Potentials of peatlands for agriculture in Tanjung Jabung Barat Regency, Jambi Province

M Hikmat, E Yatno and B Heryanto
Indonesian Center for Agricultural Land Resources Research and Development (ICALRRD). Bogor, Indonesia.

*E-mail: muhammad_hikmat@ymail.com

Abstract. Peatlands are considerably vulnerable and fragile. Despite this, peatlands serve as a place to live and to exercise sustainable farming for some communities. This study aims to examine the potentials of peatland in Tanjung Jabung Barat Regency for agricultural activities. Peatland distribution map with scale of 1:50,000 and the unanimous map on forest functions (TGHK map) are the main sources for this study. Laboratory analysis over seven soil samples were used for the assessment of land suitability, before overlaid with TGHK map to determine potentials and availability of lands for agriculture activities. Results showed that only 20,285 ha were suitable for agricultural activities. About 18,433 ha peatlands were classified as marginally suitable (S3) for food crops or horticulture, while the same level of suitability for annual crops occupied around 20,142 ha. Main limiting factors in land suitability were root condition (rc) due to deep to very deep peat depth categories; and nutrient retention (nr) due to high soil acidity. Utilization of peatlands for agricultural activities needs to appropriately conserve pristine condition to allow sustainable environment in the long term while maintaining and economic benefits. This research suggests that local water management, liming, fertilizer and minimum tillage would improve the quality of peatlands.

1. Introduction
Peat refers to soils developed from organic matters. In its natural state, peatlands sink carbon. Hence, they contribute to reducing greenhouse gas (GHG) emissions, even though the process is very slow. In forested cover, peatlands serve as habitats for rare-plant species and store large amounts of carbon (C). Peatland ecosystems play an imperative role in hydrological system of watershed because it may absorb water up to 13 times of peat weight. Carbon can be stored above or below soil surface [1, 2].

Peatlands, in some regions, support livelihood and economic activities. Because peat soils are unstable and vulnerable, agricultural management on peatland requires careful planning with a great care. Some physical and chemical properties of peat soils, such as soil acidity and root carrying capacity, inhibit plant growth. Mismanagement of peatlands can cause environmental damage that has long, oversize impacts. In some areas, however, shallow peatlands yield fairly good amount of produce, including (1) food crops/ secondary crops, (2) horticultural crops, and (3) annual crops [3-5].

Peatlands clearing has been aiming to support national policies on increasing food production. Selected areas, such as Pangkoh (Central Kalimantan), Rasau Jaya (West Kalimantan), Siak (Riau), Wendang (Jambi), and Air Sugihan (South Sumatra), were reported to be less successful at first mainly due to peat thickness. Meanwhile, in lower substratum, a layer of pyrite or sand was found. Seawater intrusion during the dry season resulted in the relocation of inhabitants. Success stories over cleared peatlands for rice production and/or plantations observed with peat depletion, soil maturation, and
improvements to water systems can be found in Delta Upang (South Sumatra), Silaut Lunang (West Sumatra), Burung Island (Riau), Suryakanta and Gambut-Kertak Hanyar (South Kalimantan) [6]. According to Noor [2], there are about 2.0–2.5 M ha of peatland used for agriculture, of which, 0.5 M ha are used for food crops and the rest are used for plantations, especially oil palm.

Indonesian peatlands occupy 13.43 M ha [7, 8]. Jambi province hosts around 496,766 ha. As commonly found in the tropics, peat soils in this area is developed from woods. Peat soils with hemic and sapric decomposition rates have a potential for agriculture with caution. Mismanagement to peatland causes land and environmental deterioration, including irreversible peat drying, land fires, air pollution and increasing carbon emissions. Currently, peatland agriculture is constrained due to climate change and environmental issues, legally formulated in regulations of Agriculture Minister (Permentan) no. 14/2009, INPRES No. 10/2011 and No. 6/ 2017. Nonetheless, for some regions having extensive peatland, the implementation of the Presidential Decree raises a dilemma with insecure regional economic development and dependency of inhabitants to peatlands.

Peat soils have different characteristics from mineral soils. Peat is physically soft and has a low load-bearing capacity [9]. When drained, peatlands subside and dry out irreversibly so that the ability to hold water (hydrophobic) would decrease, resulting in a higher risk of fire [10, 11].

This article aims to examine the potentials of peatland in Tanjung Jabung Barat Regency, Jambi Province for agricultural development.

2. Methodology
Tanjung Jabung Barat Regency is administratively bordered to the north by Riau Province, to the south by Batanghari Regency, to the west by Batanghari Regency and Tebo Regency, and to the east by Berhala Strait Regency and Tanjung Jabung Timur Regency. Tanjung Jabung Barat Regency consists of 13 sub-districts, where Batang Asam is the largest sub-district, while Tungkal Ilir is the smallest. Administrative map of Tanjung Jabung Barat Regency is presented in Figure 1.

![Figure 1](image.png)

**Figure 1.** Location map of Tanjung Jabung Barat Regency, Jambi Province

Annual rainfall in the research site ranges from 2,175 to 2,487 mm and the air temperatures ranging from 25.9°C–26.9°C. This district has ten consecutive wet months (> 200 mm) from December-September, and has no apparent dry month (< 100 mm). According to the Agroclimate Zone [12], this area possesses B1, B2, C1 and C2 zones. Zones B1 and B2 indicate wet months occur for 6-7 consecutive months with 0-2 dry months. Meanwhile, zones C1 and C2 have 5-6 consecutive wet months with 0-2 dry months.

In this study, peatland map with scale of 1:50,000 [7] was used as a basis for assessing agriculture potentials of peatlands. Specific information obtained from the peat map were soil type and peat depth. Soil classification system used in this map refers to the National Classification System (*Klasifikasi Tanah Nasional*) [13] and the Soil Taxonomy System [14].
Land evaluation was carried out through land suitability assessment through analyzing physical and chemical soil properties of seven observation points representing map units. Measured chemical and physical properties included peat depth, peat maturity level, soil pH, soil CEC, base saturation, total K, total P, and available P. Land suitability assessment was carried out using matching method, which is comparing soil characteristics and land requirement for pre-defined agricultural commodities [15]. In this research, those commodities included rice, corn and onions for food crops and horticulture groups, rubber palm and cocoa for annual crops. The determining factor for land suitability class is the one with the highest severity problem. The outcome of land suitability analysis was superimposed with TGHK map (for retrieving the function of forest areas) and land use map to extract information on the availability of land for agricultural development, either for intensification, expansion, or diversification. Land use map was issued by the National Land Agency (BPN). Land use classes associated with the outcome were rice fields, moor, shrubs, forests, clumps, settlements and water bodies.

3. Results and discussion

3.1. Peatland characteristics
In Tanjung Jabung Barat Regency, peatlands cover about 99,632 ha or 19.83%. In general, peatlands in the research site is fresh water topogenous peat, which is strongly influenced by fresh water. Based on the peatland map, peat soils in this regency are distinguished into four Soil Map Units (SMUs). According National Classification System of Indonesia (Sistem Klasifikasi Nasional), peat soils in this district are classified as Organosol Hemik. Meanwhile, in the Soil Taxonomy system, these soils are classified into subgroups of Terric Haplohemists, Fibric Haplohemists, Sapric Haplohemists, and Typic Haplohemists. Based on peat depth, peatlands are divided into shallow (D1) with 50 - <100 cm, moderate (D2) with 100 - <200 cm, deep (D3) with 200 - <300 cm and very deep (D4) with 300 - <500 cm. Peat with depth class D2 occupies the largest extent, which is 61,722 ha, followed by depth classes D1, D3, and D4 respectively. Spatial distribution of peatland in research site is presented in Figure 2.
3.2. Land Suitability

Analysis of soil samples showed that peat soils in Tanjung Jabung Barat Regency had following characteristics: high acidity, low to moderate P and K, low available P, high CEC value, and low base saturation value (Table 1). The table suggests that peat fertility was at low to moderate levels, while low base saturation value indicated low nutrient content.

Matching soil physical and chemical properties with land suitability criteria suggested that peatlands holds potentials for food crops/horticulture and annual crops was about 84,340 ha and 97,746 ha respectively. S3 (marginally suitable) was observed in the region, with prominent limiting factors were nutrient retention (nr) caused by high acidity (low pH) and plant root conditions (rc) as a result of peat depth. Peat soils which were classified as not suitable (N) possessed limiting factor of plant root conditions (rc). With this regard, these land qualities could be improved by providing some treatments. Liming can be applied to reduce soil acidity so that soil properties related to nutrient retention can be improved. This is especially important on shallow or moderately deep peatlands.
3.3. Potentials of peatlands

Land suitability analysis indicated a total of 97,746 ha of peatlands are prospective for agricultural development. When overlaid with forest function map, readily available peatland coverage (with APL or other land utilization status) is around 20,285 ha. The rests of the coverage are with Permanent Production Forest (HP), Convertible Production Forest (HPK) and Protection Forests (HL) states. This extent falls into around 20,142 ha considering the outcome of land evaluation (Table 2).

### Table 1. Results of land suitability assessment for food crops, horticulture and annual crops

| SMU Classification* | Peat depth (cm) | Obs. code | pH H2O | P-HCl mg/100 g | K-HCl ppm | P-Bray cmol(+) | CEC | BS | Land suitability class | Food, horticulture | Annual crop (ha) |
|---------------------|----------------|-----------|--------|----------------|-----------|----------------|------|----|------------------------|------------------|------------------|
| 1 Terric Haplohemists | 50-100 | HM 07 | 4.0 | 31 | 10 | 74.6 | 71.27 | 15.3 | S3-nr | S3-nr | 22.62 |
| 2 Terric Haplohemists | 50-100 | PN 14 | 4.1 | 29 | 21 | 30.2 | 80.12 | 7.2 | S3-nr | S3-nr | |
| 3 Typic Haplohemists | 100-200 | HM 23 | 3.6 | 19 | 5 | 26.3 | 63.61 | 18.2 | S3, N-nr, rc | S3-nr | 61.72 |
| 4 Typic Haplohemists | 100-200 | PN 30 | 3.7 | 18 | 11 | 18.4 | 84.28 | 10.4 | S3, N-nr, rc | S3-nr | |
| 5 Saprik Haplohemists | 200-300 | TG 74 | 3.7 | 30 | 11 | 36.4 | 78.75 | 12.3 | S3, N-nr, rc | S3-nr | |
| 6 Fabric Haplohemists | 200-300 | HM 14 | 3.3 | 16 | 7 | 35.3 | 70.53 | 12.1 | N-rc | S3-rc | 13.41 |
| 7 Fabric Haplohemists | 300-500 | - | - | - | - | - | - | - | N-rc | N-rc | 1.62 |

Note: * according Soil Taxonomy, CEC = cation exchangeable capacity, BS = base saturation

### Table 2. Distribution of peatlands in Tanjung Jabung Barat by the status of forest areas

| Forest Statue | Peat depth (Ha) | Total (Ha) |
|---------------|----------------|------------|
| D1 D2 D3 D4  |                |            |
| APL           | 7,316, 11,127, 1,699, 143 | 20,285 |
| HL            | 2,213, 10,843, -,-  | 13,055 |
| HP            | 12,988, 39,752, 11,606, 1,395 | 65,740 |
| HPK           | -,- 2,-  | 3 |
| (blank)       | 102,- 99, 79 | 279 | 99,362 |

Note: D1 = shallow, D1 = moderate, D1 = very deep, APL = Non-forest Land, HP = Permanent Production Forest, HPK= Convertible Production Forest, HPT = Limited Production Forest, HL = Protection Forest

In general, prospective agricultural development is located on peatlands with shallow (D1) and moderate (D2) depths. Although peat depth greatly affects land suitability class, consideration should also be paid over nutrient retention properties, especially soil pH of less than 4.2.

Based on land use conditions, most peatlands with APL status have been used for agricultural development, namely for plantations, gardens, dry fields and rice fields (Table 3). Plantations was the largest among other land uses, covering an area of 12,514 ha. Opportunities for agricultural expansion exist when forest, scrub, grassland and open land are meticulously managed. Moreover, agricultural intensification could be carried out over existing agricultural landscape.
Table 3. Peatland distribution on APL

| Land use      | Peatland area (Ha) | D1  | D2  | D3  | D4  | Total |
|---------------|--------------------|-----|-----|-----|-----|-------|
| Forest        | 1,987              | 2,562| 198 | -   | 4,747|
| Garden land   | 883                | 70  | -   | -   | 953 |
| Grass         | 127                | 39  | -   | -   | 166 |
| Plantation    | 3,889              | 7,054| 1,428| 143| 12,514|
| village       | 27                 | -   | -   | -   | 27  |
| Paddy field   | 2                  | -   | -   | -   | 2   |
| Seasonal farmland | 251        | 1,230| -   | -   | 1,481|
| Open ground   | 150                | 172 | 72  | -   | 394 |
| Grand Total   | 7,316              | 11,127| 1,699| 143| 20,285|

Note: D1 = shallow, D1 = moderate, D1 = deep, D1 = very deep

It has be noted, however, that development of peatlands must adhere careful planning and selecting appropriate technology to sustain the resources. Mismanagement of peatlands can cause irreversible situation and therefore, is difficult to repair. Excellent examples to this include increasing soil acidity and rapid subsidence of the peat layer. Micro-scale water management, liming, fertilizer and minimum tillage application are expected to improve the quality of peatlands allowing optimal utilization while better conserving peatlands.

4. Conclusion

Peat soil in Tanjung Jabung Barat is dominated by hemic organosols with varying depths from shallow (D1), moderate (D2), deep (D3), to very deep (D4). Root conditions related to moderate and deep peat depths, and nutrient retention from high soil acidity were main inhibiting factors for agricultural development, both for food crops and annual crops. About 97,746 ha of peatlands suited for the development of food crops, horticulture and plantations. However, after superimposing with forest area status map, available and legally developed peatlands covered only about 20,285 ha. Around 14,950 ha of which, have been used for agricultural activities, leading to the areas of intensification. The remaining can be allocated to agricultural expansion. The use of peatlands for agriculture should deal with careful strategy and correct technology to maintain the environment ought to be developed.

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