, University of Bengkulu, Bengkulu, Indonesia
[2]Magister Program of Natural Resources Management, Bengkulu University
[3]Dept. of Forestry, Faculty of Agriculture, Bengkulu University, Indonesia

Abstract. Sustainable agricultural paddy's fields determine food security and important to social equity, social prosperity, economic development, and environmental services. The main purpose of this research was to elaborate some perspectives on sustainability of irrigated upland rice cultivation in Bengkulu. The study was done in Lebong Regency, Bengkulu Province from January to April 2020. A scalable rapid appraisal multidimensional scaling (MDS) was used to examine sustainable status following to five dimensions of ecological, economical, socio-cultural, technological and institutional viewpoints consisting of 30 attributes. Accuracy of MDS analysis was analysed with goodness of fit and Monte Carlo analysis while sensitive attributes was fitted with root mean square leverage analysis. Agricultural paddy's fields in upland Bengkulu moderately sustain with scale of 51.41. Land use change perception determined socio-culture dimensions to put agriculture paddy's field on less sustain at the scale of 47.85. A low financial support and government facilities put institutional and policies dimension on 45.40, the level of less sustain for cultivated rice field sustainability. Strengthening sustainability of cultivation upland paddy's field in Bengkulu initially should be supported by government budgeting and facility, and endorsement sustainable agricultural land policies.

Keywords: Agricultural sustainability, multidimensional perspective paddy's fields.

1. Introduction

Paddy as a staple food is a national strategic commodity in Indonesia [1] which will consume about 95% [2] of the Indonesian population in 2020, based on an annual growth rate of 1.34% estimated at 264 million people [3] so future rice production must be increased in line with in population growth [4]. To meet rice demands in 2019, 54.60 million tons were harvested from 10.68 million ha of rice fields [5]. Based on data in 2017 data, the Indonesian population was only 262 million people with an average per capita rice consumption of 114.6-130 kg yr-1, and the required rice area was at least 14.59 million Ha [6].

The rice cultivation area in in Bengkulu tend to decrease, with cultivation area of 65,891 ha in 2018 and decreased to 64,406 ha in 2019, of which 9,444 are located in Lebong Regency [7]. In addition, rice productivity in Bengkulu was 4.6 t ha-1, which lower than the national rice productivities of 5.34 t ha-1. Rice productivity in Indonesia is influenced by several factors such as land and water availability, soil physical properties, and climate change [8], adoption of rice technology and resource efficiency by farmers is still low [9].

SRICOENV 2022, October 05-06, Palembang, Indonesia

DOI 10.4108/eai.5-10-2022.2328294

Dynamic factors affecting land use change triggered environmental ecosystem instability [10].

In one hand, the sustainability of rice production needs to be given attention along with the increasing population; on the other hand, a lot of agricultural lands, especially paddy's fields were converted to non-agricultural uses [11]. Some of the most productive agricultural lands had been converted for residential, commercial, or other purposes [12]. Land conversion occurred in the suitable land for agriculture activities could threaten food security in Indonesia [13]. The main constraints to the food security in the future involved decline fertile agricultural soils, decreasing water resources, coming down trends in soil quality and productivity, lessen of groundwater table [14]. Conversion of wetland rice fields into non-agricultural utilizations increased social, economic, and environmental impacts [15].

The main problems in national development recently and future were agricultural sustainability [16]. Sustainable agriculture required empowerment and engagement of all stakeholders in the agricultural production and supply chain to enable change [17]. Sustainable agricultural practices should be based on maintaining fertile soil sustainability through application of a combination package of technologies, management innovations, and concrete actions aimed at balancing socio-cultural and economic principles with environmental considerations [18]. Moreover, without a strong and sustainable agriculture, sustainable development was difficult to create a sustainable society [19]. Sustainable agriculture was a determinant variable for sustainability development to propose suitable uses of natural resources and protected environment without disturbing economic growth and applying sustainable agriculture could promote both economic and environmental development perspectives [20].

Concerning agriculture sustainability in Indonesia should be based on sustainability rice production. Implementation of sustainable agriculture concepts were conducted mostly use triangular framework of sustainability through economic, environmental, and social dimensions [20]. In facts, social, economic, and environmental benefits to sustainable agriculture were less understandable by most conservative communities in food production system [21]. The triangular Concept had been criticized for not providing a logical explanation of how these three dimensions of sustainability can grow together in a balanced way. Achieving a balance between economic, environmental and social dimensions is hardly possible without an institutional dimension that manages, mediates and facilitates growth [22]. The institutional dimension setted an important variable to ensure the harmonious and equal growth with other three dimensions [23]. Furthermore, the indicators for institutional sustainability have been introduced as far back as 1995 but these have not been widely used and seemingly to be left out in researches on development sustainability.

As for the sustainability of agriculture in Indonesia, it should be based on sustainable rice production. In the implementation of sustainable agriculture concepts, the triangular framework of sustainability with its economic, environmental, and social dimensions is usually used [20]. The fact is that the social, economic, and environmental benefits of sustainable agriculture have been less understood by most conservative communities in the food production system [21]. The triangular concept has been criticized for not providing a logical explanation of how these three dimensions of sustainability can grow together in a balanced manner. Balancing the economic, environmental, and social dimensions is almost impossible without an institutional dimension to guide, mediate, and facilitate growth [22]. The institutional dimension represents an important variable to ensure harmonious and even growth with the other three dimensions [23]. In addition, indicators of institutional

sustainability were introduced as early as 1995, but they are not widely used and do not seem to be considered in research on development sustainability.

Some perspectives that usually be applied to study the sustainable development were environmental properties, institutions and policies, economic values, and also social conditions [24]. Strong outlook environment and momentary economic perspectives had proposed to societies towards more eco-view point to resource consumption therefore technology innovation and knowledge management brought up an extra ordinary perspective in development sustainability [25]. It cannot be denied that the role of technology is very strategic in supporting increased agricultural cultivation for rice production [26]. To improve measurement sustainability development [27] updated a conceptual analysis with ecological, technological, economic, social, ethical and institutional dimensions.

Several researches have been conducted partly in terms of increasing rice production to support rice availability, yet a comprehensive perspective on the sustainability status of rice cultivation is still insufficient. The objective of this study is to find out the sustainability status of rice cultivation and some sensitive attributes that disturb the sustainability rice cultivation in Bengkulu highlands. The results of this study would provide prominent information for relevant authorities and other stakeholders.

2. Methods

This study was conducted in the Lebong Regency (geographically, 02065' – 03060' S and 1010 – 1020 E, [28], a highland area of Bengkulu Province. The research areas included 10 (ten) villages namely Sungai Gerong, Sukau Rajo, Selebar Jaya, Talang Bunut, Garus, Sukau Mergo, Pyang Embik, Nangai Tayau, Nangai Tayau I, and Amen with irrigated rice fields (Figure 1) fields about 915 ha (10.39 % of rice field in Lebong District) from January to April 2020.

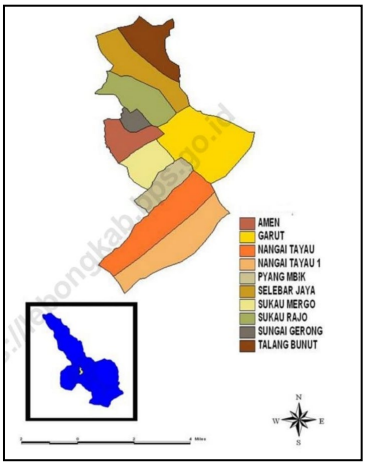

Figure 1. Research location

The study used both primary and secondary data on environmental, economic, sociocultural, technological, and political perspectives that support sustainability rice cultivation. Fifty key informants [29] and 5 experts relevant to each dimension were identified through purposive sampling and snowballing. Secondary data were collected on all

aspects related to this research such as action planning from government offices, government rules and policies, the infrastructure support including road, and market access, etc.

Figure 1a. Rice growth in Lebong

Figure 1b. Rice in early and harvest time

The scalable rapid assessment for multidimensional technique through multidimensional scaling (MDS) was used to evaluate sustainability of the irrigated rice fields. This analysis method is a modification of Rap-Assessment Techniques for Fisheries developed by the Fisheries Center of the University of British Columbia, Canada [30], which was replicated for rice cultivation in each dimension and in multiple dimensions [31]. Monte Carlo analysis was used to predict the error for this method, and leverage analysis [32] used to determine leverage of the attributes affecting the sustainable rice field cultivation.

Table 1. Index Value and Sustainability Status

Sustainability index	Classification
00.00 – 25.00	Bad
25.01 – 50.00	Poorly
50.01 – 75.00	Fairly
75.01 – 100.00	Good

3. Result and Discussion

3.1 Sustainability Status of The Paddy's Field Cultivation

Rice field cultivation in Lebong categorized fairly sustainable with an index value 51.41. The sustainability of the rice cultivation was contributed by ecological 50.08), economical (62.58) dan technological (51.16) conditions while socio-cultural (47.85) and institutional and policy (45.40) conditions suppressed to put on less sustainable status. Sustainability indices and status were revealed in Table 2 and Figure 2.

Table 2. Sustainability Indices and Status of Rice Field Cultivation in Lebong

Dimension	Sustainability index	Category
Ecology	50.08	Fairly sustainable
Socio-culture	47.85	Less sustainable
Economy	62.58	Fairly sustainable
Tecnology and infrastructure	51.16	Fairly sustainable
Institutions and policies	45.40	Less sustainable
Multidimension	51.41	Fairly sustainable

The accuracy and validity of the attributes examined and the effect of variables outside the system on the sustainability of rice field cultivation was determined with the value of S tress, determination coefficient (R2) and the Monte Carlo indices values came from the MDS

analysis using Rap-Fish software, as revealed at Table 3. The accuracy and validity of the attributes studied and the effects of the variables outside the system on the sustainability of rice paddy cultivation were determined using the value of S tress, the coefficient of determination (R2), and the values of the Monte Carlo indices from the MDS analysis using Rap-Fish software, as shown in Table 3.

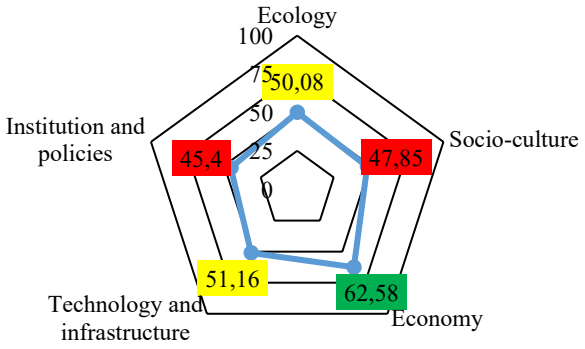

Table 3. Sustainability Indices, Monte Carlo, Stress and Determination Coefficient

Dimensions	Indices		Differen cies	Stess	R2
	MDS	Monte Carlo			
Ecology	50.08	50.12	0.04	0.24	0.93
Socio-culture	47.85	47.71	0.14	0.24	0.93
Economy	62.58	62.46	0.12	0.21	0.95
Technology and infrastructure	51.16	51.17	0.01	0.24	0.93
Institution and policies	45.40	45.43	0.03	0.24	0.92
Multidimension	51.41	51.38	0.07	0.23	0.93

All dimensions were valid and accurate as shown by the value of stress of 0.23 which less than 0.25, and the value of coefficient of determination (R2) at 0.93 shows that the attributes used in the model are able to explain valid data for the analysis of sustainable paddy framing system in Upland Bengkulu. In addition, the MDS and Monte Carlo values, which differed only slightly, indicated that the MDS for analysing the sustainability status of rice cultivation in Lebong in upland Bengkulu has high accuracy.

3.2 Ecological Constraint to Sustainability

With the exception of soil productivity, almost all ecological characteristics could limit the sustainability of rice production in these areas (Figure 3).

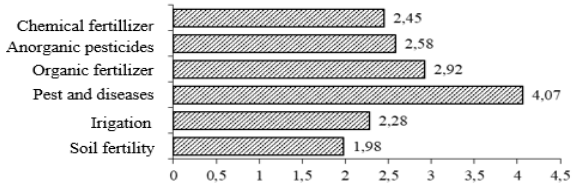

Figure 3. Root mean square value of ecological attributes

Water supply from irrigation facilities at dry season, fertilizers applied, contamination by chemical pesticides, and the highest susceptibility to plant diseases and pest infestations could determine the sustainability cultivation of rice field. Irrigation for rice cultivation was under pressure to provide more water when water sources dried up [33]. In addition, the demand for irrigation water increased due to climatic change, high crop yield requirements, the cultivation process, and farmers' perceptions [34]. Recently, rice production failures accumulated due to the widespread occurrence of brown plant hopper, small brown planthopper, rice hispa, rice leaf folder, yellow stem borer and white-backed planthopper [35]. Pests determined the stability of food security in areas where the majority of population consumed rice as a staple food [36].

3.3 Socio-cultural Constraint to Sustainability

The highly land rent ratio between land for residential purposes and for rice cultivation affected farmers prospects for land conversion. Villager perceptions of land use change posed the greatest challenge to the sustainability of rice field cultivation. Population growth and settlement expansion were the main factors affecting land use change [37]. People in rural agricultural ecosystems who depend on agriculture lands for their daily income and livelihoods are vulnerable to land use change because the availability and accessibility of agricultural land were very important [38]. In addition, smallholder farmers who build their lives on the land as their main source of production were at risk of poverty because they often live in subordinate society have no power to influence decisions in around them.

In addition, loss of mutual cooperation, time required for rice cultivation and conflict (Figure 4) in rice cultivation due to limited water supply are barriers to the sustainability of rice cultivation in these areas.

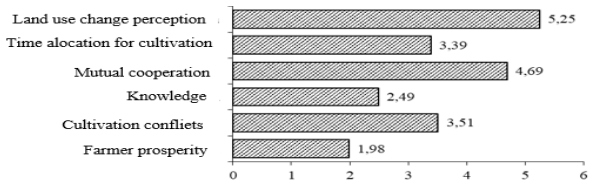

Figure 4. Root mean square value of socio-cultural attributes

3.4 Economical Constraint to Sustainability

Pests and diseases infestation of plants and lack of water supplies to rice fields both always caused rice cultivation facing with low yields. The unsuccessful rice harvests induced farmers leaving rice fields to look for other economic activities of their livelihood. Other constraints such as rice production benefits, price fluctuation of products, and product market chain (Figure 5) suppressed sustainability of rice production.

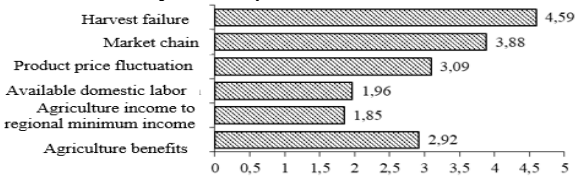

Figure 5. Root mean square value of economical attributes

The scarcity of water resources for agriculture, limited yields compared to varieties with high yield potential, decreasing rice yield in intensive rice cultivation systems, harvest failure because of abiotic and biotic attachments, and increasing production costs contributed to the slowdown of cultivation areas following rice production [39].

3.5 Technological and Infrastructure Constraint to Sustainability

Agricultural technology and infrastructure facilities were sufficient for the sustainability of paddy cultivation, but all attributes could be determinants to decrease rice production sustainability. Agricultural inputs, tillage and post-harvest equipment, technological innovation and knowledge, ability to operate agricultural machinery, irrigation infrastructure conditions (Figure 6), and paddy accessibilities were all highly sensitive to unstable rice cultivation and production.

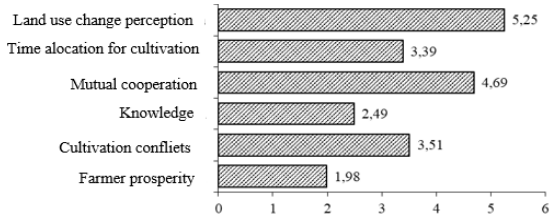

Figure 6. Root mean square value of technological and infrastructure attributes

The solution to the food security shock depends on the appropriate and efficient use of labor resources in agriculture. The labor force for agricultural activities, especially in remote areas far from well-developed settlements, was predominantly unskilled labor engaged in agricultural cultivation [40].

Agro-cultivation systems recently and future had to change from highly dependent on generosity of environmental resources and ecosystems towards more technological farming systems. The necessities for increasing productivity and agriculture intensification required innovation technologies, mechanisation farming systems, transferring knowledge, and improving infrastructure in agricultural development [41].

3.6 Institutional and Police Constraint to Sustainability

Financial support financials and government budgets were the most important factor in the sustainability paddy cultivation in Lebong Regency. All attributes of the institutional and government policies could be constraints to the sustainability of rice production. Rice cultivation training, empowerment and extention facilities, extention personnel activities, farmer institutions acitivities, and sustainable land use policy (Figure 7) were very sensitive to constrain the ustainability of rice cultivation in these areas.

Figure 7. Root mean square value of institutional and policies attributes

Government investment in agriculture and rural infrastructure was important [42]. Government financial assistance for gricultural cultivation aimed at increasing agricultural productivity through the use of innovative technologies is more attractive to small scale farmers [43]. The implementation of the subsidy policy for agricultural inputs stimulated domestic agricultural production [44]. The government was expected to provide a solution that would aim to sustainability increase rice production fruitful results for smallholder farmers. concerned with sustainable increase in rice production that would see to small-scale rice farmer fruitful conclusions.

4. Conclusion

Rice cultivation in the Lebong region of the Bengkulu highlands served as staple food security, although socio-cultural and institutional policies suppressed the sustainability of the rice cultivation. Land use change and government supports and institutions were both the main factors that could affect rice cultivation and rice production in this area.

References

[1] J. Mariyono, "Rice production in Indonesia: policy and performance," Asia Pacific J. Public Adm., vol. 36, no. 2, pp. 123–134, 2014, doi: 10.1080/23276665.2014.911489.

[2] D. K. Swastika, J. Wargiono, and dan A. Hasanuddin, "Analisis Kebijakan Peningkatan Produksi Padi Melalui Efisiensi Pemanfaatan Lahan Sawah di Indonesia," Anal. Kebijak. Pertan., vol. 5, no. 1, pp. 36–52, 2007.

[3] BPS Statistics Indonesia, Proyeksi Penduduk Indonesia 2015-2045 Hasil SUPAS 2015. 2018.

[4] A. A. Sulaiman, Y. Sulaeman, and B. Minasny, "A framework for the development of wetland for agricultural use in Indonesia," Resources, vol. 8, no. 1, pp. 1–16, 2019, doi: 10.3390/resources8010034.

[5] dan P. Direktorat Statistik Tanaman Pangan, Hortikultura, Luas Panen dan Produksi Padi Di Indonesia 2020 (Hasil Kegiatan Pendataan Statistik Pertanian Tanaman Pangan Terintegrasi dengan Metode Kerangka Sampel Area). 2021.

[6] N. H. Silalahi, R. O. Yudha, E. I. Dwiyanti, D. Zulvianita, S. N. Feranti, and Y. Yustiana, "Government policy statements related to rice problems in Indonesia: Review," 3BIO J. Biol. Sci. Technol. Manag., vol. 1, no. 1, p. 35, 2019, doi: 10.5614/3bio.2019.1.1.6.

[7] B. P. Bengkulu, "Luas Panen, Produktivitas, dan Produksi Padi menurut Kabupaten/Kota di Bengkulu 2018-2019." 2020, doi: https://bengkulu.bps.go.id/statictable/2021/07/07/634/luas-panen-produktivitas-dan-produksi-padi-menurut-kabupaten-kota-di-provinsi-bengkulu-2019-dan-2020.html.

[8] P. R. Hosang, J. Tatuh, and J. E. X. Rogi, "Analisis Dampak Perubahan Iklim Terhadap Produksi Beras Provinsi Sulawesi Utara Tahun 2013 – 2030 Analysis of the Climate Change Impact on Rice Production of the Province of North Sulawesi in 2013 - 2030," Eugenia, vol. 18, no. 3, pp. 249–255, 2012.

[9] Ekawati, Kusnandar, N. Kusrini, and Darsono, "Impact of technology and infrastructure support for sustainable rice in west kalimantan, indonesia," Bulg. J. Agric. Sci., vol. 24, no. 6, pp. 942–948, 2018.

[10] F. Firmansyah, N. A. Pratomoatmojo, U. F. Kurniawati, C. Susetyo, A. Pamungkas, and H. Idajati, "Sustainable agricultural land use determination modelling in Banyuwangi," IOP Conf. Ser. Earth Environ. Sci., vol. 202, no. 1, 2018, doi: 10.1088/1755-1315/202/1/012046.

[11] Syarif Imam Hidayat, "Analisis Konversi Lahan Sawah di Propinsi Jawa Timur," J-Sep, vol. 2, no. 3, pp. 48–58, 2008, [Online]. Available: http://jurnal.unej.ac.id/index.php/JSEP/article/view/431.

[12] A. Mulyani, D. Kuncoro, D. Nursyamsi, and F. Agus, "Analisis Konversi Lahan Sawah : Penggunaan Data Spasial Resolusi Tinggi Memperlihatkan Laju Konversi yang Mengkhawatirkan Analysis of Paddy Field Conversion : The Utilization of High Resolution Spatial Data Shows an Alarming Conversion Rate," J. Tanah dan Iklim, vol. 40, no. 2, pp. 121–133, 2016.
[13] Ricky, E. Rustiadi, and B. Barus, "A projection of land needed for settlements and conversion of paddy fields in solok city," J. Reg. City Plan., vol. 28, no. 3, pp. 186–203, 2017, doi: 10.5614/jrcp.2017.28.3.3.
[14] K. S. Devi and T. Ponnarasi, "An Economic Analysis of Modern Rice Production Technology and its Adoption Behaviour in Tamil Nadu," vol. 22, pp. 341–347, 2010.
[15] Nurliani and I. Rosada, "Rice-field Conversion and its Impact on Food Availability," Agric. Agric. Sci. Procedia, vol. 9, pp. 40–46, 2016, doi: 10.1016/j.aaspro.2016.02.121.
[16] F. I. Dolly, K. Kismartini, and H. Purnaweni, "The Land Use Change from Agricultural to Non-Agricultural in Bungo Regency, Jambi Province, Indonesia," E3S Web Conf., vol. 31, pp. 31–34, 2018, doi: 10.1051/e3sconf/20183109019.
[17] A. I. Fajri, R. Sakurai, and R. W. D. Pramono, "Factors Affecting Sustainability of Agriculture Land Management in Sarangan Magetan Indonesia," J. Asian Res., vol. 3, no. 4, p. p291, 2019, doi: 10.22158/jar.v3n4p291.
[18] W. Bank, Sustainable Land Management Sourcebook, no. May. 2008.
[19] G. Branca, N. McCarthy, L. Lipper, and C. Maria, "Climate Smart Agriculture: A Synthesis of Empirical Evidence of Food Security and Mitigation Benefits from Improved Cropland Management. Mitigation of Climate Change in Agriculture Series 3. Food and Agriculture Organization of the United Nations (FAO)," no. December 2014, pp. 1–35, 2011, [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/20110467.
[20] T. W. Bank, Sustainable Land Management, no. May 2006. 2006.
[21] M. Elias and R. Marsh, "Innovations in agricultural and food systems sustainability in California," Case Stud. Environ., vol. 4, no. 1, pp. 1–14, 2020, doi: 10.1525/cse.2019.002170.
[22] A. Valentin and J. H. Spangenberg, "A guide to community sustainability indicators," Environ. Impact Assess. Rev., vol. 20, no. 3, pp. 381–392, 2000, doi: 10.1016/S0195-9255(00)00049-4.
[23] F. Shen, S. P. Cottrell, K. F. D. Hughey, and K. Morrison, "Agritourism sustainability in rural mountain areas of China: a community perspective," Int. J. Bus. Glob., vol. 3, no. 2, pp. 123–145, 2009, doi: 10.1504/IJBG.2009.022604.
[24] R. K. Pokharel, P. R. Neupane, K. R. Tiwari, and M. Köhl, "Assessing the sustainability in community based forestry: A case from Nepal," For. Policy Econ., vol. 58, no. April 2018, pp. 75–84, 2015, doi: 10.1016/j.forpol.2014.11.006.
[25] V. Kumar and U. Kumar, "Introduction: technology, innovation and sustainable development," Transnatl. Corp. Rev., vol. 9, no. 4, pp. 243–247, 2017, doi: 10.1080/19186444.2017.1408553.
[26] F. Faisal, M. Mustafa, and Y. Yunus, "A Review of Technology Innovation in Increasing Rice Production," Agrotech J., vol. 4, no. 2, pp. 75–82, 2019, doi: 10.31327/atj.v4i2.1095.
[27] T. J. Pitcher et al., "Improvements to Rapfish: A rapid evaluation technique for fisheries integrating ecological and human dimensionsa," J. Fish Biol., vol. 83, no. 4, pp. 865–889, 2013, doi: 10.1111/jfb.12122.
[28] B. P. S. K. Lebong, Kabupaten Lebong dalam Angka 2018, vol. 1999, no. December. 2018.
[29] B. M. Wildemuth, Applications of Social Research Methods to Questions in Information and Library Science. 2009.
[30] T. J. Pitcher and D. Preikshot, "RAPFISH: A rapid appraisal technique to evaluate the sustainability status of fisheries," Fish. Res., vol. 49, no. 3, pp. 255–270, 2001, doi: 10.1016/S0165-7836(00)00205-8.
[31] P. Goswami and S. N. Nishad, "Assessment of agricultural sustainability in changing scenarios," Curr. Sci., vol. 106, no. 4, pp. 552–557, 2014.
[32] S. Fauzi, A. and Anna, Pemodelan Sumber Daya Perikanan dan Kelautan untuk Analisis Kebijakan, vol. 20, no. 5. 2005.

[33] N. Anika, A. C. Farhani, R. Fil'aini, and D. Cahyani, "Water productivity analysis in irrigated central rice production area of SolokRegency, Indonesia," IOP Conf. Ser. Earth Environ. Sci., vol. 355, no. 1, 2019, doi: 10.1088/1755-1315/355/1/012100.

[34] L. Levidow, D. Zaccaria, R. Maia, E. Vivas, M. Todorovic, and A. Scardigno, "Improving water-efficient irrigation: Prospects and difficulties of innovative practices," Agric. Water Manag., vol. 146, pp. 84–94, 2014, doi: 10.1016/j.agwat.2014.07.012.

[35] M. P. Ali et al., "Establishing next-generation pest control services in rice fields: eco-agriculture," Sci. Rep., vol. 9, no. 1, pp. 1–9, 2019, doi: 10.1038/s41598-019-46688-6.

[36] K. Luen, L. Wong, and J. H. D. L. Reyes, "ADB Sustainable Development Working Paper Series Addressing Planthopper Threats to Asian Rice Farming and Food Security : Fixing Insecticide Misuse ADB Sustainable Development Working Paper Series Addressing Planthopper Threats to Asian Rice Farming and F," Asian Dev. Bank, no. 27, 2013.

[37] M. S. Allahyari, A. Poshtiban, and V. Koundinya, "Effective factors on agricultural land use change in Guilan Province, Iran," Mediterr. J. Soc. Sci., vol. 4, no. 11, pp. 744–751, 2013, doi: 10.5901/mjss.2013.v4n11p744.

[38] E. L. Johansson and E. Isgren, "Local perceptions of land-use change: Using participatory art to reveal direct and indirect socioenvironmental effects of land acquisitions in Kilombero Valley, Tanzania," Ecol. Soc., vol. 22, no. 1, 2017, doi: 10.5751/ES-08986-220103.

[39] N. Van Nguyen and A. Ferrero, "Meeting the challenges of global rice production," Paddy Water Environ., vol. 4, no. 1, pp. 1–9, 2006, doi: 10.1007/s10333-005-0031-5.

[40] S. A.M, "Agriculture labour market in India," Agric. Updat., vol. 57, no. 2, pp. 183–186, 2019, doi: 10.15740/has/au/14.2/183-186.

[41] C. Chhun, B. Bora, and E. Sothy, "Effect of labour movement on agricultural mechanisation in Cambodia," no. 107, p. 27, 2015, [Online]. Available: https://cdri.org.kh/wp-content/uploads/wp107e.pdf.

[42] N. E. Rada, S. T. Buccola, and K. O. Fuglie, "Government policy and agricultural productivity in Indonesia," Am. J. Agric. Econ., vol. 93, no. 3, pp. 863–880, 2011, doi: 10.1093/ajae/aar004.

[43] A. Poernomo, "Analysis of the Protection of Input Subsidies Policy (Fertilizer and Seed) and Production Output in Rice Plant Agriculture in Indonesia," Eko-Regional J. Pengemb. Ekon. Wil., vol. 12, no. 1, pp. 49–55, 2018, doi: 10.20884/1.erjpe.2017.12.1.1069.

[44] S. B. Azumah and A. Zakaria, "Fertilizer Subsidy and Rice Productivity in Ghana: A Microeconomic Study," J. Agric. Stud., vol. 7, no. 1, p. 82, 2019, doi: 10.5296/jas.v7i1.14367.