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Land suitability evaluation in the Northern Limestone Mountains of Tuban Regency, East Java for torch ginger (*Etlingera elatior* Smith) cultivation

Evaluasi kesesuaian lahan Pegunungan Kapur Utara Kabupaten Tuban, Jawa Timur untuk budidaya kecombrang (Etlingera elatior *Smith*)

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ABSTRAK

Kecombrang (*Etlingera elatior*) merupakan tanaman herba asli Asia Tenggara, yang biasa dimanfaatkan sebagai bahan obat herbal oleh masyarakat lokal karena bermanfaat sebagai antibakteri, antivirus, antiradang, antialergi, antioksidan, dan antikanker. Dibalik beragam manfaatnya, tanaman ini masih sulit diperoleh dipasaran karena belum dibudidayakan secara massal. Oleh karena itu, peluang usaha budidaya kecombrang masih terbuka lebar. Kabupaten Tuban merupakan salah satu kabupaten agraris yang potensial di Pulau Jawa dan cukup strategis untuk transportasi karena berada di jalan raya penghubung Provinsi Jawa Tengah dan Provinsi Jawa Timur. Sayangnya, belum banyak dilakukan penelitian mengenai evaluasi kesesuaian lahan pada wilayah pertanian di Kabupaten Tuban. Tujuan penelitian ini adalah melakukan kajian evaluasi kesesuaian lahan budidaya kecombrang di Kabupaten Tuban. Berdasarkan kajian yang dilakukan dalam penelitian ini, lahan-lahan pertanian di Kabupaten Tuban tergolong cukup subur, namun diperlukan irigasi yang memadai agar tanaman dapat bertahan pada musim kemarau. Kecombrang secara alami tumbuh pada wilayah bervegetasi rapat dengan ketersediaan air yang cukup. Oleh karena itu, budidaya tanaman kecombrang di wilayah Tuban memerlukan adanya beberapa perlakuan khusus, yaitu: menjaga ketersedian air dengan membangun saluran irigasi atau melakukan penyiraman rutin, pemberian naungan untuk menjaga suhu dan kelembaban lingkungan disekitar pertanaman, pemberian mulsa pada daerah perakaran kecombrang untuk menjaga kelembaban tanah dan mencegah tanaman mengalami kekeringan, pemberian pupuk P dan pupuk organik untuk mengatasi fiksasi P yang terjadi di tanah kapur, serta perlakuan pemberian zat pengatur tumbuh (ZPT) seperti paclobutrazol untuk mengatasi hambatan pembungaan. Dari berbagai literatur yang diteliti, ditemukan bahwa tanah di Pegunungan Kapur Utara Kabupaten Tuban cukup subur dan cocok untuk lahan pertanian.

Kata kunci: fiksasi P, karst, paclobutrazol

ABSTRACT

Torch ginger (*Etlingera elatior*) is a herbaceous plant from Southeast Asia, traditionally used as herbal medicine by local people due to its antibacterial, antiviral, anti-inflammatory, anti-allergic, antioxidant, and anti-cancer properties. Despite its various benefits, this plant has struggled to enter the market because it has not been cultivated on a large scale. Therefore, the opportunity for commercial cultivation of this plant remains wide open. Tuban Regency is a potential agricultural

district in Java, strategically positioned on the main road between Central Java Province and East Java Province. Unfortunately, little research has been conducted on land suitability evaluation in Tuban Regency's agricultural areas. This research aimed to evaluate land suitability for torch ginger cultivation in Tuban Regency. Based on the studies conducted, agricultural land in Tuban Regency is quite fertile, but adequate irrigation is necessary to help the plants survive during the dry season. Torch ginger naturally grows in densely vegetated areas with sufficient water availability. Therefore, cultivating torch ginger in Tuban requires several special treatments, such as maintaining water availability, providing shade and mulch to regulate temperature and humidity, applying phosphorus and organic fertilizers to address phosphorus fixation in limestone soil, and using growth regulators like paclobutrazol to overcome flowering inhibition. From the various literature that has been studied, it was found that the land in the Northern Limestone Mountains of Tuban Regency, is quite fertile and suitable for agricultural land.

Keywords: karst, paclobutrazol, P fixation

INTRODUCTION

Torch ginger (*Etlingera elatior*) is a tropical plant that has colorful and distinctively shaped flowers. At first glance, the shape of the flower stalk and crown when it blooms will resemble a torch. Torch ginger flowers are widely used as cut flowers, cooking ingredients, and herbal/traditional medicine (Hidayat, 2023). Torch ginger are mostly cultivated by small farmers for their own consumption or sold in limited quantities. Torch ginger commercial cultivation is uncommon, but this plant often harvested from nature or cultivated as side crops. Meanwhile, not many farmers are interested in producing high quality torch ginger flowers for commercial purposes (Ismail et al., 2020). The lack of large-scale torch ginger plantations indicates that this plant is still difficult to find on the market. Therefore, there are business opportunities for *kecombrang* cultivation, Indonesian name of torch ginger.

Tuban Regency is one of the agricultural districts in Java Island, with a population density of 701 people km^{-2}, or below average compared to other areas in Java (Widiatmaka et al., 2016). Even though this area has rocky landscape, uneven hills, sparse vegetation, and no surface water flow, this unique area provides food, living space, and water for the people who inhabit it (Reinhart et al., 2023). Population density is relatively low compared to other areas on the island of Java, causing most of land in Tuban to be used for agriculture. Apart from that, Tuban's position is quite strategic because it is located on the main road connecting Central Java Province and East Java Province.

Unfortunately, there has been no specific study of land suitability for torch ginger cultivation in the North Limestone Mountains of Tuban Regency. Therefore, in this article we will evaluate land suitability in the northern limestone mountains of Tuban Regency, East Java for tForch ginger (*Etlingera elatior* Smith) cultivation. The objective of this research was to study land suitability evaluation of torch ginger cultivation in Tuban Regency.

MATERIALS AND METHODS

The method used in this research was qualitative analysis through study and literature review. The classification of land suitability refers to the Food and Agricultural Organization/FAO (1976) criteria, which were Suitable (S) and Not Suitable (N) with the following details (Table 1).

Table 1. Land suitability classification (FAO, 1976)

Classification	Explanation
S1	Land having no significant limitations to sustained application of a given use, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.
S2	Land having limitations which in aggregate were moderately severe for sustained application of a given use; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class S1 land.
S3	Land having limitations which in aggregate were severe for sustained application of a given use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will be only marginally justified.
N	Land having limitations which appear unsuitable for certain uses on a sustainable basis.

RESULTS

The Northern Lime Mountains Land Characteristics in Tuban District

The North Limestone Mountains on the island of Java were known for its karst characteristics, which were composed of limestone. Karst was formed after going through a series of natural processes that occurred in thousands to millions of years. Karst formation comes from the deposition of lime on the seabed, as well as animal and plant residuals that contain lime. When there was a collision between the earth's plates, the sediment will be lifted because the plates rise to the surface. Therefore in karst areas, fossils of marine animals or plants could be found. Even though karst areas have barren and rocky surfaces, the karst ecosystem actually has a vital function to store ground water. Another characteristic of karst was that it dissolves easily with rainwater and allows water to leak into the ground very easily. Therefore, many natural basins and caves were located in karst areas. Rainwater that enter through these cracks will create underground rivers. As a result, the karst area naturally becomes a water catchment area for the surrounding areas (Figure 1).

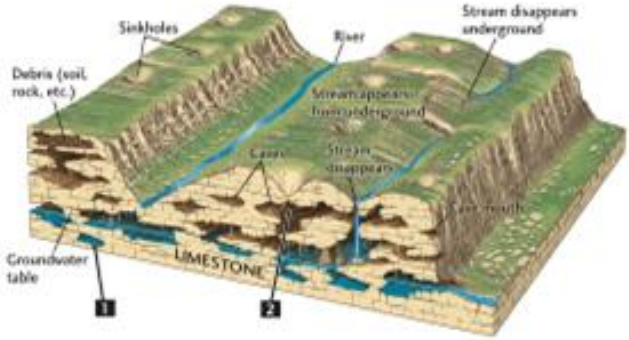


Figure 1. Characteristics of karst areas (Solidaridad, 2019)

Kendeng Karst was one of the karst ecosystem areas in Indonesia. If mapping was carried out, the Kendeng Karst could be classified into two mountain ranges, namely the North Limestone Mountains (North Kendeng) and the Kendeng Mountains (South Kendeng). This second row of mountains stretches from Central Java Province to East Java. If mapped from west to east, the area includes southern Pati Regency, northern Grobogan Regency, Rembang Regency, Blora Regency, Tuban Regency, northern Bojonegoro Regency and western Lamongan Regency (Figure 2). The width of this mountain range was around 30–50 km with a height of less than 800 meters above sea level. There were two young volcanic mountains in this area, i.e. Mount Lasem (806m) and Mount Butak (679 m). In the Central Java region, the Kendeng Mountains located in the mainland. Meanwhile at East Java, parts of the Kendeng Mountains were located in the coast. Karst areas have shallow and stable groundwater levels throughout the year. This was characterized by the existence of perennial wells around groundwater basins in karst areas (Solidaridad, 2019).

According to the results of identification of karst morphological differentiation in Tuban Regency by Zaenuri and Haryono (2015), karst in the region was relatively young. The karst morphology was composed of young reef limestone which was formed during the Quaternary era. Karst hills in Tuban Regency tend to extend from west to east with more developed southern area than the northern. However, the karst land in Tuban Regency was classified as imperfect or does not fully showed karst characteristics due to the influence of surface flow erosion from the surrounding rivers. Widiatmaka et al. (2015) has grouped the types of soil in Tuban Regency into 5 types, which were: Alfisols, Entisols, Inceptisols, Ultisols, and Vertisols. Soil with the Inceptisols classification type occupies the highest percentage, which was 45.2% of the area (83.152.9 ha). The second most dominant soil type was Alfisol, which was 22.8% (41.967.5 ha). Meanwhile, Entisols, Vertisols and Ultisols were each less than 15% of the study area. The dominance of Inceptisols soil showed that most of the soil in Tuban Regency was at a relatively young stage of development and has not experienced much weathering. In the USDA soil classification (*United States Department of Agriculture*), the term Inceptisol comes from *Inceptum* which means "young" in Latin. Meanwhile, the discovery of Alfisols showed further soil development which was shown through clay accumulation/illuviation horizons (argillic horizon, kandic horizon, or natric horizon) due to the leaching of clay from the topsoil (Soil Survey Staff, 2022) (Figure 3).

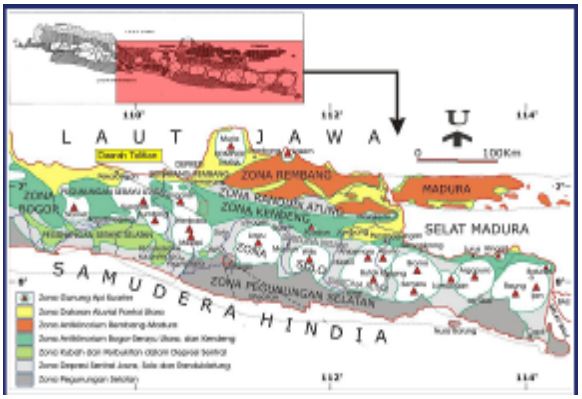


Figure 2. Physiology of the central and eastern parts of Java Island (van Bemmelen, 1949 in Solidaridad, 2019)

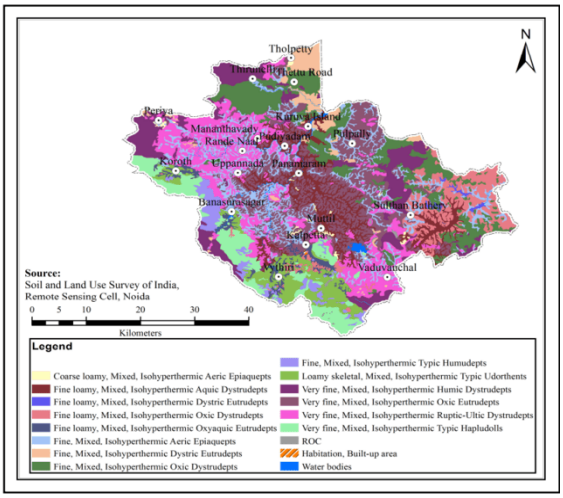


Figure 3. Soil taxonomic class map of Wayanad District (Gahlod et al., 2017)

Previous Research on Land Suitability Evaluation of Torch Ginger

Until now, there has been no research that specifically focuses on land suitability of torch ginger cultivation, so the references were still limited. One of the studies related to location assessment was carried out by Ismail et al. (2020). This research examines the interaction effects of genotype and environment to determine the response of several genotypes of torch ginger plants, by comparing the levels of antioxidants production. However, the results of this study showed more of a response to genotype than a response to the environment. Location assessment was important information to find out how environmental conditions could affect physical conditions, metabolism, nor plants productivity, as a reference source that could be used to choose the most appropriate location for cultivating torch ginger (Figure 4). Because research on torch ginger was still limited, this study used reference from plants with the same family (*Zingiberaceae*). One type of *Zingiberaceae* whose land suitability has been studied was the cardamom plant. There were two types of cardamom in Indonesia, namely Javanese cardamom (*Amomum compactum*) and Indian cardamom (*Elettaria cardamomum*). Research on land suitability on cardamom was carried out by Gahlod et al. (2017), in Wayanad District, Kerala State, India. The average rainfall in this area was 1.871 mm with an average soil temperature of 22.56^{0}C. There were three soil classifications identified in this research area, which were: Entisols, Incepisols and Mollisols. Most of the areas were located in the steep to very steep slope class (42.1%) followed by the very gentle to moderately steep slope class (26.1%). Very deep soil (75.3%) occupies most of the area followed by deep soil (23.6%), drainage was imperfect to excessive, soil pH was acidic with values ranging from 4.23 to 6.01. Soil organic carbon ranges between 0.28–2.88% and base saturation ranges between 20.81–81.16% (Table 2).

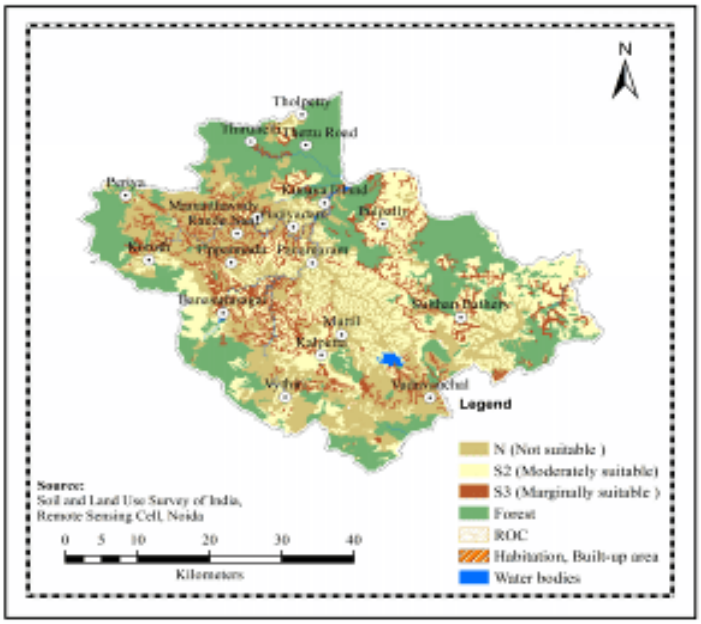


Figure 4. Suitability of land locations for cardamom in Wayanad District (Gahlod et al., 2017)

Table 2. Distribution of suitable areas for cardamom (Gahlod et al., 2017)

Suitability	Area (ha)	Area (%)
S2	57.319	26.92
S3	25.762	12.1
N	60.603	28.46
ROC	399	0.2
Habitation, Built-up area	161	0.1
Water bodies	1.848	0.9
Forest	66.848	31.39
Total	212.940	100.07

Cardamom naturally grows in cool, humid climates under the forest canopy. Research conducted on cardamom showed that this plant was able to grow at temperatures of 18°C to 26°C. Wayanad district has a rainfall of around 1800 mm and the temperature remains constant throughout the year at ±25°C, so it was assumed to be suitable for cardamom cultivation. In this study, to assess the suitability and classification of land, it was concluded that around 39.02% of the total geographical area was included in the Suitable (S) class, such as in the Wayanad District which was located at a height between 1000 to 2100 meters above sea level. Then the land classification was further divided into quite suitable (S2) and marginally suitable (S3). Areas that showed sufficient suitability (S2) were 26.92%, marginally suitable (S3) were 12.10% and unsuitable (N) were 28.46% found on hill slopes.

Types of Plants which were Suitable for Cultivation in the Northern Limestone Mountains of Tuban District

Karst areas in Indonesia were tropical karst which was characterized by cone-shaped hills with polygonal or cockpit landscapes. Several large islands in Indonesia (Java, Sumatra, Borneo, Sulawesi and Papua) have extensive karst areas. Some well-known karst areas were Gunung Sewu Karst (Java), Maros Karst (Sulawesi), and Sangkulirang-Mangkakerja Karst (Kalimantan) (Reinhart et al., 2020). Apart from the Gunung Sewu Karst, Java Island has other, smaller karst areas. Some of them were Gombong Karst (Central Java), Kendeng Karst (Central Java & East Java), Kalapanunggal Karst (Bogor Regency, West Java), and Tuban Karst (East Java). Each karst region has a different landscape and characteristics, including the karst region in the north of Java Island (Reinhart et al., 2023).

Tuban Regency was located on the north coast of Java Island and was divided into 19 sub-districts. Several areas bordering Tuban Regency were Rembang, Lamongan, and Bojonegoro Regency which each other located in the west, east, and south. On northern part, Tuban Regency was directly facing the Java Sea. Geologically, the limestone that makes up the Tuban Karst was the Pliocene Paciran Formation (Mulyadi et al., 2019). This tertiary limestone was composed of three different phases, which were calcarenite, calcitelite and reef limestone. The nature of the lithology and the nature of the climate shape the surface and form certain land forms such as blind valleys, closed depressions, and caves (Reinhart et al., 2023) (Figure 5).

The presence of limestone parent material found in Tuban Regency indicates the presence of high base saturation in the soil due to the Ca content of the mineral calcite ($CaCO_3$) and Mg from dolomite minerals ($CaMg(CO_3)_2$). High base saturation correlates with higher soil pH values. On the other hand, high Ca content in soil in karst areas could fixate P (phosphorus), making it unavailable to plants. Apart from that, the element P could also be bound by clay particles in the soil (Leytem & Mikkelsen, 2005) (Figure 6). The map of karst distribution areas in Tuban Regency (Figure 6) showed that not all areas of Tuban Regency classified with karst areas, but only concentrated in several sub-districts, which were Tambakboyo, Jenu, Merakurak, Kerek, Montong, Parengan, Soko, Rengel, Semanding, Palang, and Tuban City sub-district. A land suitability study in Tuban Regency was carried out by Iswi & Santoso (2015) by mapping superior commodities according to regional potential in each sub-district in Tuban Regency (Figure 7). In this research, land suitability data for agricultural commodities with a very suitable value (S1) was obtained, dominated by rice (53,077 ha), corn (6,412 ha) and green beans (2,064 ha) located in Palang, Semanding, Rengel, Plumpang, Widang, Soko, Parengan, Montong, Merakurak, Kerek, Bancar, Jatirogo, Tuban, and Kenduruan sub-districts. In addition, potentially suitable land was obtained with S2 values (quite suitable) for peanuts (41,879 ha) and soybeans (20,693 ha) located in Palang, Semanding, Rengel, Plumpang, Widang, Soko, Parengan, Montong, Merakurak, Kerek, Bancar, Jatirogo, and Kenduruan sub-districts (Figure 7). Unfortunately, research conducted by Iswi & Santoso (2015) was still limited to food crops, so to date no land suitability data has been found on horticultural crop commodities in Tuban Regency (Figure 8).

Figure 5. Distribution of karst areas on Java Island (Reinhart et al., 2023)

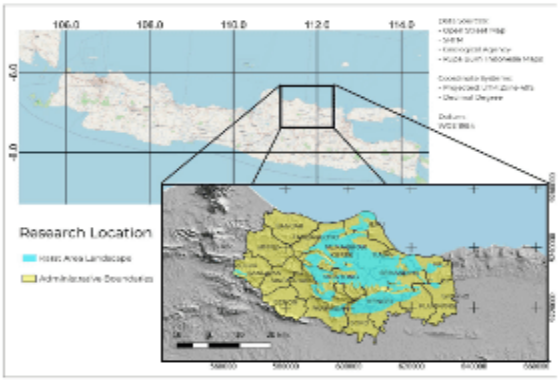


Figure 6. Distribution of karst areas in Tuban Regency (Reinhart et al., 2023)

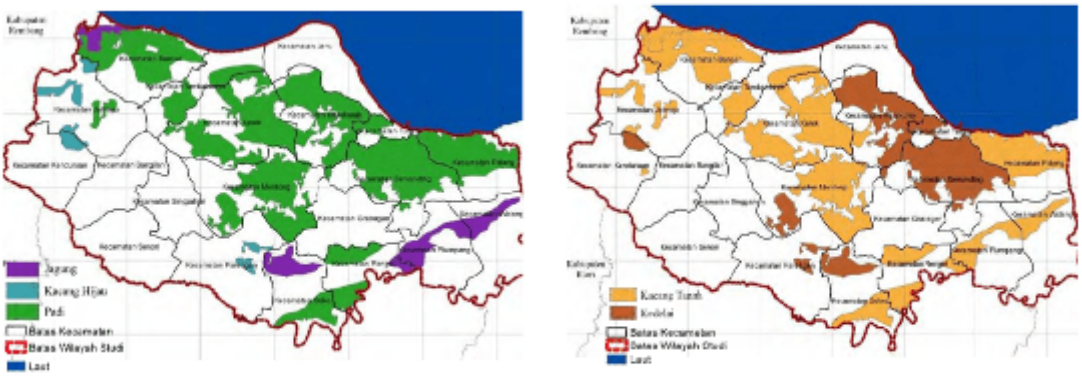
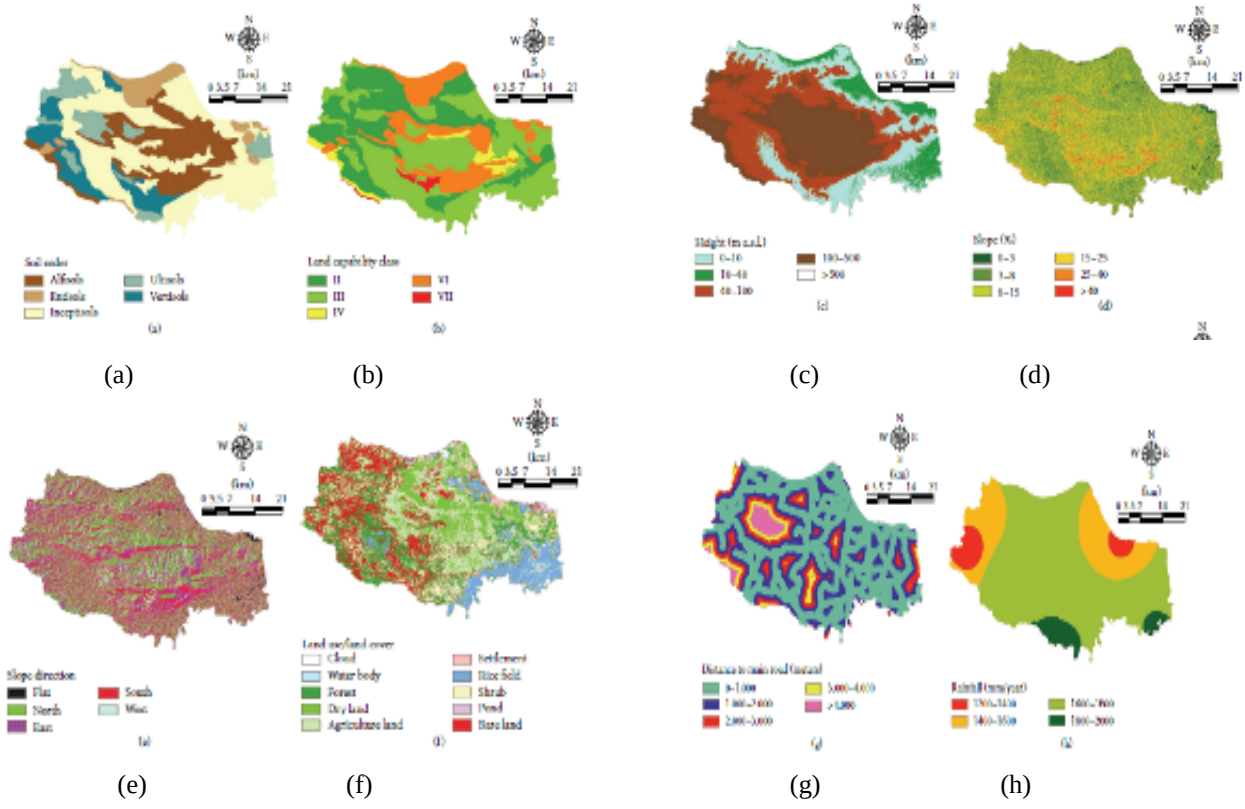


Figure 7. Suitability of land with S1 (above) and S2 (bottom) values (Iswi & Santoso, 2015)



(a) (b) (c) (d)

(e) (f) (g) (h)

Figure 8. Criteria used to determine land suitability in Tuban Regency: (a) soil order, (b) soil capability class, (c) height, (d) slope, (e) slope direction, (f) land use/land cover , (g) distance to the main road, and (h) rainfall (Widiatmaka et al., 2016)

In research conducted by Widiatmaka et al. (2015) mapping was also carried out to determine potential disasters and land use. This was because the flow of the Bengawan Solo River that flows through Southern Tuban which has the potential to overflow during the rainy season (Figure 9). Research on land suitability in the Tuban Regency area was carried out by Widyatmaka et al. (2016), which resulted that most (90.7%) of the areas in Tuban Regency were suitable for agriculture (Table 3).

The mapping results showed that 166,916.3 ha, out of the total area of the district, which was 183,994.6 ha, was an area that suitable for agricultural development (Figure 10). Then in this research a more detailed grouping was made with the results that the majority (33.1%) classified as very suitable land (S1) for agriculture. There was only 9.3% of the area whose land was classified as not suitable for agriculture.

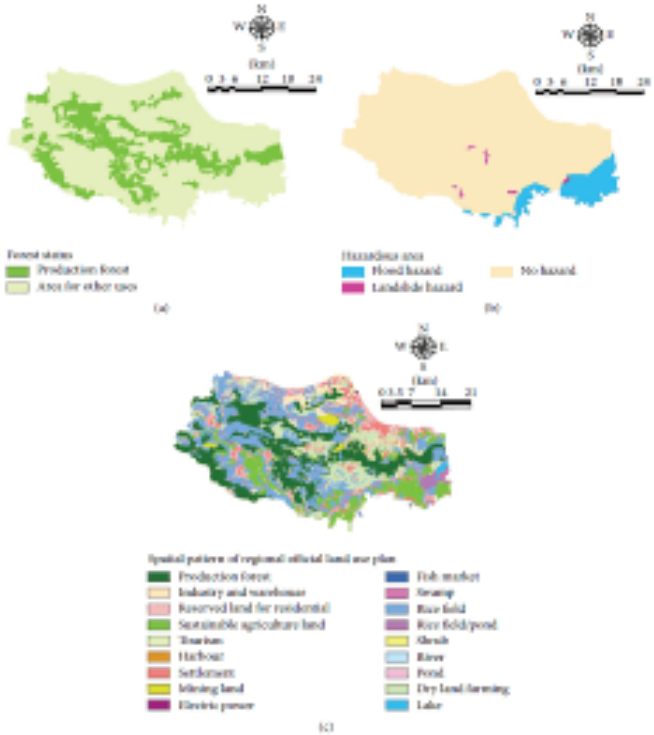


Figure 9. Map of production forest areas (a), map of disaster-prone areas (b), and map of land use plans (c) (Widiatmaka et al., 2016)

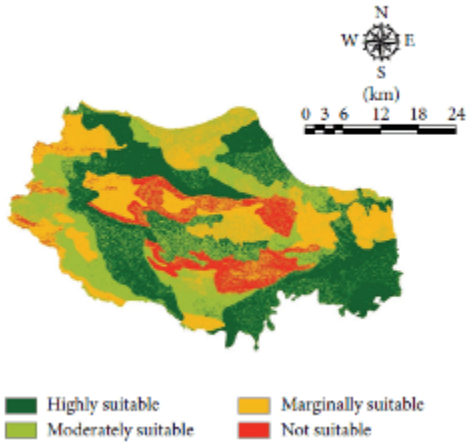


Figure 10. Map of land suitability for agriculture in Tuban Regency (Widiatmaka et al., 2016)

Land Suitability Evaluation for Torch Ginger Crops

Torch ginger was often found growing naturally in forests of Indonesia. One of the regions in Indonesia where torch ginger grow a lot was Aceh Province. The local name for torch ginger was *bak-kala*, which was used as traditional medicine to treat diseases such as coughs, fevers and sprains by traditional tribes in Aceh. Saudah et al., (2022) has conducted research by exploring and collecting samples of torch ginger from various regions in Aceh such as Gayo Lues, Southeast Aceh, South Aceh, Nagan Raya, Aceh Tamiang, Simeulu, Pidie, and Central Aceh to examine their genetic diversity. The large number of explored areas in Aceh found that Aceh region was a natural habitat for wild torch ginger that was suitable for their reproduction. When viewed from a geographical perspective, Aceh was located at 2°–6° north latitude and 95°–98° south latitude, and has an average altitude of 125 meters above sea level. The air temperature in Aceh ranges between 22.9°C–32.5°C, with humidity 70–80%. Rainfall in Aceh varies quite widely, between 1,500–2,500 mm/year. Other research related to torch ginger habitat has also been carried out by Lianah et al. (2020) who evaluated and identified native species of *Zingiberaceae* family in Central Java. Observations were carried out at three locations, which were Mijen District, Mount Prau, and Darupono Teak Forest. *Zingiberaceae* was a versatile species that was often used as a medicinal plant. Members of this family have wild relatives that have not been identified and live in the tropical forests of Asia, including Indonesia. Tropical climate was a suitable environment for *Zingiberaceae*.

Based on research, it was found that there were differences in the number of species in different seasons. The first period starting in January (rainy season) found 12–19 species, while in July-December (dry season) only 9–16 species were found (Table 4). This showed that the growth of *Zingiberaceae* was strongly influenced by rainfall or requires a consistent water supply for optimal growth. The diversity of species found in a forest ecosystem was related to biotic and environmental factors, including topography, altitude, soil, air, light, rainfall and humidity. Mijen teak forest was a type of lowland forest with the height of 200–500 meters above sea level with high rainfall, thus resulting in a high diversity of flora types. *Zingiberaceae* could survive in the lowlands to an altitude of more than 200 meters above sea level, with high rainfall and humidity. Thus, *Zingiberaceae* was the most common genus in Mijen, Darupono, and Gunung Prau (Figure 11). In the study region, several species were observed growing in open forest, river banks, and swamps. The two species of the genus Etlingera found in this research were Kecombrang (*torch ginger*) and Tepus. Kecombrang was found in Mijen and Wonoplumbon, while Tepus was found in Mijen and Bubakan (Table 5). Until now, specific research regarding the habitat and cultivation of orch ginger was still very limited, including research regarding the suitability of land for cultivating torch ginger. Therefore, additional references Tused come from other plants that was in the same family (*Zingiberaceae*). One of which was *Etlingera coccinea* known by the local Malaysian community as Tuhau. Naturally, Tuhau could be found in gaps or forest shade, and near water sources such as rivers with sandy or clay soil. Dosuil et al. (2020) conducted research to compare the vegetative growth of Tuhau in two different locations. First location was Kokol, Manggatal City, State of Sabah located at an altitude of 733–738 m. The average monthly rainfall at this location was 48.8–583.9 mm, with an average monthly temperature of 26.5–28.9 °C, and an average relative humidity of 67.0–85.2%. The second location was located in Marakau, Ranau District, Sabah State with an altitude of 697–703 m. The average monthly rainfall in this area was 99.6–437.6 mm, with an average monthly temperature of 23.7–25.1°C, and an average relative humidity of 73.5–88.0%. The results of research at both locations did not find significant differences in vegetative growth, so it was assumed that both locations were still classified as suitable for Tuhau growth.

Table 3. Land distribution area suitable for agriculture in Tuban Regency (Widyatmaka et al., 2016)

Suitability level	Total area classified by the suitability analysis	
	ha	%
Highly suitable	60.812.30	33.1
Moderately suitable	53.866.80	29.3
Marginally suitable	52.237.20	28.4
Not suitable	17.078.30	9.3
Total	183.994.60	100.1

Table 4. *Zingiberaceae* species found in Mijen, Darupono, and Mount Prau (Lianah et al., 2020)

Location	Number of Species	
	Period I (January–June 2017)	Period II (July–December 2017)
Mijen	19	16
Darupono	12	6
Gunung Prau	16	9

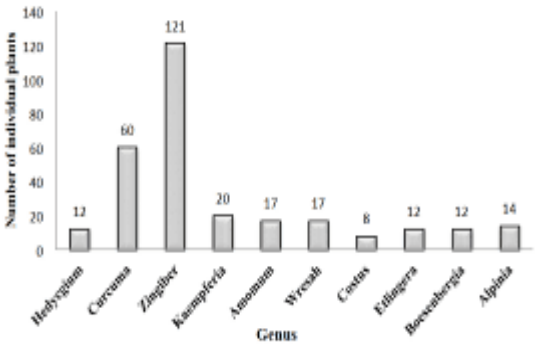


Figure 11. Number of each genus found in the research (Lianah et al., 2020)

Table 5. Identification of *Zingiberaceae* species found in the three research locations

Genus	Species	Number of Plants
Hedycgium	*Hedychium coronarium J.König*	12
Curcuma	• *Curcuma longa L*	20
	• *Curcuma zanthorrhiza Roxb*	30
	• *Curcuma amada Roxb*	5
	• *Curcuma heyneana Val.& van Zijp*	5
Zingiber	• *Zingiber officinale Roxb.*	23
	• *Zingiber officinale var. rubrum*	15
	• *Zingiber zerumbet subsp. Zerumbet*	21
	• *Zingiber zerumbet (L.) Roscoe ex Sm*	22
	• *Zingiber montanum (J.König) Link ex A.Dietr.*	40
Kaempferia	• *Kaempferia galanga L.*	8
	• *Kaempferia rotunda*	12
Amomum Wresah	• *Amomum compactum Soland.ex Maton*	17
	• *Amomum maximum Roxb.*	17
Costus Etlingera	• *Costus specios (koening) J.E.Smith*	8
	• *Etlingera foetens (Blume) R.M.Sm*	2
	• *Etlingera elatior (Jack) R.M. Sm*	10
Boesenbergia	*Boesenbergia rotunda (L.) Mansfeld*	12
Alpinia	• *Alpinia galanga (L.) Willd*	10
	• *Alpinia purpurea (L.) Willd*	4
10 Genus	19 Species	293

DISCUSSION

In general, the land in the North Limestone Mountains in Tuban Regency is quite fertile and suitable for cultivating plants. This is in accordance with Widiatmaka's et al. (2016) research who analyzed land structure, land capacity, elevation, slope of hillside, slope direction, land use/cover, accessibility, and climate in Tuban Regency. The research results show that land suitable for agriculture covers 91% of the total study area, so that indicates high soil fertility. It is like karst areas in general, water availability is far below the soil/rock layer. Therefore, adequate irrigation is needed so that plants can survive through the dry season.

Torch ginger has a natural habitat in tropical forests which has special characteristics in the form of dense vegetation and high diversity. If we compare the environmental conditions of tropical forests with karst areas, the main difference is the availability of water, especially in the dry season. Second, the air temperature in karst areas tends to be higher with lower air humidity compared to tropical forests.

Therefore, cultivating torch ginger in the Tuban area requires some special treatment. First, maintain water availability by building irrigation channels or carrying out routine watering. This needs to be done because a long dry period in the torch ginger will prevent the plant from moving from the vegetative to the generative phase. Second, it is necessary to provide shade to maintain the temperature and humidity of the environment around the plants. Providing natural shade can be achieved by planting torch ginger nursery transplant under the shady canopy of trees. Meanwhile, providing artificial shade using paranets is possible if planting is done on a small scale. Third, it is necessary to mulch the torch ginger root area to maintain soil moisture and prevent the plant from drying out. Providing natural mulch from plant residues is more important, because torch ginger is a clumping plant, so applying plastic mulch is more difficult to apply. Fourth, the application of P fertilizer combined with the application of organic fertilizer or organic materials is needed to overcome P fixation which occurs in limestone soil. This is very important considering the nutritional elements P can stimulates the formation of flowers and fruit on torch ginger which is widely used for commercial. P fertilization can be done with a single fertilizer such as SP-26, DAP, and TSP and compound fertilizers such as NPK. Lastly, there is the possibility of flowering being inhibited due to higher air temperatures, longer dry seasons and lower air humidity. When after 120 days of planting there is no initiation of flowering, the treatment using plant growth regulators such as paclobutrazol is needed (Wardani, 2020). The use of paclobutrazol is more often found in the field to initiate plant's flowering because it is better known to farmers and easier to find on the market under various trademarks.

CONCLUSION

From the various literature that has been studied, it was found that the land in the Northern Limestone Mountains of Tuban Regency, is quite fertile and suitable for agricultural land. Unfortunately, the water source is located far below the ground/rock so efforts are needed to provide water for torch ginger cultivation through irrigation or the help of pumps to suck water from below the surface. Torch ginger can be planted in the Tuban area, but requires special treatment to initiate flowering, including: regular watering, providing shade, applying mulch, applying P fertilizer and organic fertilizer, as well as applying plant growth regulators to initiate flowering.

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