125985882 (7)

by Andin Muhammad Abduh

Seventy Years of Rice Crop Cultivation in Tidal Swampland: Potential, Constraints, and Limitations

Nukhak Nufita Sari[1](✉), Riza Adrianoor Saputra[1], and Muhammad Noor[2]

[1] Department of Agroecotechnology, Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru, Indonesia
nukhak.sari@ulm.ac.id

[2] Research Center for Food Crops, National Research and Innovation Agency, Jakarta, Indonesia

Abstract. The reclamation of tidal rice fields has a long history, from the beginning to seventy years of independence. Around 3.4 million ha of swamp land have been utilized, including 2.8 million ha to produce rice. An available area of 16.75 million ha has not been reclaimed from 20.10 million ha. The gap is quite large between the vast potential and suitable land for agriculture (cultivation). On the other hand, the farmer's productivity is still low, around 2–3 t ha^{-1} of dry-milled rice, while it had reported can be achieved at 4.5–7.5 t ha^{-1}. It also indicated a difference between farmers and the results of the study. The obstacles faced in swamp land development are complex and varied, including soil acidity, water management, drainage, toxic elements and compounds, macro and micronutrient deficiencies, pests, and plant diseases. The plans and implementation of programs/projects that have been implemented by the government provide lessons that the development of tidal swamp land is faced with inadequate support for water management infrastructure; planning and implementation steps are still partial, and it seems that each road sector is independent without proper management and not integrated one each other; service and marketing institutions are still weak and limited so that they do not have an impact on the welfare of farmers.

Keywords: Food barn · Staple food · Wetland

1 Introduction

The Indonesian government has long constructed new rice fields in wetlands, especially tidal swamps, through the Dredge, Drain, and Reclamation Program (1956–1958), The Reclamation of Tidal Rice Fields (1969–1985), the One Million Hectare Peatland Development Project (1995–1999), and Development of the Swamp Food Estate Area (2021–2023). Tidal swamp land is considered to have strategic and political value because it covers a spacious area, spreads over 300 districts, and has land suitability for food crops. Politically, it deserves to be a national and even world food barn [1]. The development of these wetlands indirectly opens up new job opportunities, alleviates poverty, evens out

S. B. Sulistyo et al. (Eds.): ICSARD 2022, ABSR 30, pp. 217–229, 2023.
https://doi.org/10.2991/978-94-6463-128-9_23

the distribution of the population, and reduces demographic pressures for densely populated areas on the islands of Java & Bali, as well as equitable distribution of development to swampy areas that are sparsely populated and relatively lagging.

The development of swamp land was inseparable from national food security from the beginning of World War I [2] until the post-Covid-19 pandemic [3]. Since 1950 various exploratory surveys and research have been carried out covering many aspects and fields to explore the potential, constraints, and opportunities of tidal swamp land by researchers from many countries, including Indonesia [4, 5]. Of the 32.64 million ha of swamp land, about 11.68 million ha and 20.96 ha of tidal swamps and swampy lands, respectively [6]. The area of tidal swamp land cultivated by the government for transmigration and the local community is around 1.45 and 2.99 million ha, respectively, while utilized for new rice cultivation is about 0.70 million ha [7]. Thus, there is still quite a lot of available swamp land that has not been utilized or developed.

There is a controversy of opinion on the use of swamp land for food crop farming between two sides. The constituency expressed concern over its stable and fragile nature and character and the environmental impact caused by changes in the natural balance due to reclamation and land use. But on the other hand, showing the potential for rice yields and farmers' income also provides job opportunities for the local community. The series of harvests reported showed a good enough productivity of swamp land. For example, the harvest in August 2015 in the tidal swamp land of Karang Buah Village reached 4.5 dry-milled rice ha^{-1} (Margasari variety) and 6.7 t dry-milled rice ha^{-1} (Inpara 2 variety), and at the same time in Terusan Mulya Village, Kapuas Regency, Central Kalimantan reached 7.5 t dry-milled rice ha^{-1} (Sembada hybrid variety) [8].

This paper is a summary (review) of various studies and knowledge about the potential, utilization, productivity, constraints, and limitations in swamp land development for food crop agriculture during seventy years.

2 Potential, Utilization and Productivity

Agriculture in tidal swamp land had conducted by local people and migrants (transmigrants) in Kalimantan, Sumatra, Sulawesi, and Papua [1]. Yet, most are still traditional, simple methods, without fertilizer, not treated intensively so that production and productivity are low. The introduction of intensive cultivation technology such as water management, soil management, amelioration, and balanced fertilization, plantation of new superior varieties, and integrated pest and disease control has not been widely adopted by farmers. The productivity achieved by farmers generally ranges from 2–3 t dry-milled rice ha^{-1} [9, 10].

2.1 Extensive Potential

According to survey and mapping results by the Indonesian Agency for Agricultural Research and Development, the area of tidal swamp land in Indonesia reaches 8.92 million ha [11] and 11.68 million ha [6] spread over Kalimantan, Sumatra, Papua, Maluku and Java (Table 1 and Table 2).

Table 1. Tidal swamp land area per region 2015 and 2020 versions

Island	Tidal Swamp Area 2015 Version			Tidal Swamp Area 2020 Version		
	Mineral Soil	Peat soil	Total	Mineral Soil	Peat soil	Total
Kalimantan	2.30	0.68	2.99	3.04	0.47	3.51
Sumatera	2.50	0.52	3.03	3.53	0.96	4.49
Sulawesi	0.32	0.0	0.32	0.37	0.0	0.37
Papua	2.26	0.16	2.43	2.61	0.36	2.97
Maluku	0.07	0.0	0.07	0.14	0.0	0.14
Java	0.08	0.0	0.09	0.19	0.00	0.19
Total	7.55	1.37	8.92	9.89	1.79	11.68

Source: ICALRD [11 and 6]

The most extensive tidal swamp land is in Papua Province (1,362 million ha), followed by East Kalimantan (1,140 million ha), West Kalimantan (1,114 million ha), and West Papua (1,074 million ha). Tidal swamp land can be classified into mineral and peat soils, as presented in Table 2.

2.2 Utilization

The use of tidal swamp land, especially for agriculture, began with the Anjir Project or the Dredge, Drain, and Reclamation Project in 1956–1958, followed by the Tidal Rice Reclamation Project in 1969–1984, which targeted the reclamation of 5.25 million ha of swamp land. However, it can only achieve the target of around 2 million ha with the placement of transmigration from Java, Bali, and Nusa Tenggara of 2 million families in Kalimantan and Sumatra [3].

The government, through the Ministry of Public Works and Housing, has built swamp irrigation areas (SIA) whose management is under the authority of the central government (>3,000 ha), about 120 SIA, where 50 and 53 SIA are in Kalimantan and Sumatra, respectively. Then, under the authority of the province government (1,000–3,000 ha) and district is about 238 and 1,876 SIA, respectively [7].

Of the tidal swamp land area of about 11.68 million ha (Table 1), of which 2.801 million ha have the potential for the development of rice cultivation (Table 3). In addition, the potential for horticultural and plantation crops is about 0.519 million ha and 0.124 million ha, respectively (Table 4). Diversification of crop commodities to increase production and income in tidal swamp land is potentially through a *Surjan* system and proper water management in integrated farming of various food commodities such as rice, secondary crops, vegetables, fruits, coconut, livestock, and fish [12–14].

Farming with many commodities in an integrated farming system encourages diversification of agricultural production both horizontally and vertically to produce many processed products. Future, the primary and secondary industries will grow in swamp land areas.

Table 2. Tidal swamp land area per province in Indonesia

Province	Area (million ha)		Total (million ha)
	Mineral	Peat	
Aceh	0.128	-	0.128
North Sumatera	0.309	0.084	0.393
West Sumatera	0.077	0.002	0.079
Riau	0.768	-	0.768
Kepulauan Riau	0.057	-	0.057
Jambi	0.267	0.415	0.682
Bengkulu	0.029	-	0.029
South Sumatera	0.855	-	0.855
Bangka Belitung	0.138	0.012	0.150
Lampung	0.153	0.003	0.156
Sumatera	**2.501**	**0.517**	**3.018**
West Kalimantan	0.664	0.450	1.114
Central Kalimantan	0.333	0.139	0.472
South Kalimantan	0.258	-	0.258
East Kalimantan	1.045	0.095	1.140
Kalimantan	**2.301**	**2.986**	**5.287**
North Sulawesi	0.019	-	0.019
Gorontalo	0.016	-	0.016
Central Sulawesi	0.047	-	0.047
West Sulawesi	0.020	-	0.020
South Sulawesi	0.118	-	0.118
Southeast Sulawesi	0.098	-	0.098
Sulawesi	**0.318**	**-**	**0.318**
West Papua	0.910	0.164	1.074
Papua	1.355	0.007	1.362
Papua	**2.265**	**0.164**	**2.429**
North Maluku	0.009	-	0.009
Maluku	0.066	-	0.066
Maluku	**0.074**	**-**	**0.074**
Banten	-	-	-
West Java & Jakarta	0.017	-	0.017

(*continued*)

Table 2. (*continued*)

Province	Area (million ha)		Total (million ha)
	Mineral	Peat	
Central Java & Yogyakarta	0.018	-	0.018
East Java	0.060	-	0.060
Java	**0.947**	**-**	**0.947**
Indonesia	**7.552**	**1.366**	**8.918**

Source: ICALRD [11]

Table 3. The area of tidal swamp land that has the potential for rice farming

Island	Area (million ha)		Total
	Mineral	Peat	(million ha)
Kalimantan	0.567	-	0.567
Sumatera	1.656	0.173	1.829
Sulawesi	0.010	-	0.010
Papua	0.286	0.003	0.289
Maluku	0.011	-	0.011
Java	0.095	-	0.095
Total	**2.625**	**0.176**	**2.801**

Source: ICALRD[11]

Table 4. Potential of tidal swamp land for horticultural crops and plantations

Island	Area (million ha)		Total (million ha)
	Horticulture	Plantation	
Kalimantan	0.235	0.100	0.335
Sumatera	0.284	0.007	0.291
Sulawesi	-	-	-
Papua	-	0.017	0.017
Java	-	-	-
Total	**0.519**	**0.124**	**0.643**

The gap is quite large between the potential of tidal swamp land suitable for agriculture, with those that had reclaimed (utilized) and those that had not been (Table 5). The prospective swamp land that can be developed into food agriculture areas in the long term to increase food production and diversify farming, sources of agribusiness and

Table 5. The area of tidal swamp land that has been and has not been reclaimed and utilized

Reclamation (ha)			Utilization (ha)		Total (ha)
Not Reclaimed	Reclaimed		Not Utilized	Utilized	
	Government	Society			
15,746,994	1,452,569	2,897,237	725,758	726,811	20,096,800

Table 6. Superior varieties of rice productivity by overflow type in South Kalimantan

Type of overflow	Site/Swamp Irrigation Area	Productivity (t dry-milled rice ha^{-1})			
		1988/89	1989/90	2015/16	2021/22
Type A	Tabunganen/Terusan	3.2	2.8	5.0–7.5	5.4–7.3
Type B	Anji Serapat/Terantang/Belanti II	2.3	2.8	4.5–6.7	3.5–7.4
Type C	Barambai/Tamban Catur	1.9	2.8	4.0	-
Type D	Sakalagun	3.4	-	x	x

Note: - = no data, x = land conversion to rubber plantation
Source: Subagio *et al.* [8], Noor [20],; Hairani & Noor [21], Hairani *et al.* [22].

agro-industry growth, opportunities for employment, and improvement of community welfare are still widely available.

2.3 Productivity

Various crop commodities that can be cultivated in tidal lands include food crops (rice, corn, soybeans, peanuts, green beans, and sweet potatoes), vegetables (tomatoes, chilies, cucumbers, long beans, eggplant, beans, cabbage, shallots, pumpkins, mustard greens, lettuce, spinach, and kale), fruit crops (pineapple, watermelon, cucumber, oranges, rambutan, and bananas), and plantation (coconut, oil palm, coffee, pepper, ginger, and aromatic ginger) [15].

Rice cultivated in tidal swampland consists of local varieties that are photoperiod sensitive, superior varieties, and hybrids. The varieties considered adaptive in tidal rice fields with not too high acidity and iron content are Cisanggarung, Cisadane, Cisokan, Membramo, Ciherang, IR42, and IR66 [16]. That yield can reach 3–5 t ha^{-1}. Meanwhile, for land with high acidity and iron content, several local superior varieties can be used, such as Talang, Ceko, Mesir, Jalawara, Siam Lemo, Siam Unus, Siam Pandak, Siam Putih, Semut, Pontianak, Sepulo, Pance, Salimah, Jambi Rattan, and Tumbaran. The yield of the local rice variety is around 2–3 t dry-milled rice ha^{-1} [17].

The choice of commodities other than rice is possible if the land is arranged in a surjan or tukungan system, especially on B or C type and dried-field system on C and D type supported by intensive shallow drainage. Second crops and horticultural or industrial plants can be cultivated on the surjan system, while C and D type during the dry season [18]. It shows a wide choice of commodities and varieties that can be developed for agribusiness in tidal lands according to market or consumer preferences. Rice productivity in tidal swamp land is not only determined by variety, but also by the type of overflow and land typology (Table 6). Rice productivity in acid sulfate land, peatland, and saline land range from 4.5–6.0, 4.0–5.0, and 4.0–4.5 t dry-milled rice ha^{-1}, respectively [19]

3 Biophysical, Social, Economic, and Environmental Constraints

3.1 Land Biophysic

Tidal swamp land has biophysical properties, and soil fertility is less favorable for a rice cultivation area. Most of the soil in tidal swamp land is still raw, mud form, and has high clay content, shallow pyrite layers, and thick peat layers, making it difficult to cultivate [23]. Tidal swamp soil also has high porosity, especially peat soil has a very high hydraulic conductivity horizontally compared to vertical, so it is easy to pass water [24]. The chemical aspect and soil fertility of tidal swamp soil are acidic with a pH of 3.5–4.5, so it requires ameliorant material. The macronutrients and some micronutrients (Cu, Zn, Mo, B) are less available or low and have high levels of Al, Fe, and Mn, which are toxic to plants and reduce productivity. Tidal lands require a proper water system to prevent flooding during the rainy season and drought during the dry season. However, the water system performance is inefficient, especially at the tertiary water network level, and less proper operational irrigation management [25].

3.2 Social Economic

Low education and capital have hindered the transfer of agricultural technology to tidal swamp land [26]. Farmers are very aware of the importance of fertilizers in increasing land productivity, but often the need to fertilize rice crops together with other urgent needs, such as payment of tuition fees. Markets and supporting institutions that do not play a role cause ineffectiveness in overcoming capital problems, providing production facilities, and marketing. The Sub-District Extension Center has not provided optimal services due to inadequate and equitable transportation facilities. The limitations of agricultural extension workers involve the limit in number, area coverage, transportation facilities, road infrastructure, and limited knowledge of swamp land [27].

Moreover, limited labor is also one of the constraints in tidal swamp land, especially at planting and harvesting [26]. The lack of labor in farming causes low planting and maintenance intensity to affect low land productivity. Labor problems related to low incomes can cause farmers to neglect their rice crops because they are looking for work in urban areas, such as construction workers. The intervention of agricultural machine tools as a substitute for the lack of labor on tidal swamp land still has problems due to its limited availability. Also, it has not been balanced with training and workshops in the farmers' working area.

3.3 Environment

Agricultural development in tidal lands frequently does not take notice of the environmental impact aspect. For example, excessive drainage on peatlands causes peatland degradation, resulting in a lot of GHGs and creating a subsoil that is toxic to plants. Likewise, the uncontrolled use of pesticides and insecticides causes pollution of the aquatic environment [28]. The issue of climate change also has an impact on the cultivation of food crops on tidal land. The submerged condition during rice cultivation in tidal land could increase methane emission [29]. Climate change causes an increase in air temperature, an increase in sea level, changes in rain patterns, and an increase in the frequency of extreme climate events [30]. Various studies have shown that climate change has caused a decrease in productivity and crop production due to an increase in air temperature, flooding, drought, the intensity of pest and disease attacks, and degradation in the quality of agricultural products [14].

The old problem in tidal swamp land is the water and soil aspect that comes from overflowing river water due to the ebb and flow of seawater and rain. Water puddle becomes a problem for agricultural development in tidal swamp land type A because the topography makes it difficult to drain water. Drought in the dry season in tidal swamp land types C and D also often occurs. Salinity at the peak of the dry season will cause plant damage, especially before panicles appear on rice plants. High salinity in the root zone will inhibit the absorption of water and nutrients.

4 Dynamics of Swamp Land Development 1950–2020

The Indonesian government opened up swampy areas due to the awareness of the world food crisis after World War I [2]. The development of swamp land for seventy years from 1950–2020 is divided into four periods, i.e., 1950–1965; 1966–1994; 1995–2010; and 2011–2022. The planned development of the swamp area is mainly to increase food production, especially rice.

4.1 1950–1965 Period

During this period, swamp development had carried out through the Dredge, Drain, and Reclamation Project from 1956–1958. The project is called the Anjir reclamation system, which is the construction of a large canal that connects two large rivers to distribute and drain the swamp area (in the middle). President Soekarno launched the Three-Year Rice Production Plan Program (1959–1961) to achieve food self-sufficiency in 1961 [8]. During this period, the swamp area development activities continued the previous system at Anjir Serapat (28.5 km) and Anjir Tamban (25.3 km) in South Kalimantan and Central Kalimantan. The development of swamps with an anchor system was continued in 1960–1980, such as Anjir Kelampan/Pulang Pisau, Central Kalimantan (20 km) built in 1980, Anjir Basarang, Central Kalimantan (24.5) in 1982, Anjir Talaran, South Kalimantan (26 km) in 1969 [24].

4.2 1966–1994 Period

During this period, swamp development had carried out through the Tidal Rice Reclamation Project, the fork reclamation system in South and Central Kalimantan, and the comb system in Sumatra and West Kalimantan. The fork system is the construction of primary and secondary canals from large rivers into the interior between 5–10 km, which at the secondary end of the fork system made a tide pool (300–500 hectares). About 5.25 million hectares of swamp area had been reclaimed for 15 years (1969–1984). The development area at this time was called the Transmigration Settlement Unit because it coincided with the arrival of transmigrants from Java, Bali, and East Nusa Tenggara to occupy this new opening area. The Transmigration Settlement Unit area ranged from 2,500–7,500 hectares [20]. During this period, around 29 and 22 reclamation schemes (areas) were built in South and Central Kalimantan and Sumatra and West Kalimantan, respectively [31]. From the target of 5.25 million hectares, about 2.0 million hectares were spread across various districts/cities of Sumatra, Kalimantan, Sulawesi, and Papua.

4.3 1995–2010 Period

During this period, swamp development had carried out through the One Million Hectare Peatland Reclamation Project in Central Kalimantan located in Kapuas, Pulan Pisau, South Barito, and Palangka Raya Regencies. In the plan, the reclaimed swamp area was 1.2 million hectares. However, in 1999 the project was discontinued. Then by President Susilo Bambang Yudhoyono (SBY), a restructuring was carried out in 2007 (Inpres No. 2/2007). The plan was to place around 350,000 families in transmigration, but the implementation was about 15,000. Some of these areas returned to forests and grasslands after being cleared due to most of the farmers backed to their origin [1]. Then, those areas had included in the Serasi Program in 2016–2019 and the Swamp Land Food Estate Program in 2021–2023.

4.4 2011–2022 Period

From 2008–2015, activities in swampland were optional and sporadic infrastructure improvements. Swamp land development activities began to rise after a technology show held at the World Food Day Anniversary in Jejangkit Muara Village, Barito Kuala Regency, and National Swamp Week II in Banjarbaru, South Kalimantan. At that event, the Serasi (*Selamat Rawa, Sejahterakan Petani*) Program had established. The plan was to optimize land and intensify food crops, particularly rice covering an area of 200,000 hectares in Kalimantan, 200,000 hectares in Sumatra, and 100 hectares in Sulawesi in the 2018–2020 period.

During the Covid 19 pandemic, the swamp area development program experienced a calling down, and then the idea emerged to form a swamp food estate area in Central Kalimantan in 2021. It had feared that rice importing countries hold back their rice from exporting and prioritize the fulfillment of their respective domestic needs for fear of a world food crisis after Covid 19 [3]. President Joko Widodo opened a food estate area of 770 thousand hectares in stages over three years (2021–2023) in the swamp land of Kapuas and Pulang Pisau Regencies, Central Kalimantan. Unfortunately, there were some technical, socio-cultural, and planning obstacles during the implementation. The technical obstacle concerns the readiness of the infrastructure water system. Infrastructure preparation did not plan simultaneously with the implementation of agricultural cultivation. The laborers compete for other jobs. Also, the less enthusiasm for farmers because of failure experiences before.

5 Learning, Opportunities, and Limitations

Land potential, development constraints, and the history of swamp land reclamation for seventy years from time to time show that swamp areas are the future of Indonesia.

5.1 Learning

Swamp areas have high diversity, so the progress of a region needs to be adjustable regarding the characteristics of the new one. For example, the progress of the swamp area in Belanti Siam Village, Pulang Pisau Regency, and Central Kalimantan was introduced to the swamps of Tajau Landung Village, Barito Kuala Regency, and South Kalimantan. Or the Lebak area in Pamulutan Village, Ogan Ilir Regency, South Sumatra was introduced in Hambuku Village, Hulu Sungai Utara Regency, South Kalimantan. Each area has different potential and suitability for land and environment [21].

In addition, environmental biophysical factors and socio-cultural conditions of the local community, which are different in each region, need to be considered so that there are no social or cultural clashes. Each region also has local customs and wisdom as local wealth that needs attention and appreciation in knowledge and technology.

From various development periods, it seems that there is no sustainable approach after the program/project was completed. Besides, the success of a reclamation requires lag time. Therefore, in planning, it is necessary to establish definite institutions and management with short, medium, and long-term measurable goals and targets based on studies and information, not based on the tenure of power or budgetary costs. In addition, considering that agricultural problems in swamp areas are not only in the agriculture sector but also in public works, rural areas, the environment, and others, an integrated approach is absolute. However, for the time being, it seems that they are still running independently, not integrated, even planned and carried out by each sector.

5.2 Opportunities

Several countries success in managing swamp areas as centers of rice production and world food exporters, such as Thailand and Vietnam. On a small scale, some swamp areas are nodal of rice production for their region. For example Belanti Siam Village in Pulau Pisau Regency; Terusan Mulya and Tamban Catur Village in Kapuas Regency (Central Kalimantan); Telang I Village in Banyuasin Regency (South Sumatra); Karang Buah Village, Anjir Muara Village in Barito Kuala Regency, Kurau Village in Tanah Laut Regency, Gambut Village in Banjar Regency (South Kalimantan); Matang Danau Village in Sambas Regency, Rasau Jaya Village in Kubu Raya Regency (West Kalimantan). In addition, several locations or villages have developed into rubber, citrus, coconut, and oil palm production nodal.

The development of swamp areas is considered cheaper, prospective, and strategic. Those are due to (1) relatively flat topography; (2) abundant water availability; (3) suitable to marginal land suitability with moderate limiting factors; (4) abundant of other choice rather than rice; (5) access to land is getting easier with many land roads connected to swamps; (6) the local community is rich in local wisdom, and (7) sufficient technological innovation support is available. The potential of 1.0 million hectares of swamp land developed by increasing the intensity of cropping twice a year (IP 200) and productivity of 4–5 t milled rice ha^{-1} will obtain double rice production so that it has the opportunity for export [8].

5.3 Limitations

From the history of development as stated above, the limitations include the development approach, which is still partial, not comprehensive, and even seems to be more concerned with the target of planting area than supporting equipped infrastructure and suitable the characteristics of the region. In addition, the development had not taken consideration to the lag time and gradually processes with an adaptation approach. Moreover, the limitation of development is that there is no guaranteed market for the products produced by farmers. Amid high prices for fertilizers, pesticides, and wages, farmers lose more money because the selling price of grain is low due to not having the bargaining power. While the government's role in providing subsidies is limited and declining. Also, logistics affair agency sometimes buy the rice grain below the market price.

6 Conclusion

Strengthening the development of swamp land for rice cultivation is needed through reclamation and development through an integrated approach based on regional characteristics. The diversity of swamp areas requires different planning steps and policy implementation specific locations. The development of swamp land requires a comprehensive, integrated, not partial, gradual, and sustainable approach. Supporting infrastructure for water and road systems, the availability of human resources, institutions and management of planning, services for production facilities, and marketing are the keys to the success of future swamp development.

Authors' Contributions. Nukhak Nufita Sari contributed to conceptualization, writing-original draft preparation, writing-review and editing. Riza Adrianoor Saputra contributed to writing-original draft preparation, funding acquisition. Muhammad Noor contributed to resources, writing-original draft preparation, funding acquisition.

References

1. A.A. Sulaiman, K. Subagyono, T. Alihamsyah, M. Noor, Hermanto, A. Muharram, I.G.M. Subiksa, I.W. Suwastika, Membangkitkan Lahan Rawa Membangun Lumbung Pangan Indonesia, Kementan. Rep. Ind. Jakarta, IAARD Press. 2018, 156p.

2. Notohadiprawiro, Twenty-five Years Experience in Peatland Development for Agriculture in Indonesia. In J.O. Rieley and S.E. Page (eds). Proc. of the Intern. Symp. On Biodiversity, Environmental Importance and Sustainablity of Tropical Peat and Peatland, UK, 1997, pp, 301–310.
3. M. Noor, Y. Sulaeman, Pemanfaatan dan Pengelolaan Lahan Rawa: Kearifan, Kebijakan, dan Kerberlanjutan, Yogyakarta: Gadjah Mada Univ. Press, 2021. 242p.
4. K. Nugroho, Sejarah Penelitian Gambut dan Aspek Lingkungan, In Husien *et al.* (eds). Prosiding Seminar Nasional Pengelolaan Lahan Gambut Berkelanjutan. Bogor 2012 4th Mei, Balitbangtan, Kementan, 2012, pp, 173–184.
5. M. Noor, Sejarah Pembukaan Lahan Gambut untuk Pertanian di Indonesia, In E. Husien *et al.* (eds). Prosiding Seminar Nasional Pengelolaan Lahan Gambut Berkelanjutan, Bogor 2012 4th Mei, Balitbangtan, Kementan, 2012, pp. 399–412.
6. ICALRD (Indonesian Center for Agricultural Land Resources Research and Development), Sosialisasi Peta Gambut serta Potensi Lahan Gambut untuk Pertanian, presented at Webinar Pemanfaatan Gambut Secara Berkelanjutan, Bogor, 28 Mei 2020.
7. Birendradjana, Strategi Peningkatan Produktivitas Lahan Rawa Pasang Surut untuk Pertanian Berkelanjutan. Direktorat SSPSDA, Dirjen SDA, Kementerian PUPR, presented at Webinar Pusat Data dan Informasi Kawasan Rawa dan Pantai, Univ. Sriwijaya, Palembang, 2021 15th September.
8. H. Subagio, M. Noor, W.A. Yusuf, I. Khairullah, Perspektif Pertanian Lahan Rawa: Mendukung Kedaulatan Pangan, Jakarta, IAARD Press, 2015, 108p.
9. M. Sarwani, M. Noor, E. Husien, Tidal Swamps for Future Food Support in Facing of Climate Change, In E. Husien *et al.* (eds). Proc. Intern. Workshop on Sustainable Management of Lowland for Rice production. Banjarmasin 2012 27–28th Sept, IAARD Press, Jakarta, 2013.
10. D. Nursyamsi, Haryono, M. Noor, Sistem Surjan: Model Pertanian Lahan Rawa Adaptif Perubahan Iklim, IAARD Press, Jakarta, 2014, 133p.
11. ICALRD (Indonesian Center for Agricultural Land Resources Research and Development), Sumber Daya Lahan Pertanian Indonesia. Luas, Penyebaran, dan Potensi Ketersediaan, Redactor, Ritung *et al.*; Editor, E. Husien, F. Agus, D. Nursyamsi, Jakarta, IAARD Press, 2015, 100p.
12. I.P.G. Widjaja-Adhi, Pengelolaan Tanah dan Air dalam Pengembangan Sumber Daya Lahan Rawa untuk Usaha Tani Berkelanjutan dan Berwawasan Lingkungan. Presented at Pelatihan Calon Pelatih untuk Pengembangan Pertanian di Daerah Pasang Surut. 1995 26–30th June. Karang Agung Ulu Sumatera Selatan, 1995.
13. I. Ar-Riza, Alkasuma, Pertanian Lahan Pasang Surut dan Strategi Pengembangannya dalam Era Otonomi Daerah, Jurnal Sumberdaya Lahan, 2008, 2(2), 95-104.
14. A. Susilawati, D. Nursyamsi, Sistem Surjan: Kearifan Lokal Petani Lahan Pasang Surut dalam Mengantisipasi Perubahan Iklim. Jurnal Sumberdaya Lahan, 2014, 8(1), 31–42. https://doi.org/10.21082/jsdl.v8n1.2014.25p
15. D. Nazemi, A. Hairani, Nurita, Optimalisasi Pemanfaatan Lahan Rawa Pasang Surut Melalui Pengelolaan Lahan dan Komoditas. Agrovigor, 2012, 5(1), 52–57 https://doi.org/10.21107/agrovigor.v5i1.308
16. M. Noor, A. Jumberi, Potensi, kendala, dan peluang pengembangan teknologi budi daya padi di lahan rawa pasang surut, pp. 223–244, In A.A Daradjat, A. Setyono, A.K. Makarim, A. Hasanuddin, (Ed.). Padi, Inovasi Teknologi Produksi. Book 2. Balai Besar Penelitian Tanaman Padi, Sukamandi, Subang, 2008.
17. Balittra (Balai Penelitian Tanaman Pangan Lahan Rawa), Lahan Rawa Pasang Surut: Pendukung Ketahanan Pangan dan Sumber Pertumbuhan Agribisnis, Balittra, Banjarbaru, 2003, 53p.
18. D.A. Suriadikarta, Pengelolaan Lahan Sulfat Masam untuk Usaha Pertanian, Jurnal Litbang Pertanian, 2005, 24(1), 36-45.

19. Haryono, Lahan Rawa Lumbung Pangan Masa Depan Indonesia, Balitbangtan, IAARD Press, Jakarta, 2012, 142p.
20. M. Noor, Padi Lahan Marjinal, Jakarta, Penebar Swadaya, 1996, 213p.
21. A. Hairani, M. Noor, Water management for increase rice production in the tidal swampsland of Kalimantan Indoenesia: contrains, limiteedness and oppurtinities, IOP Conf. Ser. Earth Environ. Sci, 2020, 499 012006.
22. A. Hairani, M. Alwi, M. Noor. Rice productivity on tidal swamplands that flowing spring tide: the case of Terusan Karya village, Submit to the 1st Intern Conferen on Food and Agriculltural Sciences 2022.
23. M. Noor, I. Hairullah, H. Sosiawan, Pengelolaan Air untuk Pertanian Tanaman Padi di Lahan Rawa: Kasus Desa Jejangkit Muara, Kabupaten Barito Kuala, Kalimantan Selatan, In Masganti *et al* Sumber Daya Lahan Rawa Dukungan Teknologi Menuju Lumbung Pangan Dunia 2045, IAARD Press, Bogor, 2019, pp, 13–34.
24. M. Noor, Pertanian Lahan Gambut, Potensi dan Kendala, Yogyakarta, Kanisius, 2001, 174p.
25. H. Sosiawan, W. Annisa, Pengelolaan Infrastruktur dan Tata Air di Lahan Rawa Pasang Surut, In Masganti *et al* Optimasi Lahan Rawa Akselerasi Menuju Lumbung Pangan Dunia 2045, IAARD Press, Bogor, 2020, pp, 23–47.
26. H. Subagio, Y.R. Darsani, Karakteristik Sosial Ekonomi Petani di Lahan Rawa, In Masganti *et al* Agroekologi Rawa, IAARD Press, Bogor, 2017, pp. 565-594.
27. Y.R. Darsani, S. Umar, Kelembagaan Pertanian di Lahan Rawa, In Masganti *et al* Agroekologi Rawa, IAARD Press, Bogor, 2017, pp, 595-630.
28. E. Maftuah, A. Hayati, Teknologi Pengelolaan Lahan Gambut Rendah Emisi GRK untuk Budidaya Cabai Merah (*Capsicum Annum* L.), In Masganti *et al* Optimasi Lahan Rawa Akselerasi Menuju Lumbung Pangan Dunia 2045, IAARD Press, Bogor, 2020, pp, 265–288.
29. N.S. Nukhak, Nurlaila, M.F. Azhari, Jumar, Effect of Water Management on Methane Flux and Chemical Properties of Acid Sulfate Soil, *Jurnal Ecosolum*, 10(2), 15–24, 2021. https://doi.org/10.20956/ecosolum.v10i2.18293
30. IPCC, Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, In: S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, H.L. Miller, (eds.). p. 996. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.
31. M. Noor, Lahan Rawa: Sifat dan Pengelolaan Tanah Bermasalah Sulfat Masam, Jakarta, Raja Grafindo Persada, 2004, 239p.

125985882 (7)

ORIGINALITY REPORT

6%	4%	4%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	download.atlantis-press.com Internet Source	3%
2	Mariani. "Agricultural innovation to increase climate change resilience in Tapin Regency", IOP Conference Series: Earth and Environmental Science, 2023 Publication	1%
3	A Hairani, M Noor. "Water management on peatland for food crop and horticulture production: research review in Kalimantan", IOP Conference Series: Earth and Environmental Science, 2020 Publication	1%
4	epublikasi.pertanian.go.id Internet Source	1%
5	Fitriani Fitriani, Hesty Tambajong, Ransta L Lekatompessy, Fransin A Kontu, Imelda C Laode. "THE IMPACT OF THE FOOD CRISIS AND CLIMATE CHANGE ON THE LIVES OF LOCAL COMMUNITIES", AGROLAND The Agricultural Sciences Journal (e-Journal), 2023 Publication	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		