JSSEW
Journal of Sustainability, Society and Eco-Welfare
JSSEW 1(1): 1-16
ISSN 3025-1524

Availability and potential for expansion of agricultural land in Indonesia

Nor Isnaeni Dwi Arista[1*], Annisa Dhienar Alifia [1,2], Husni Mubarok[1], I Made Satria Dwi Arta [1], Dian Novira Rizva [1], and Abiet Ilham Wicaksono [1]

1 Master Program of Agronomy and Horticulture, Faculty of Agriculture, Institut Pertanian Bogor University; Bogor, Indonesia.
2 National Research and Innovation Agency; Jakarta, Indonesia.
* Correspondence: dewi.arista@apps.ipb.ac.id

Received Date: July 12, 2023 Revised Date: July 25, 2023 Accepted Date: July 28, 2023

Abstract
Land is a critical factor in agriculture, especially in soil-based cultivation. The prevailing problem in agricultural land use that is yet to be solved is the rapid conversion to non-agricultural use, which raised concern for agriculture's existence in the future. Moreover, the population continues to grow despite the receding agricultural land to produce food. Therefore, research and policies are starting to lean towards optimization of marginal land for agricultural activities. Indonesia still has potential marginal land for agricultural expansion. This paper uses secondary data and former studies to summarize the potential and availability of marginal land for agricultural expansion based on the land categories: forest land, dryland, and wetland (tidal swamp and peat). This paper also discusses the government's extensification program and the results of its implementation. We found that various reports about marginal lands utilization emphasized optimizing the target land with appropriate agricultural technology. The presentation of data obtained through literature studies can strengthen the opinion that the potential availability and potential for expansion of agricultural land in Indonesia is real. This paper is expected to provide a comprehensive reference for all Indonesian regional governments, so stakeholders continue optimizing the potential of existing natural resources.

Keywords: agricultural land Indonesia; challenge of agriculture; data of agriculture; marginal land; optimizing agriculture

Cite This Article:
Arista, N. I. D., Alifia, A. D., Mubarok, H., Arta, I. M. S. D., Rizva, D. N., & Wicaksono, A. I. (2023). Availability and potential for expansion of agricultural land in Indonesia. *Journal Sustainability, Society and Eco-Welfare, 1*(1), 1-16, https://doi.org/10.61511/jssew.v1i1.2023.242

1. Introduction

The agricultural sector has a strategic role in the structure of national economic development and needs to receive serious attention from the government in nation-building. Government protection, credit, and policies have yet to profit this sector, which was made worse by unclear agricultural development goals. However, this sector accommodates an overflow of labor and is depended by large percentage of this country's population (Salamah, 2021). Thus, all this significantly impacted Indonesians, especially on food security.

Improvement of agricultural development includes agricultural intensification and land extensification/expansion. Agricultural intensification includes good soil management, regular irrigation, use of superior seeds, fertilization, pest control, and crop processing. Meanwhile, agricultural extensification includes diversification, mechanization, and rehabilitation (Ningsih et al., 2022). A well-implemented intensification aspect will produce high quality agricultural products, therefore increasing the marketable value.

On the other hand, land availability has become a problem amid the rapid land conversion rate to non-agricultural use. The conversion rate of lowland paddy field to non-agricultural land in 9 provinces in Indonesia from 2000-2015 is 96.512 ha per year (Mulyani et al. 2016). Therefore, Indonesian's Ministry of Agriculture stated in its second revision of 2020-2024 Strategic Plan (2021) that future initiatives to suppress the rapid agricultural land conversion and maintain food production is to protect the existence of agricultural land by spatial planning and control, increasing land optimalization, rehabilitation, and extensification, increasing farming productivity and efficiency, and population control. Extensification is carried out by opening new lands for agriculture, one of which is utilizing land where weeds have grown, such as reeds. Tjimpolo and Kesumaningwati (2009) stated that using land overgrown with *Imperata* weeds for agriculture is relatively better when compared to clearing forests because it lowers costs and maintains the hydrological function of the forest. Infrastructure is available, although it is still minimal.

Implementation of agricultural extensification can be carried out by farmers or government programs participants. Expansion of agricultural land can be carried out independently and continuously, the implementation of which is fully supervised by the government. Potential land available for food production or agriculture activities can be classified to their ecosystem: dry land, swamp (tidal and non-tidal), and other wetlands. About 50.19% of the potential land for agriculture in Indonesia is in the category of Other Use Area (APL), Limited Production Forest (HPK), and Production Forest (HP) (Ritung et al., 2015); this research shows that the potential of land in Indonesia is very large to be developed to support clothing, food, shelter, and human feed. This is because Indonesia's population continues to grow, with a total population of 278,696.2 thousand people (BPS 2023).

Research on the potential of land use in Indonesia is very important to meet the domestic needs for clothing, food, shelter, and human feed. Identification is crucial to specify which land can be used in agricultural production. Identification can be done of them by using previous research studies. In this paper, a literature study is carried out regarding the potential in terms of area and constraints for the extensification of Indonesian agricultural land by utilizing marginal land (forest land, dry land, and wetlands), as well as discussing the government's extensification program and the results of its implementation. This paper aims to provide a comprehensive picture of the prospects for expanding agricultural land and its problems and become valuable input for readers in planning and implementing agricultural land extension.

2. Methods

This paper uses qualitative methods with a literature review. The strategy for collecting data in this paper is to use secondary data by analyzing Indonesian government regulations, the Ministry of Agriculture's annual report book, and the results of scientific research that has been carried out. The authors also conducted a literature search in various journals and books for relevant research to support the potential availability and potential for expansion of agricultural land in Indonesia. Based on the data obtained, the authors analyzed the condition of agricultural land in Indonesia and described the challenges and potential of converting marginal land for agricultural use. This research examines the potential of Indonesia's marginal lands, such as forest, dryland, peat, and swamps. Furthermore, this paper is expected to provide a comprehensive reference for all Indonesian regional governments, so stakeholders continue optimizing the potential of existing natural resources.

3. Results and Discussion

3.1. Indonesian Agricultural Land Expansion Potential

The need for food is increasing along with the increase in population. In 2050, an additional land area of around 14.8 million ha will be required. Therefore, increasing food production in the future must be balanced with expanding or expanding new areas. There are several approaches of carrying out agricultural land extensification:

3.1.1. Forest Clearing

People in Indonesia have carried out this method for a long time, namely using the nomadic system to clear forest areas to open agricultural land. The results of monitoring Indonesia's forests in 2020 show that the Area of forested land throughout mainland Indonesia is 95.6 million ha or 50.9 of the total land area, of which 92.5 of the total forested Area or 88.4 million ha is within forest areas and suitable for farming and generally located in rural areas in the form of relatively flat or relatively hilly land. Until 2019, the forested land area in Indonesia decreased by 1.6 million ha during 2014-2019. *Indonesia's forests* are an essential national resource that must maximize the community's benefit. Therefore, the utilization of forest resources should be carried out through the involvement and empowerment of all elements of society and encourage the community to use all of their potentials fully. The government has implemented social forestry programs as a manifestation of the community to develop their capacities and encourage them to participate in forest management in a fair and environmentally friendly manner.

3.1.2. Utilization of Dry Land

Indonesia's total Area of dry land is around 144.47 million ha (Ritung et al., 2015); due to its nature, around 82% of the total dry land is classified as suboptimal. Acid dry land is suboptimal dry land which occupies the most dominant Area, around 107.36 million ha (about 74.3% of the total dry land area). In comparison, around 10.75 million ha (7.4% of the total dry land area) is dry land dry climate. The Area of acid dry land and dry climate dry land, which has the potential for agricultural development, is approximately 62.64 and 7.76 million ha, respectively (Table 1). Mulyani and Sarwani (2013) stated that the suboptimal dry land area suitable and available for expansion of annual crop farming is around 7.08 million ha, while for annual crops, it is around 15.31 million ha.

The role of dry land as the primary alternative food producer is becoming increasingly important. Based on data from the Central Bureau of Statistics (2012), approximately 83.9% of corn, 55.2% of soybeans, 82% of peanuts, and 84% of cassava are cultivated on dry land. Furthermore, if the food diversification program is successfully carried out, the next challenge will be the readiness of dry land to play a more significant role in supporting food needs. Therefore, to support the success of the food security policy through the food diversification program, the main option that must be carried out immediately is to improve the productivity of dry land so that dry land can act as a food provider.

According to Agricultural Statistics data sourced from BPS data on the development of Area (ha), Harvested Area (ha), Production (Tons), and Productivity of Dry Land in Indonesia 2013–2018, which have been used for agricultural cultivation, especially rice, can be seen in Table 1.

Table 1. Data on the development of Area (ha), harvested area (ha), production (tons), and productivity of dry land in Indonesia 2013–2018 that have been utilized.

No.	Year	Area (ha)	Harvested Area (ha)	Production (tonne)	Productivity (kg/ha)
1	2013	5,123,625	1,163,000	3,888,000	3.342
2	2014	5,036,409	1,131,000	3,744,000	3.311
3	2015	5,190,378	1,087,000	3,631,000	3.339
4	2016	5,074,223	1,171,000	3,872,000	3.307
5	2017	5,222,066	1,156,000	3,783,000	3.272
6	2018	5,222,066	1,274,000	4,179,000	3.281

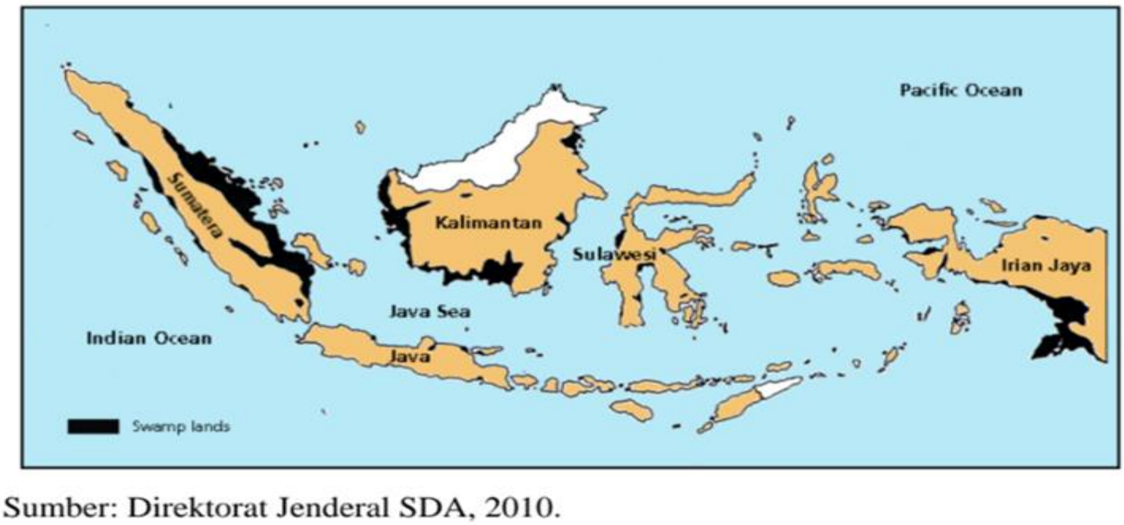
The distribution map of dry land is based on the development of the area (ha), harvested area (ha), production (tons), and productivity of dry land in Indonesia from 2013 to 2018, which has been used for agricultural cultivation, especially rice in the ten largest provinces, which can be seen in Figure 1.

Figure 1. Map of the distribution of dry land based on the development of area (ha), harvested area (ha), production (tons) and productivity of dry land in Indonesia
2013 – 2018 that have been utilized

From the data above, the potential of dry land in helping to meet national food needs, especially rice, can be very significant if it is developed and provides input for proper cultivation and production facilities, proper cultivation systems and management, and ongoing water management because water needs significantly affect dry land. If the area potential is utilized optimally with the right technology, then national food production will increase even though most apply IP 100. The increase in cropping index can be increased by cultivating various commodities by adjusting cropping patterns according to the area and potential of local land resources.

3.1.3. Swamp Potential

The potential for swamp land in Indonesia is immense. Where Indonesia has a swamp area of 33.4 million hectares (Directorate of Irrigation and Swamp 2012), spread over Sumatra 32.9%, Kalimantan 40.4%, Papua 21%, Sulawesi 5.7%, and the rest are partially scattered over small area (Wahyunto et al., 2012), which can be optimized for agricultural land (Triadi, 2021). Swamps cover 15% of Indonesia's area. In Sumatra, Kalimantan, and Papua, most are tidal swamps (93%), and the rest are lowland swamps (7%). Of the total swamp land (33.9 million hectares), it consists of peat land (41%), mineral soil (53%), and mangroves (6%). A map of the distribution of swamps in Indonesia can be seen in Figure 2.



Sumber: Direktorat Jenderal SDA, 2010.

Figure 2. Map of the distribution of swamps in Indonesia

Swamp land resources, both tidal and lowland, suitable for agricultural business, are still quite extensive. Until now, the use of swamp land as an agricultural business is still limited, so the opportunity to increase the role of this land in the future is still quite significant as a source of agricultural growth. However, caution is needed in its management because of the unique physico-chemical properties of the soil. The approach that can be taken in the development of swamp land must refer to the typology of the land and the type of water overflow. Each land typology requires a different management method (Sudana, 2005).

3.2. Extensification Based on Origin Land Type

3.2.1. Agricultural Extensification of Dry Land

Dryland farming is a type of farming that is carried out on land that lacks water. *Drylands* tend to be dry and do not have a definite water source, such as rivers, lakes, or irrigation canals. Dry land is a type of marginal land because drought causes various negative impacts on plants (Garfansa et al., 2022). *Dry land* is defined as an area that is never flooded or inundated with water most of the year or all the time. The Indonesian plains, with an area of 188.2 million ha, include potential land for dryland food crops (Puslitbangnak, 2000). Potential land for dryland food crops is biophysically, especially from topography/slope, climate, and physical, chemical, and biological properties of the soil suitable or suitable to be developed for dryland food crops.

Most of the dry land area is suitable for seasonal crops of 25.09 million ha has been used for agricultural land and other uses (Settlements/Industrial Areas, infrastructure, etc.). It is not yet known with certainty the data on the area of dry land that has been used for crop farming with certainty the data on the area of dry land that has been used for farming seasonal crops because the harvested area from BPS data does not separate paddy fields from dry land. However, as an estimate, a 1:1,000,000 scale land use map has been used to identify lands currently in the form of Imperata. The map is superimposed (overlayed) with the agricultural spatial direction map so that an estimate of dry land that is still available is indicative of expanding the agricultural area of dry land food crops covering an area of 7.08 million ha, consisting of dry land with a wet climate of 6.83 million ha and dry land with an area of 0.26 million ha.

For the expansion of dry land annual plant areas in Java Island, there is around 40,544 ha, and around 26,394 ha of them are dry land with dry climates in East Java Province. The location of the land area is scattered, so practically expanding the area of dry land annual crops in Java is difficult to do. The most significant opportunities for expanding the area of dry land annual crops are in Kalimantan, which is around 3.6 million ha, the largest in East Kalimantan (1.89 million ha) and West Kalimantan (0.856 million ha). The dry lands in Kalimantan are all dry lands with a wet climate. Opportunities for developing dry land with dry climates are in Nusa Tenggara, with an area of 137,659 ha, and in Southeast Sulawesi, with an area of 93,417 ha. Another opportunity for expanding the area of dry land annual crops is in Papua, which is around 1.69 million ha, then Sumatra Island, especially in North Sumatra, with an area of 0.429 million ha. In other provinces, opportunities for area expansion are under 300,000 ha.

Based on the description above, getting a large enough area to expand the area of food crops is challenging. However, there are still opportunities to obtain available land to develop food crops, including from Convertible Production Forests (HPK). HPK is a forest area that can be converted for non-forestry activities, including agricultural cultivation. The official use of HPK for agricultural areas must go through a change in status/allocation to non-forest areas following statutory regulations.

The government issues: 1) Government Regulation No. 60 of 2012 concerning Amendments to Government Regulation Number 10 of 2010 concerning Procedures for Changing the Allocation and Function of Forest Areas, and 2) Government Regulation No. 61 of 2012 concerning Amendments to Government Regulation Number 24 of 2010 concerning Use of Forest Areas to make it easier to change the status of areas HPK becomes non-forestry. Article 4, Government Regulation No. 61 of 2012, states that the Use of Forest

Areas for development purposes other than forestry activities can only be carried out for strategic objectives and cannot be avoided between certain agricultural activities in the food security framework and energy security.

As a follow-up to the Decree of the Coordinating Minister for the Economy No. KEP-S6N.EKON/07/2012 concerning the Coordinating Team for Land Provision for Agriculture, the Director General of Forestry Planning, the Ministry of Forestry has issued a letter and a map of the location of HPK, which can be submitted to change its status to a non-forest area in three Provinces covering an area of 307,700 Ha. These locations are in Central Kalimantan Province, with an area of 178,500 Ha, and in East Kalimantan Province, with an area of 9,900 Ha. And in West Kalimantan Province, with an area of 119,300 Ha. A map of the distribution of HPK locations that can be converted into West Kalimantan and Central Kalimantan provinces is presented in Figure 3 and Figure 4.

The land area of 307,700 Ha on Figure 3. must be assessed for land suitability for agricultural crop commodities. For land suitability assessment activities, the Center for Research and Development of Agricultural Land Resources has a vital role in land suitability assessment procedures based on land characteristics resulting from land identification. There is no need to re-identify land that will be assessed for suitability and already has characteristic land data.

Figure 3. HPK locations in West Kalimantan Province that can be converted into agricultural land

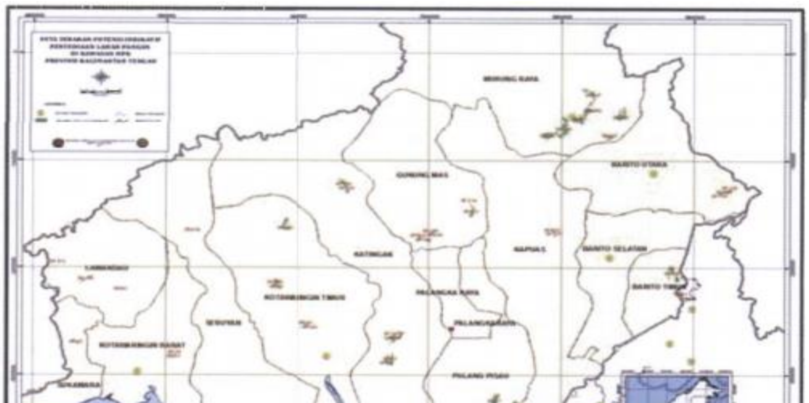


Figure 4. HPK locations in Central Kalimantan Province that can be converted into agricultural land

3.2.1.1. Agricultural Extensification of Forest Lands

Forests have a vital function as the world's lungs, a source of biodiversity for both flora and fauna, hydrological functions, and so on. Land use for trees of the same type includes industrial plantation forests (coffee, rubber, tea, cocoa, oil palm, and others), pine forests, teak forests, mahogany forests, and so on. In particular, industrial forest plantations are referred to as plantations.

Granting permits for the conversion of forest functions in the upstream watershed area needs to be considered because it can damage water sources, push watershed conditions to become critical, and trigger a reduction in sources of clean water in a number of regions in Indonesia. The decline in the function of water management has resulted in ecological damage, such as in South Sumatra, which has resulted in flooding during the rainy season and land fires during the dry season. This has also happened in West Kalimantan, such as in Singkawang. In the last two years, it has become a flood-prone area because the Singkawang River often overflows due to the conversion of forests in the upstream watershed to oil palm plantations.

Another obstacle is the extensification of agriculture in forests with a high slopes, meaning that land use for agriculture will be increasingly limited. If this is not paid attention to, the land will experience damage (degradation) within a certain period, and its capacity will decrease drastically and be challenging to overcome. The steepness of the slope will affect land management techniques. The steeper the slope, the higher the input required for land management.

Regulations for land use in former forest areas for sustainable food agriculture land are found in Article 29 Paragraph (5) of the Law on Sustainable Food Agricultural Land regarding land used for forest areas not utilized in part or whole following permits issued by the authorities. Moreover, if it is not followed up with a request for land rights within one year or more, the land can be converted into sustainable food agriculture land. This regulation aligns with the laws and regulations related to forest areas in the Basic Agrarian Regulations, namely Article 10 of the UUPA, which emphasizes the prohibition of agricultural land abandonment.

A forest area can be released if it meets the specified requirements. Regulations regarding the release of forest areas are contained in Government Regulation Number 10 of 2010 concerning Procedures for Changes in the Allocation and Function of Forest Areas, whereby a forest area can be released with predetermined conditions: 1) The former forest area land that has been released by the Minister of Forestry both in terms of rights and control (Bezit) and the status of the land is State land given to the applicant, which in principle has been approved by the Minister of Forestry through several predetermined processes. 2) Utilization of ex-forest area land can also be carried out on former forest area land that has become or has the status of freehold land, such as usufructuary rights (HGU), which are not optimized in part or in whole where the land can also be categorized as abandoned land.

This regulation reflects the prohibition of abandonment of agricultural land and tries to implement it in a formulation according to the concept of sustainability where the use of former forest area land for sustainable agricultural land must pay attention to the concept of sustainable development because the purpose of this law is to fulfill food needs for the present and the future in addition to its primary objective to maintain national food security. The process of agricultural extensification from forest land can be through the use of former forest area land, but this is regulated in various regulations related to forest areas. The concept of former forest area land being used as sustainable food agriculture land generally aims to optimize forest land that needs to be optimally utilized in part or whole.

3.2.1.2. Development of Agricultural Commodities from Clearing Forest Land

Changes in allotment of forest areas for the development of a Food Estate as a national food strategy are carried out in Convertible Production Forest Areas (HPK) (Article 6 Paragraph 1), with the condition that they must pass a study. Another option is using Protected Forests that are open/degraded/no longer standing forests (KLHK, 2020b). It is preferable to apply an integrated pattern to the extensification of forest land p because of maintaining biodiversity, climate mitigation, and maintaining carbon chains (Sunderland et al., 2020). This has been proven in Subang, West Java. The development of a food estate is carried out in an integrated manner covering agriculture, plantations, and even animal husbandry in an area that previously existed but was in a production forest which included rice commodities, but also for other commodities such as corn, cassava, and sago. as well as livestock (Dewi et al., 2021).

Industrial crops (coffee, rubber, tea, cocoa, oil palm, and others) have high economic value. Several studies state the positive influence of oil palm plantations on the economy and socio-culture, which encourages competitive commodity advantage towards competitive advantage (Heriyanto et al., 2021). This is because the Indonesian palm oil commodity has enormous prospects for the agricultural industry regarding price, exports, and product development. This is also supported by the potential availability of land and the development of downstream industries in the most significant agricultural oil palm areas in Sumatra, Kalimantan, and Sulawesi, with a high density of oil palm plantations in Jambi, Riau, and Central Kalimantan due to HPK. The area of HPK directives is in the 2022 KLHK decree in Table 2.

Table 2. Area of Utilization Directives for Business Permits for Forest Utilization in 2022

No	Provinsi	Arahan Pemanfaatan Hutan pada Kawasan (± ha)			Jumlah (± ha)
		HL	HP/HPT	HPK	
1	2	3	4	5	6
1	Aceh	7.734	330.382	-	338.116
2	Sumatera Utara	36.231	221.984	-	258.215
3	Sumatera Barat	224	171.216	-	171.440
4	Riau	798	448.840	26.691	476.329
5	Jambi	-	138.574	-	138.574
6	Sumatera Selatan	737	168.646	-	169.383
7	Bangkulu	1.810	40.354	-	42.164
8	Lampung	8.423	12.844	-	21.267
9	Kep. Bangka Belitung	875	99.346	-	100.221
10	Kep. Riau	768	52.866	-	53.634
11	Bali	-	4.492	-	4.492
12	Nusa Tenggara Barat	11.545	208.299	-	219.844
13	Nusa Tenggara Timur	718	132.227	-	132.945
14	Kalimantan Barat	4.841	605.299	29.859	639.999
15	Kalimantan Tengah	124	623.197	8.574	631.895
16	Kalimantan Selatan	32.299	184.998	15.631	232.928
17	Kalimantan Timur	523	431.965	-	432.488
18	Kalimantan Utara	213	330.830	-	331.043
19	Sulawesi Utara	5.125	131.696	-	136.821
20	Sulawesi Tengah	403	639.690	-	640.093
21	Sulawesi Selatan	28.566	218.618	-	247.184
22	Sulawesi Tenggara	2.748	373.018	-	375.766
23	Gorontalo	83	143.307	-	143.390
24	Sulawesi Barat	-	233.054	-	233.054
25	Maluku	98	521.236	29.842	551.176
26	Maluku Utara	5.613	211.431	-	217.044
27	Papua	30.750	1.447.100	-	1.477.850
28	Papua Barat	2.264	357.782	137.552	497.598
	Jumlah	**183.513**	**8.483.291**	**248.149**	**8.914.953**

3.2.1.3. Agricultural Extensification of Wetlands

Wetlands are areas of land or soil saturated with water, either permanently or temporarily (seasonally), partially or entirely inundated by a shallow layer of water. Examples of wetlands include swamps (including mangrove swamps), brackish, and peat. The water that floods wetlands can be fresh, brackish, or saltwater. Wetlands are vibrant ecosystems. This ecosystem directly or indirectly contributes as (a) a source of food, water (freshwater), fiber, fuel, biochemical, and genetic resources, (b) plays a role in climate regulation, erosion, hydrology, pollination, and so on, (c) support in soil formation and nutrient formation, and (d) cultural development (Mulyani et al., 2011). Wetland biodiversity is relatively higher compared to other ecosystems. On the wetlands grow various vegetation such as freshwater swamp forest, peat swamp forest, mangrove forest, brackish grass, and others. Wetlands are also fertile, so they are often cleared and converted into agricultural fields, ponds, etc.

Swamps are land that is constantly saturated with water or is inundated by shallow water throughout the year or for a long time of the year. Swamps are included in the group of natural wetlands, some of which are included in the category of inland wetlands (e.g. swamps). Others are marine or coastal wetlands, while rice fields are artificial wetlands (human-made wetlands). The swamp land area in 2010 was 33.39 million hectares. Around 1.8 million hectares (5.4%) of this area has been used as agricultural land, consisting of 347.4 thousand hectares of lebak swamps and 1 million hectares of tidal swamps. The locations of agricultural land from the conversion of tidal swamps, which are the largest among others, are in Central Kalimantan (409 thousand hectares), South Sumatra (359 thousand hectares), Riau (163 thousand hectares), South Kalimantan (86 thousand hectares), West Kalimantan (76 thousand hectares). thousand hectares), Jambi (69 thousand hectares) (Figure 5). The land is utilized as plantation land (oil palm and rubber) and paddy fields.

Peat is soil formed from the accumulation of half-decayed plant remains and has a high organic matter content. Wetland management in Indonesia is in the international spotlight. On the one hand, the data shows that of the total tropical peatland area (37.8 million hectares), around 26.2 million hectares are in Southeast Asia. Of that area, 20 million hectares are in mainland Indonesia. Efforts to realize a sustainable peatland management system must be carried out consistently. This is based on the following objective conditions: (a) the expansion of agricultural land is a necessity that is difficult to avoid because the existing agricultural land area is not sufficient to support food security in particular, as well as agricultural development in general, (b) even though from an agro-climatic point of view the level of land feasibility peat for agriculture is lower than mineral land (soil), socio-economic constraints on utilization are lower, and (c) financially, the most profitable use of peat land for agriculture (to date) is oil palm plantations. The Agricultural Research and Development Agency has conducted research and development to create a productive, sustainable, and low greenhouse gas emission farming system on peatlands to realize a sustainable peatland management system.

The potential for expansion of agricultural areas differs from the available land area from the results of land suitability mapping because the parameters used in land suitability mapping only include agro-climatic variables. On the other hand, for the operational benefit of land utilization for agriculture, various factors must be considered. There are at least five aspects that must be considered, namely: (a) tenure status, (b) administrative area or location, (c) availability of labor, (d) availability of infrastructure for procurement of inputs and distribution of farming output, and (e) opportunities to be converted into agricultural land concerning spatial planning (land allotment for residential, urban development, forest conservation, etc.). The potential land area for expanding the agricultural area is a subset of the land area resulting from land suitability mapping for agriculture. These five factors help assume an estimate of the potential availability of potential land for expanding agricultural areas.

In expanding agricultural areas, the direction of land use change and the factors that influence it need to be studied so that land use planning can achieve goals efficiently and effectively. This is very important in planning to expand Indonesia's rice field farming area because it is the primary support for developing staple food production and requires costly investment. In contrast, potential areas with high technical-economic feasibility could be more extensive. The potential land area for rice field expansion is shown in Table 3.

Table 3. Potential land area for rice field expansion

Wilayah	Lahan yang Sesuai		Telah Didayagunakan		Perkiraan Potensi Perluasan		
	Rawa	Nonrawa	Rawa/PS	Irigasi	Rawa/PS	Nonrawa	Total
Sumatera	2. 432,6	3.616,8	508,6	1.603,6	1.924,0	2.013,2	3.937,2
Jawa	124,1	4.462,8	2,4	3.341,9	121,7	1.120,9	1.242,5
Bali+NTT	-	482,1	1,0	396,9	1,0)	85,2	84,3
Kalimantan	1.425,8	1.587,1	412,1	556,3	1.013,7	1.030,8	2.044,4
Sulawesi	10,4	2.075,3	3,0	961,5	307,4	1.113,8	1.421,2
Maluku+Papua	149,0	7.891,4		-	149,0	7.891,4	8.040,3
Indonesia	4.441,9	20.115,4	927,2	6.860,2	3.514,8	13.255,3	16.770,0

Sumber: Puslitbangtanak (2000).
Catatan: Termasuk yang sudah didayagunakan menjadi lahan sawah.

Based on sub-optimal land characteristics combined with soil and climate databases, it shows that of Indonesia's total land area of 189.1 million ha, around 143.0 million ha is dry land and 46.1 million ha is wetland. Approximately 157.2 million ha of which is sub-optimal land, which consists of 123.1 million ha of dry land and 34.1 million ha of wet land. The potential for sub-optimal land for agriculture in Indonesia is shown in Figure 6.

Figure 6. Potential sub-optimal land for agriculture in Indonesia
Development potential and opportunities

To find out how much sub-optimal land area is suitable for agriculture, an overlay has been carried out between the distribution of sub-optimal land and potential land for agriculture. The results show that of the 157.2 million ha of sub-optimal land in the five groups mentioned above, around 91.9 million ha are suitable for agricultural development. The rest is not recommended for agricultural development because it is forest area or land that is not suitable with various limiting factors such as very steep slopes > 40%, deep peat (> 3 m thick), sandy soils (Spodosols or Quartzipsamments), actual acid sulfate soils, and deep valley with an inundation duration of > 6 months, so it is advisable to keep it as a conservation area with natural vegetation, which can adapt to these conditions and is safe for sustainability and environmental safety. The potential area for agricultural development on sub-optimal wetlands is shown in Table 4.

Table 4. Area potential for sub-optimal wetland agricultural development

Agroekosistem	Lahan sub optimal	Potensi LSO untuk pertanian
	..................ha....................	
LK masam	108.775.830	62.647.199
LKIK	13.272.094	7.762.543
Rawa ps surut	11.031.956	9.319.675
Rawa Lebak	9.261.110	7.499.976
Gambut	14.905.575	4.675.250
Total	157.246.565	91.904.643

Most primary food production comes from paddy fields, especially in Java. Over the last two decades, the rate of converting intensive paddy fields in Java and big cities has yet to be matched by the rate of creating new paddy fields outside Java. Both of these will threaten national food security and sovereignty. Therefore, in addition to optimizing the use of land resources and applying various technologies to support P2BN, land conversion must be controlled, and the production of new rice fields must be continuously improved. In 2050, to meet food needs, it is necessary to expand the area of paddy fields to 6.08 million ha and up to 11.75 million ha of dry land. Land suitable for agriculture and until now has yet to be used (neglected), covering an area of 30.67 million ha and 8.28 million ha of which is suitable for paddy fields. The ownership status of this land is still being determined. However, most of it (20.4 million ha) is in forest areas (production forest, conversion forest, HPH), and 10.30 million ha is in agricultural cultivation areas. Even though it has yet to be utilized, abandoned land in agricultural cultivation areas already has an owner, making it difficult to make it into an agricultural development area.

The development of various agricultural commodities will increase competition for land needs. With the existence of the PLPPB Law, abandoned land can be used optimally. Utilization of potential land for expanding agricultural areas must follow its designation. Areas for wet and dry land agriculture for seasonal food crops must be used for food crops and horticulture. Non-food and plantation bioenergy-producing commodities are directed to potential dry land for annual crops. The use of abandoned land needs to be accompanied by the development of varieties that have high adaptability on suboptimal land (Mulyani et al., 2013). The suitable and available land area for expanding the wetland farming area is shown in Table 5.

Table 5. Available and optimal land area for agricultural expansion

Pulau	Lahan basah semusim (000 ha)			Lahan kering semusim[1] (000 ha)	Lahan kering tahunan[2] (000 ha)	Jumlah (000 ha)
	Rawa	Nonrawa	Jumlah			
Sumatera	354,9	606,2	961,1	1.312,8	3.226,8	5.500,7
Jawa	0	14,4	14,4	40,5	159,0	213,9
Bali dan Nusa Tenggara	0	48,9	48,9	137,7	610,2	796,8
Kalimantan	730,2	665,8	1.396,0	3.639,4	7.272,0	12.307,4
Sulawesi	0	423,0	423,0	215,5	601,2	1.239,7
Maluku + Papua	1.893,4	3.539,3	5.432,7	1.739,0	3.441,0	10.612,7
Indonesia	2.978,5	5.297,6	8.276,1	7.084,9	15.310,2	30.671,2

[1]Lahan kering semusim juga sesuai untuk tanaman tahunan.
[2]Lahan kering tahunan pada lahan kering dan sebagian gambut.
Sumber: Badan Litbang Pertanian (2007).

3. 3. Indonesian Government Extensification Program: Upsus Pajale and Printing New Fields

As discussed in the previous chapter, identifying potential marginal land areas for agricultural land extensification requires appropriate regulations and policies so that land expansion can be carried out optimally. Expansion of agricultural land also continues to race against the conversion rate of agricultural land into non-agricultural land, which is high every year. Therefore, the Indonesian government has issued various agricultural land extension programs to increase production and meet the increasing demand due to population growth and other challenges.

3.3.1. UPSUS Pajale Program and Print New Rice Fields

Special Efforts (UPSUS) in supporting food self-sufficiency are carried out by the Government, especially the Ministry of Agriculture, to solve problems of increasing production, stock management, national food distribution, and farmer welfare. Since 2016, UPSUS activities have focused on national strategic food commodities, namely rice-corn-soybeans (place) (Sulaiman et al., 2018). Guidelines for UPSUS Pajale activities are regulated in the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 03/Permentan/OT.140/2/2015. The scope of UPSUS Pajale's activities includes several activities, including the Pajale Integrated Plant Management Movement, as well as the expansion of the planting area. Adding rice planting areas is focused on optimizing the existing (existing) irrigated, rainfed, tidal, dry land, and lowland rice fields to be planted more than once a year (increasing cropping index/IP). Meanwhile, for corn and soybeans, the expansion of the planting area is prioritized for new areas in paddy/rainfed/dry/tidal land, swamps, forestry land, etc. (Ministry of Agriculture 2015).

The implementation of UPSUS rice is based on efforts to avoid rice production that is lower than consumption, so it is necessary to plant as widely as possible. To anticipate the famine season in November-December-January, UPSUS seeks to multiply the planting area in the planting season in July-August-September. Planting expansion activities are carried out, including land optimization and utilization of tidal land, swampy land, and cultivation technology engineering (Sulaiman et al., 2018).

The availability of land and water resources for agricultural activities is limited, so it needs proper management. The rate of conversion of paddy fields to non-agricultural land is very high, while the Government's ability to increase the standard area of paddy fields is minimal. During the 2006-2013 period, the rate of increase in the common paddy field area was only around 40 ha/year, far below the conversion rate of 100,000 ha/year (Sulaiman et al., 2018). Therefore, the UPSUS place boosted the increase in planting area by utilizing alternative land that had been idle or idle, such as dry fields and fields. The addition of the planting area, or the Additional Planting Area (LTT), is monitored directly by the Ministry of Agriculture through various methods, such as routine reporting by field officers and satellite imagery technology (Sulaiman et al., 2018).

The importance of increasing planting area to increase production prompted the Government to create a program to support the UPSUS Pajale, namely increasing the standard area of paddy fields designed through a self-managed rice field expansion mechanism in 2016. This program is overseen by the Directorate General of Agricultural Infrastructure and Facilities, Ministry of Agriculture, and implemented by the local Government in collaboration with the Indonesian Army (Ditjen PSP, 2016). The New Paddy Field Printing Program has the following objectives: a) to increase the standard area of paddy fields and b) to produce mainly rice production in new paddy fields, c) to reduce the deficit of paddy fields due to land conversion, and d) to increase the regional economy, especially in rural areas (Ditjen PSP, 2016).

3.3.2. Program Implementation Results

UPSUS Pajale is a national program and is implemented up to the district/city level with varying degrees of success. Each region also applies the UPSUS strategy to increase the planting area through LTT activities. The addition of planting area is expected to contribute to increasing the harvested area and rice production (Erviyana 2014). UPSUS activities in Malang Regency increase the planting area by increasing IP and utilizing dry/rainfed and tidal land. During the Covid-19 pandemic, there was an increase in rice production which was significantly influenced by the addition of the harvested area in the area (Nugroho et al. 2021). The LTT movement in Bengkulu Province also increased the planting area by 34.53% and managed to increase production by 37.91%, namely from 559,829 tons to 772,106.39 tons (Sugandi and Wibawa 2017).

In Belitung and East Belitung Regencies, the UPSUS program increased the rice planting area by 243.5 ha with a harvested area of 242.5 ha in 2016. However, the increase in rice production by 801.1 tons was considered less significant than the increase in planting area and harvest. This is thought to be caused by blast disease during the planting season (Ahmadi and Rusmawan 2017). The trend of increasing planted area accompanied by increased rice production also occurred in Bolaang Mongondow Regency due to the implementation of UPSUS in 2015-2016. The calculated planting area includes paddy fields and dry land. However, this program failed to increase the indicated production of corn and soybeans because there was no additional planting area (Ponto et al. 2017). Meanwhile, corn production through the UPSUS Pajale program increased rapidly in Mamuju Regency in the 2015-2019 period. The increase occurred by more than 100% annually, from 27,906 tonnes in 2015 to 457,164 tonnes in 2019 (Effendi et al. 2021).

3.3.3. Print New Field

The activity of printing new rice fields also gave varying results. Darwis (2019) reports that paddy field printing in West Kalimantan, especially Sanggau and Landak Regencies, succeeded in printing new rice fields in 2016 according to the target set. Owner and cultivator farmers are also available, and some have succeeded in harvesting with a productivity of 0.5 – 1 GKP/ha. The physical realization of paddy field printing activities in 2016 can be seen in Table 6.

Table 6. Physical Realization of 2016 New Rice Field Printing Activities

No	Provinsi	Target	Realisasi fisik	Luas tanam	Belum tanam
1	Kalimantan Barat	16.905	16.905	11.736	5.169
2	Kalimantan Tengah	16.550	16.550	7.899	8.651
3	Lampung	11.995	11.875	10.335	1.540
4	Nusa Tenggara Barat	11.537	11.537	3.474	8.063
5	Sumatera Selatan	11.475	11.475	8.833	2.642
6	Sulawesi Selatan	9.940	9.940	9.558	382
7	Kepulauan Babel	7.130	7.130	3.694	3.436
8	Sulawesi Tenggara	6.000	6.000	2.911	3.089
9	Sulawesi Tengah	4.962	4.962	3.344	1.618
10	Sulawesi Barat	4.260	4.260	1.805	2.456
11	Papua	4.150	4.150	2.502	1.648
12	Kalimantan Selatan	3.236	3.000	2.642	358
13	Sulawesi Utara	2.855	2.855	2.731	124
14	Jambi	2.580	2.580	2.140	440
15	Aceh	2.500	2.450	1.341	1.109
16	Papua Barat	2.272	2.372	1.892	481
17	Gorontalo	2.090	2.090	303	1.787
18	Nusa Tenggara Timur	2.864	1.722	585	1.137
19	Maluku	1.525	1.610	867	744
20	Maluku Utara	1.500	1.460	574	886
21	Kalimantan Timur	1.184	1.162	634	528
22	Riau	950	813	616	197
23	Kalimantan Utara	922	726	610	116
24	Sumatera Barat	608	601	371	230
25	Jawa Barat	500	500	500	0
26	Kepulauan Riau	1.537	232	125	107
27	Bengkulu	140	140	109	31
	Total Jumlah	132.167	129.096	82.128	46.968

The obstacles to implementing new rice field printing include technical and non-technical aspects, namely poor soil fertility, low rice productivity in new printing land, irrigation channels that are not yet available or not yet correctly built, and difficulty getting initial farming capital to take advantage of new rice field printing (Astuti et al. 2019, Hasril et al. 2021). Expansion of agricultural land, especially the creation of new rice fields usually undergoes physico-chemical changes in the soil. Common problems are the high amount of water required, low productivity, and iron or manganese poisoning (Nursyamsi et al., 1996). Low productivity is associated with soil acidity due to toxic concentrations of Al and Mn, Ca and Mg deficiency, easy K leaching, P, S, and Mo adsorption, harmful effects of Ha+, and the relationship between water and air systems (Widjaja-Adhi 1984). Therefore, the expansion program to print new rice fields requires a long time and intensive treatment to be able to produce maximum rice productivity results.

4. Conclusions

Expansion of agricultural land by opening new land has enormous potential in Indonesia. The importance of increasing production to support national food security and increase farmers' income makes agricultural land extensification still considered necessary. Indonesia still has areas with this potential, namely the expansion of agricultural land by clearing forest land, dry land, peat, and swamps. However, extensification efforts must consider the history of successful programs that have been implemented. Successes, constraints, or failures that occur need to be studied to become input so that the technical extension of agriculture carried out in the future becomes better and wiser in resource management. By doing so, it is hoped that the extensification of agricultural land can achieve its goals and increase the area and provide high agricultural productivity results in a sustainable environment.

Acknowledgement

-

Author Contribution

-

Funding

-

Ethical Review Board Statement

-

Informed Consent Statement

-

Data Availability Statement

-

Conflicts of Interest

-

References

Astuti NB, Khairati R, Rahmi E. 2019. Mendukung ketahanan pangan nasional melalui kegiatan perluasan lahan sawah: kasus program pencetakan sawah baru di Kabupaten Solok Selatan. Semiloka Nasional FKPTPI, Universitas Padjadjaran.

Balai Penyuluh Pertanian (BPP). (2015). Program penyuluhan, badan pelaksana penyuluhan pertanian, perikanan, dan kehutanan. Kecamatan Sungayang Kabupaten Tanah Datar.

Badan Pusat Statistik (BPS). 2012. Statistik Indonesia. Badan Pusat Statistik. Jakarta.

Dewi IGS, Silviana A, Adhim N, Novana M. 2021. Protected forest function change policy for food estate land in Subang, Indonesia. J Environ Manag Tour. 12(7): 1893-1898. https://doi.org/10.14505/jemt.12.7(55).14

Direktorat Irigasi dan Rawa. 2012. Pohon Rawa. Direktorat Jenderal Sumber Daya Air, Kementerian Pekerjaan Umum. Jakarta.

[Ditjen PSP] Direktorat Jenderal Prasarana dan Sarana Pertanian. 2016. Pedoman Teknis Perluasan Sawah Pola Swakelola. Jakarta(ID).

Effendi Z, Siregar AR, Sirajuddin SN. 2021. Strategi Pemasaran Jagung Hasil Pengembangan Upsus Pajale di Kabupaten Mamuju. Syntax Literate: Jurnal Ilmiah Indonesia. 6(7). Doi: http://dx.doi.org/10.36418/syntax-literate.v6i7.3513

Erviyana, P. 2014. Faktor-faktor yang mempengaruhi produksi tanaman pangan jagung di Indonesia. Journal of Economics and Policy. 7(2): 194–202

Garfansa, M, P., Iswahyudi. M, Rohman. R, Awidiyantini. 2022. Pertumbuhan dan Produksi Padi Beras Merah Varietas Inpari Arumba pada Lahan Kering dan Lahan Basah. *Jurnal Pertanian*, 13: 13-25,

Hasril A, Muhammad AS, Prastya IY. 2021. Evaluasi program cetak sawah di Kabupaten Lingga Provinsi Kepulauan Riau. JIANA: Jurnal Ilmu Administrasi Negara. 19(3):29-39.

Heriyanto M, Achmad FF, Frini KA, Tito H, Dodi S. 2021. Antecedents of sustainable competitive advantages: a case study of palm oil industries in Indonesia. J Asian

Finance Econ Bus. 8 (2): 911–21. https://doi.org/10.13106/jafeb.2021.vol8.no2.0911.

[KEMENTAN] Kementerian Pertanian Republik Indonesia. 2005. Komoditas Pertanian dan Rencana Aksi Ketahanan Pangan. 2005-2010. [diakses 2022 Dec 5]. http://www.litbang.pertanian.go.id/special/komoditas/komoditas.

[KEMENTAN] Kementerian Pertanian Republik Indonesia. 2015. Peraturan Menteri Pertanian Republik Indonesia Nomor 03/Permentan/OT.140/2/2015.

[KEMENTAN] Kementerian Pertanian Republik Indonesia. 2021. Perubahan Kedua Atas Keputusan Menteri Pertanian Nomor 259/KPTS/RC.020/M/05/2020 Tentang Rencana Strategis Kementerian Pertanian Tahun 2020-2024. Keputusan Menteri Pertanian Republik Indonesia Nomor 484/KPTS/RC.020/M/8/2021

[KLHK] Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia. 2020a. Status Hutan dan Kehutanan Indonesia 2020. [diakses 2022 Dec 5]. https://www.menlhk.go.id/uploads/site/post/1647235041.pdf

[KLHK] Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia. 2020b. Penjelasan KLHK Tentang Penyediaan Kawasan Hutan Untuk Pembangunan Food Estate. [diakses 2022 Dec 5]. http://ppid.menlhk.go.id/siaran_pers/browse/2747

[KLHK] Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia. 2022. Peta Arahan Pemanfaatan Hutan 2022. [diakses 2022 Dec 5]. https://phl.menlhk.go.id/static/file/peraturan/1656571965-SK%20Peta%20Arahan%202022.pdf

Mulyani A, Ritung S, Las I. 2011. Potensi dan ketersediaan sumber daya lahan untuk mendukung ketahanan pangan. *J. Lit. Pert.* 30:2.

Mulyani A, Sarwani M. 2013. Karakteristik dan potensi lahan sub optimal untuk pengembangan pertanian di indonesia. *J. Sumb. Lah.* 7 – 1.

Mulyani, A., Kuncoro, D., Nursyamsi, D., & Agus, F. 2016. Analisis Konversi Lahan Sawah: Penggunaan Data Spasial Resolusi Tinggi Memperlihatkan Laju Konversi yang Mengkhawatirkan. Jurnal Tanah dan Iklim. 40(2):121-133.

Ningsih, A., Hakim, L., & Aryani, L. 2022. Peranan dinas pertanian dalam alih fungsi lahan pertanian menjadi kawasan industri di Kabupaten Karawang. *NUSANTARA: Jurnal Ilmu Pengetahuan Sosial*, *9*(8), 3002-3009.

Nugroho P., Pudjiastuti AQ, Sumarno. 2021. Peningkatan Produksi Padi di Kabupaten Malang Melalui Program UPSUS Pajale Selama Pandemi Covid-19. Jurnal Agrikultura 2021, 32 (3): 199 – 206

Nursyamsi D, Setyorini D, Adiningsih J S. 1996. Pengelolaan hara dan pengaturan drainase untuk menanggulangi kendala produktivitas sawah baru. hlm. 113-128 dalam Prosiding Pertemuan Pembahasan dan Komunikasi Hasil Penelitian Tanah dan Agroklimat. Buku III Bidang Kesuburan dan Produktivitas Tanah. Cisarua, Bogor, 26-28 September 1995. Pusat Penelitian Tanah dan Agroklimat, Bogor.

Ponto J, Benu NM, Kumaat RM. 2017. UPSUS pajale dalam menunjang program swasembada pangan di Kabupaten Bolaang Mongondow. Agri-Sosio Ekonomi Unsrat. 12(2A):253-260

Pusat Penelitian Tanah dan Agroklimat. 2000. Hasil Rumusan Seminar Nasional Sumber Daya Lahan. Prosiding Seminar Nasional, Cisarua 9-11 Februari 1999. Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian.

Ritung S, Suryani E, Subardja DS, Kartawisastra S, Nugroho K, Suparto, Hikmat H, Mulyani A, Tafakresnanto C, Sulaeman Y, Subandiono RE, Wahyunto. 2015. Sumberdaya Lahan Pertanian Indonesia: Luas, Penyebaran, dan Potensi Ketersediaan. IAARD Press. Jakarta.

Salamah, U. (2021). Kontribusi Generasi Muda Dalam Pertanian Indonesia. *Journal Science Innovation and Technology (SINTECH)*, *1*(2), 23-31.

Sudana W. 2005. Potensi dan prospek lahan rawa sebagai sumber produksi pertanian. Balai Pengkajian dan Pengembangan Teknologi Pertanian Bogor. 3(2):141-151.

Sugandi, D, dan W Wibawa. 2017. Peran inovasi teknologi dan gerakan luas tambah tanam dalam peningkatan produksi padi. Jurnal Pertanian Agros. 19(2): 105–115.

Sulaiman AA, Suwandi, Sarwani M, Suherman M, Prabowo A. 2018. Jurus Mendongkrak Luas Tambah Tanam. Ed: Haryono. IAARD PRESS:Jakarta (ID).

Sunderland TC, Vasquez W. 2020. Forest conservation, rights, and diets: Untangling the issues. Front For Glob. 3: 29. https://doi.org/10.3389/ffgc.2020.00029

Triadi BL. 2021. Teknik Pengembangan Lahan Rawa di Indonesia. Deepublish. Yogyakarta.

Wahyunto RS, Nugroho K, Sarwani M. 2012. Inventarisasi dan Pemetaan Lahan Gambut di Indonesia. Prosiding Seminar Nasional.

Widjaja-Adhi I P.G. 1984. Pengapuran tanah masam untuk kedelai. Dalam Makalah Rapat Teknis Penelitian dan Pengembangan Kedelai. Bogor, 2- 4 Oktober 1984.