The limiting factor of land suitability for development of gambir cultivation (case study in Sari Laba Jahe Village Deli Serdang North Sumatra)

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Abstract. Gambir (Uncaria gambir) is commonly found in North Sumatera, especially in Pak-pak Bharat and Dairi Regency. This study aimed to determine the limiting factors for gambir cultivation land suitability in Sari Laba Jahe Village, Sibiru-biru Sub-district, Deli Serdang Regency, North Sumatera Province. This study was conducted from January 2020 to June 2020. Soil sampling based on land unit was carried out through a field survey to determine soil characteristics in the study location. The land suitability was evaluated based on the matching method between data from laboratory analysis and available gambir land suitability criteria. The results showed that the actual land suitability class for gambir in Sari Laba Jahe Village is marginally suitable (S3) with temperature limiting factor (tc) and root zone media (rc) of 65.39% in land units I, III, VI, XI and marginally suitable (S3) with a temperature (tc) factor of 34.61% in land units II, IV, V, VI, VII, VIII, IX, X. The limiting factor of temperature (tc) and root zone media (rc) were difficult limiting factors to overcome so that the potential land suitability for gambir in Sari Laba Jahe Village is the same as the actual land suitability.

1. Introduction
One of the land use efforts to achieve sustainable development in Indonesia, especially in North Sumatera Province in an optimal manner is by planting local indigenous plants that have commercial value and have benefit for community. One of the indigenous plants in North Sumatera Province is gambir. The gambir plant in North Sumatera is commonly found in Pak-pak Bharat Regency and Dairi Regency [1]. Gambir also are commonly found in West Sumatra Province [2]. To find out the suitability of gambir land for the possibility of gambir cultivation in other districts in North Sumatra Province, it is necessary to conduct a land evaluation study for the gambir. Land evaluation requires environmental physical characteristics of an area that are divided into land qualities, and each land quality usually consists of one or more land characteristics [3-7]. Several land characteristics generally have relationship with each other regarding of land quality and will affect of the type use and/or growth of crops and other land-based commodities. Land evaluation is conducted to determine the characteristics of land by taking into account the appropriateness and potential aspects of the land in that location so that the results become a maximum. Land suitability is the suitability level of a plot of land for a particular use [5-7]. Land suitability evaluation is conducted by matching between data of soil physical environmental and the land suitability rating table that have been prepared based on land requirements, including the requirements for plant growth, management and conservation [5, 7]. Land evaluation
results will prepare the information and/or directions for land use according to their needs. The land evaluated can be conducted in conversion forest, unproductive land, or agricultural land whose productivity is less than satisfactory but which can still be increased if the commodity is replaced with more suitable crops [7].

According to the Food and Agriculture Organization (FAO) framework [8,9], there are two types of land suitability, namely: quantitative and qualitative land suitability. Each of this land suitability can be assessed both actual and potential land suitability. The qualitative land suitability is is only stated in qualitative terms, without precise calculations of either cost or capital or benefits. This classification is based only on physical potential of the land. The quantitative land suitability is based not only on the physical land, but also considers economic aspects, such as input-output or cost-benefit. Project operational planning usually requires quantitative land evaluation. Actual land suitability is the suitability of land carried out in present land use conditions, without improvement input. Potential land suitability is the suitability of land carried out in conditions after being given improvement inputs, such as irrigation or terracing, the addition of fertilizers depending on the type of limiting factor [5-7].

Land evaluation for gambir to be cultivated in Deli Serdang have never been conducted, especially in Sari Laba Jahe Village. The previous study about Uncaria gambir as one of important medicinal plants in Pak-pak Bharat Regency, North Sumatra Province has been conducted [1], but the research about land suitability of gambir in Sibiru-biru Sub-district have never been conducted, especially in this village. Given the importance of the availability of information regarding the results of gambir land suitability, which will be used by government and the community in land use for gambir cultivation, this research is necessary. The aim of this study was to determine limiting factor for gambir land suitability classes and to map land suitability class for gambir in Sari Laba Jahe Village.

2. Methodology

2.1. Research site and materials
This research was conducted at Sari Laba Jahe Village, from January 2020 to June 2020. This village is located in Sibiru-biru Sub-district, Deli Serdang Regency, North Sumatera Province. Geographically, area of Sibiru-biru is approximately 89.69 km² [10] (Figure 1). Sibiru-biru is an area that has fertile land. Land in Sari Laba Jahe was cultivated for agriculture by farmers with implementing agroforestry system.

![Figure 1. Study site map in Sari Laba Jahe Village, Sibiru-biru Sub-district, Deli Serdang Regency.](image-url)
2.2. Data collection/procedures

This research was divided into three steps which were research preparation, field research implementation, and classification analysis. In preparation step, was conducted library analysis and secondary data collection. Land units was done by overlaying among soil type map, land cover map and slope map using geoprocessing tool. It available in ArcGIS application. Several studies have been conducted in term of land suitability evaluation using GIS [11-19], but for gambir is rarely conducted. In the field research implementation step, primary data was collected, included physical parameters. It can be have measured in the field, such as: soil depth, erosion and drainage. Soil samples was taken in the field for analysis in the laboratory (soil texture, soil acidity, C-Organic and Cation Exchangeable Capacity (CEC)). Soil sample is divided into: disturbed and undisturbed soil sample. Soil sample using a soil drill called as disturbed soil sample. Soil sample was done by using ring sample called as undisturbed soil sample.

Determination of soil sample point in the field was carried out randomly. The number of soil sampling as conducted on each land unit. The sampling of land units with a small area will be less than that of a wider land unit. Tools were used, such as: ArcGIS Software, hardware/laptop sets, Global Positioning System (GPS) and digital cameras. Tools for survey, namely: soil drills, hoes, sieves, pH meters. Soil samples obtained from the field were analysed for physical characteristics analysis, and biological characteristics analysis as well as chemical characteristics analysis at the Laboratory of Soil Biology and Central Laboratory, Faculty of Agriculture, Universitas Sumatera Utara. In the analysis and classification step, the data that has been obtained from primary and secondary data as well as laboratory data will be matched with land requirements or land characteristics.

2.3. Data analysis

Land suitability classes consist of four levels [8,9], namely: highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N). The final result of the classification is determined based on the worst class by providing all the existing barriers [4-6]. A change in classification to a better level can be done if the all existing obstacles can be improved. In general, there are eight inhibiting factor in land suitability, namely: temperature (tc), root zone media (rc), water availability (wa), oxygen availability (oa), nutrient retention (nr), erosion hazard (eh), flood hazard (fh) and land preparation (lp) [4-7]. The results of land evaluation were presented in actual and potential land suitability class table as well as distribution map of land suitability class. The actual land suitability class assessment was conducted by matching, namely; comparing the land characteristics parameters with the land suitability criteria required of gambir. The potential land suitability assessment was conducted after assessment of the actual land suitability class. In potential land suitability assessment, land improvements were needed on possible inhibiting factors so that land quality can be better and land suitability is expected to increase.

The mapping of land suitability classes distribution for gambir was conducted in the Forest Inventory Laboratory, Forestry Study Program, Faculty of Forestry, Universitas Sumatera Utara. The assessment of gambir land suitability was conducted using matching method [4-7], by comparing between data from laboratory and field observations. The criteria determined by Agricultural Technology Research Institute, North Sumatra [20]. The highly suitable (S1) for gambir namely: temperature is 18 to 22°C, rainfall is between 2000 to 2500 mm, drainage is good and rather good, soil texture is smooth to slightly coarse, soil depth is more than 100 cm, CEC is more than 16 me / 100g, base saturation is more than 50%, pH H2O is 5.0 to 7.0 and C-organic is more than 0.4% [20].

3. Results and discussion

Based on the overlay using the GIS application, it was obtained eleven land units in Sari Laba Jahe Village. The total area of the land map unit is 874.68 Ha (Table 1). The largest land unit is in land unit III covering area of 495.41 ha or about 56.64% of the total area of Sari Laba Jahe Village. Followed by land unit X with an area of 133.53 ha or about 15.64% and land unit VIII with an area of 118.34 ha or about 13.53%. Land units have area of less than 10%, such as: land unit XI with an area-of 60.52 ha
(6.92%), land unit IV covering area of 26.06 ha (2.98%), land unit VII covering 19.50 ha (2.23%), land unit VI an area of 11.28 ha (1.29%), land unit I is 4.75 ha (0.54%), land unit V is 3.26 ha (0.37%), land unit IX is 1.75 ha (0.2%), and land unit II is 0.28 ha (0.03%). Based on laboratory analysis, the characteristic of land in Sari Laba Jahe were: soil texture in the research location consists of four types, namely: fine, slightly fine, medium, and slightly coarse; Soil depth was ranges from 52 cm to 98 cm, pH was ranges from 6.46 to 6.72; C-organic was ranges from 0.79 to 1.45%; CEC was ranges from 10.33 to 17.31 me/100g; temperature was ranges from 25°C to 26°C.

Land over is one of the factors that need to be considered in land evaluation study. Based on observations in the research location, dry land agriculture was dominant. The community in this village manage the land as a mixed garden with agroforestry and plantation systems. The land cover in land units III, land unit VIII, and land unit X was dominated by dry land agriculture. Paddy field land cover was found in land units IV and land unit XI with an area of 86.58 ha and settlement was found in land units II, land unit V and land unit VII with an area of 23.04 ha.

Based on the results of GIS analysis, the actual and potential land suitability areas were obtained in eleven land units with the limiting factors in Sari Laba Jahe Village (Table 1). The actual and potential land suitability map of gambir can be seen in Figures 2 and 3. The results of the comparisons (matching) show that the actual and potential land suitability classes for gambir in Sari Laba Jahe Village, Sibiburubur Sub-district was marginally suitable (S3) with a limiting factors were temperature (tc) and root zone media (rc) (65.39%) were in land units I, III, VI and XI. In land units II, IV, V, VI, VII, VIII, IX and X, the actual and potential land suitability classes were marginally suitable (S3) with a limiting factor of root zone media (rc) (34.61%). The actual and potential land suitability evaluation results as presented in Table 1.

| Actual land suitability | Potential land suitability | Land unit   | Area  |
|-------------------------|---------------------------|------------|-------|
| S3, tc, rc              | S3 tc, rc                 | I, III, VI, XI | 571.96 | 65.39 |
| S3 tc                   | S3 tc                     | II, IV, V, VI, VII, VIII, IX, X | 307.72 | 34.61 |
| Total                   |                           |            | 874.68 | 100   |

In land unit I, temperature was 25 to 26°C and soil depth was 68 cm. After being matched with gambir characteristics criteria, the actual land suitability in land unit I was marginally suitable (S3). Therefore, in land unit I, the limiting factors were tc and rc. Studies related to land suitability assessment for forestry, agricultural and multi-purpose tree species in North Sumatra Province, the limiting factor is the same, namely soil depth [21,22]. The same results with land units III, land unit VI and land unit XI. The data values for temperature and soil depth belong to land suitability class S3. In land unit II, the temperature data value obtained is 25-26°C, after being matched with gambir characteristics criteria, land unit II was class S3. However, the soil depth in land unit II is 82 cm. after matched with gambir criteria, land unit II class S2. Therefore, in land unit I, the suitability of the actual land was S3 with the only limiting factor being temperature (tc). Similar to land units II, IV, V, VI, VII, VIII, IX and X, the actual land suitability was S3 with the temperature (tc) limiting factor. Temperature and soil depth were natural limiting factors that cannot be overcome by human intervention, therefore the potential land suitability of the gambir was the same as the actual land suitability (Table 1) [23-25]. The actual and potential for gambir land suitability map is presented in Figures 2 and 3.

Based on Figure 2 and Figure 3, it can be seen that the actual land suitability of the gambir in Sari Laba Jahe Village was marginally suitable (S3). Likewise, with potential land suitability classes with limiting factors temperature (tc) and root zone media (rc). Temperature is a climatic element that affects plant metabolic processes that determine plant productivity. Therefore, the air temperature is used as a characteristic of the land related to the requirements for plant growth. Temperature and soil depth are
natural limiting factors, so that they cannot be overcome by human intervention, therefore, the potential land suitability for gambir in Sari Laba Jahe Village was the same as the actual land suitability.

Figure 2. Actual land suitability map for gambir in Sari Laba Jahe Village.

Figure 3. Potential land suitability map for gambir in Sari Laba Jahe Village.

Temperature and soil depth were limiting factors that difficult to overcome, so that the potential land suitability for gambir in Sari Laba Jahe Village is the same as the actual land suitability. Results land
evaluation for gambir will provide information. Land evaluation is carried out so that land use planning can be well structured, especially in North Sumatra Province. In land use planning, it is necessary to know the potential and suitability of land for various types of land use. Therefore, by evaluating the land of gambir in this village, so the stakeholder get the information about the potential land for cultivating the gambir in this village. In land suitability assessment, there are three factors that must be considered, namely: crop requirements, management requirements and conservation requirements. Three main factors are reflected in the quality and characteristics of the land [7].

Several studies related to land suitability that have been carried out, such as: Parkia speciosa [26], Lansium domesticum [16] and Persea americana [27,28], show that rc is a limiting factor. Land evaluation on Pinus merkusii [23] which was carried out in Telagah Village, Sei Bingai Sub-district, showed that limiting factors were the temperature (tc) and erosion hazard (eh) [12]. Likewise, with Elaeis guenensis [4,22,24,25] in several areas in North Sumatra Province. Different from Durio-zibethinus [29] in Perkebunan Tambunan Village, the limiting factor is water availability (wa). The difference in limiting factors shows that each plant is different requirements to grow.

4. Conclusions

Based on land evaluation for gambir in Sari Laba Jahe Village, the actual and potential land suitability was marginally suitable (S3) with temperature (tc) limiting factor and root zone media (rc) (65.39% from total area) located in land units I, III, VI and XI. The actual and potential land suitability was marginally suitable (S3) with with temperature (tc) factor (34.61% from total area) located in land units II, IV, V, VI, VII, VIII, IX, and X with the limiting factor were temperature (tc) and root zone (rc) media.

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**Acknowledgements**

This research is part of research grant/research project based on Contract Number 11 / AMD / E1 /KP.PTNBH/2020 on May 11, 2020. Thank to the Directorate General of Higher Education of Indonesia (DIKTI) through the Deputy for Strengthening Research and Development, the Ministry of Research and Technology/National Research and Innovation Agency 2020 and the Universitas Sumatera Utara (USU) for providing financial assistance.