Decision Support Systems Suitability In Agarwood Tree Planting Using Simple Additive Weighting Method (Saw) In Merauke District

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Abstract. Gaharu is a blackish colored wood produced by a number of tree species from the genus *Aquilaria,* especially *Aquilaria Malaccensis*. This type is used in the fragrance industry (perfume and clover) because it has a fragrant aroma. Gaharu is a commodity of non-timber forest products (HHBK) which is quite reliable, especially when viewed from its very special price when compared to other NTFPs. A simple decision support system (DSS) can be defined as a computer-based system that is used to make it easier to make decisions. The decision-making ability used by the community is still conventional in determining suitable land for gaharu planting, without a model to assist the assessment process. Based on the results of research conducted using the Simple Additive Weighting (SAW) method with three samples of land and the type of gaharu to be planted is *Aquilaria Malaccensis*, which refers to several indicators including soil type, soil pH, altitude, rainfall, and temperature. land C with a value of 0.42.

Keywords: *Gaharu, DSS, SAW*

1 Introduction

Gaharu is a blackish colored wood produced by a number of tree species from the genus *Aquilaria,* especially *Aquilaria Malaccensis*. This type is used in the fragrance industry (perfume and clover) because it has a fragrant aroma. Gaharu since the beginning of the modern era (year 2000) has been a trading commodity from the archipelago to India, Persia, the Arabian Peninsula, and East Africa. Gaharu is one of the non-timber forest product (NTFP) commodities that is quite reliable, especially when viewed from a very special price when compared to other NTFPs [1].

The high selling value of this agarwood encourages people to take advantage of it. The benefits of the agarwood tree are numerous, ranging from the leaves to the roots which are used for business and medical purposes. From a medical point of view, agarwood is used to improve digestion, lower blood pressure, prevent tumor disease, and become an important antioxidant. Meanwhile, in terms of business, agarwood is used for cosmetic ingredients such as scrubs, perfume, incense, cone incense sticks, liquid soap, solid soap, and can be used as coffee, tea, prayer [1]beads bracelet, and sculpture carvings. However, the benefits and results obtained from the agarwood tree itself are still not widely known by the community [2].

Indonesia has a variety of agarwood producing trees, of which approximately 27 species in eight genera grow in natural forests, namely *Aetoxylon, Aquilaria, Enkleia, Gonystylus, Gyrinops, Dalbergia, Excoccaria, and Wikstroemia.* Of the eight clans, only the *Aquilaria, Gyrinops, and Gonsystylus clans* are the most used. The distribution of places to grow agarwood producing trees is relatively wide and can almost be found in various regional conditions and forest types, both in Java, Sumatra, Kalimantan, Sulawesi, Maluku, Nusa Tenggara, and Papua. Meanwhile, gaharu trees that can grow in the Merauke area itself are *Aquilaria Malaccensis* in potential areas which can reach a tree height of about 40 m and a diameter of 80 cm. It grows at an altitude of up to 750 m above sea level in lowland and somewhat highland forests in hot climates with average temperature 32ºC and humidity around 70%, with rainfall less than 2000 mm / year. And also this type *Gyrinops* of gaharu plantis shaped as a tree that has morphological characteristics and characteristics. Leaves oblong, dark green, leaf edge evenly distributed, tapered tip, about 8 cm long, 5-6 cm wide. Fruit is yellow-reddish in color with an oval shape. Brownish-brown trunk, many branches, tree can reach 30 m high and about 50 cm in diameter. The land where the agarwood tree grows in various variants of soil structure and texture conditions, whether on fertile, medium or

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marginal land. Gaharu trees can be found in forest, swamp, peat ecosystems, even on sandy land with a soil pH between 4.0 and 6.0. The area of the agarwood tree planted at the time of planting was 30 × 50 meters, with the number of plants being 250 trees with a spacing of 3 meters each. Harvesting age for gaharu trees 5-6 years and over is most dependent on the spacing. The selling price of brown agarwood trees alone can reach 10-100 million. The super alone can cost 100-300 million [3].

In Papua Province, there are not many gaharu trees that have been preserved, especially the indigenous people of Merauke. The process of searching for gaharu trees still focuses on mud or swamp areas such as the Keppi area for example. Without further preservation, it is difficult for the community to obtain gaharu trees, which have been a source of their livelihoods. Based on the results of interviews with several people who are members of the Gaharu Cultivation Community in Merauke Regency, it is said that Merauke has very good potential in planting agarwood trees due to the soil and geographical conditions of Merauke Regency, especially in Kurik and Muting Districts which are known to have carried agarwood tree nurseries.

The high selling value of gaharu encourages people to continue looking for aloes in their natural habitat without paying attention to its sustainability so that its population in the wild decreases. This becomes a potential if this plant species is conserved. Conservation efforts are one of the concrete steps towards a program to utilize natural products by taking into account the high selling value. However, the process of preserving gaharu trees still has various kinds of obstacles, one of which is the process of determining the suitability of land in planting agarwood trees, starting from soil type, soil ph, altitude, rainfall, and temperature. On the other hand, agarwood trees are also very necessary in order to understand the real conditions of the world of trade [4].

The cultivation of agarwood tree planting is often an obstacle. One of the obstacles faced is when identifying which types of land are suitable for planting agarwood trees. The method of identifying land is still manual. The point of manual is that they only use their experience to determine which land can be planted with agarwood trees. The community standard in seeing the land that can be planted with agarwood trees is usually from alkaline or moist soil types, as well as the number of reeds that grow on a land. Determination of land is still often constrained by even forcing the agarwood cultivation community to plant on unsuitable land. Besides clearing land in an unsuitable area, it can cost more than the value of gaharu cultivation [5].

A simple decision support system can be defined as a computer-based system that is used to make it easier to make decisions [6]. The decision-making ability used by the community still conventionally determines which land is suitable for gaharu planting, without a model to assist the assessment process. So that the information to support decision making of agarwood tree land suitability is inaccurate, while this information is very useful for the agarwood tree community to recommend and identify specific land locations for agarwood tree planting. From the above problems, the idea arises to design an information system that makes it easier for the community to determine the suitability or suitability of the location of the land to be planted with agarwood trees using an information system in the form of a website. Therefore, the author will design a land suitability decision support system for agarwood tree planting using the simple additive weighting (saw) method in Merauke district.

2 Theoretical Framework Gaharu

2.1 Tree Gaharu

Gaharu began to be known to the Indonesian people around the year 1200 which is shown by the history of trade in the form of exchanges (barter) between the people of South Sumatra and West Kalimantan with traders from mainland China, Kwang Tung. The community obtains gaharu as a result of levies from natural forests by utilizing trees that have died naturally in the form of products in the form of clumps, debris and pulp, which are waste from the cleaning process [7]. As a commodity of Non-Timber nt of science and technology in the Forest Products (HHBK), originally it had a limited use value only to scent the body, space and completeness of religious ritual ceremonies in Hindu and Muslim communities. In line with the developme chemical and pharmaceutical industries and supported by the development of a paradigm in the world of medicine and medicine to reuse natural plant ingredients (back to nature), agarwood products are not only needed as an ingredient in the perfume and cosmetics industry, but are also widely needed as ingredients for herbal medicine. treatment of stress, asthma, rheumatism, inflammation of the kidneys and stomach, antibiotics for tuberculosis, as well as tumors and cancer. Indonesia is the largest agarwood producing country in the world, until the end of 1990 it was able to produce more than 600 tons per year, since 2000 production has continued to decline and with a quota of around 300 tons / year has only been able to be met between 10-15%, even since 2004 with quota of 50 - 150 tonnes / year, there is no record of agarwood export data from Indonesia [8].

2.2 Types of Tree Gaharu

The types of Gaharu producing trees that are scattered throughout Indonesia's forest areas, especially in Sumatra and Kalimantan are from thefamily *Thymelaeaceae (genus Aquilaria, Gonystylus, Aetoxylon, Enkleia, Wikstroemia, Gyrinops) Leguminoseae (Dalbergia) and Euphorbiaceae (Excoccaria).).* In Sulawesi, it is estimated that there is only one species, namely *Wikstroemia androsaemifolia.* In Nusa Tenggara there are types of *Wikstroemia androsaemifolia* and *Gyrinops cuminianga,* while in Papua there are types of *Gyrinops and Aquilaria Malaccensis*. [3] Among the types mentioned above, *Aquilaria Malaccensis* is the producer of the best quality

agarwood and high selling value, so it is over-exploited. The following types of aloes producing trees include:

2.2.1 Aquilaria

Aquilaria has a hard tree trunk with white and slippery bark. Trees can reach a height of up to 40 m with a trunk circumference of about 60 cm. Recognizable features include leaves 5-8 cm long and 3-4 cm wide. Elongated oval leaf shape with tapered leaf tips. The color of the leaves is shiny green. Flowers will grow on the armpits or the ends of branches. The fruit is oval-shaped with a length of 5 cm and a width of 3 cm. The seeds are round, layered with fine reddish hair. Theclan *Aquilaria* has 6 species spread across Indonesia. The explanation can be found in table 1 data on the distribution of *Aquilaria* spp in Indonesia:

Table 1. Distribution of Aquilaria spp in Indonesia

Species	Distribution area of
Aquilaria malaccensis Lamk.	Aceh, Sibolangit, Riau, Bangka, Palembang, Jambi, West Kalimantan, East Kalimantan
A. filaria (Oken) Merr.	Maluku, Nusa Tenggara, Papua
A. becariana Van Tiegh.	Sumatra, Kalimantan
A. cumingiana (Decne) Ridl.	Sulawesi and Maluku
A. hirta Ridl.	Sumatra, Kalimantan
A. microcarpa Baill.	Sumatra, Kalimantan

(Source Germplasm Resources Information Network, online database)

2.2.2 Aetoxylonagarwood

Gaharu This type ofhas regional names, including laka harrow, crocodile rake, and pelabayan. This tree grows in lowland forest areas with dry sandy land. The genus Aetoxylon requires a temperate climate with rainfall around 1400 mm / year, temperature around 27º C, and humidity around 80%. Plants with bark stems gray or blackish with white sap. The average tree has a height of about 15 cm with a diameter of 25-75 cm. The leaves are oval, oval, smooth, and shiny. Petiole about 8 mm. The shape of the flower is rounded or pentagonal and about 4 mm in diameter. The flowers in the petals are 5-6 flowers that are shaped like umbrellas. The length of the flower stalk is about 9 rounded pieces, about 3 cm long, about 2 cm wide, and 1 cm thick. The following is a picture of the aloe tree of the genus Aetoxylon. It is shown in picture 2 of Aetoxylon aloes.

The following is a picture ofaloe tree *Aquilaria* in Figure 1. Picture ofaloe tree *Aquilaria* .

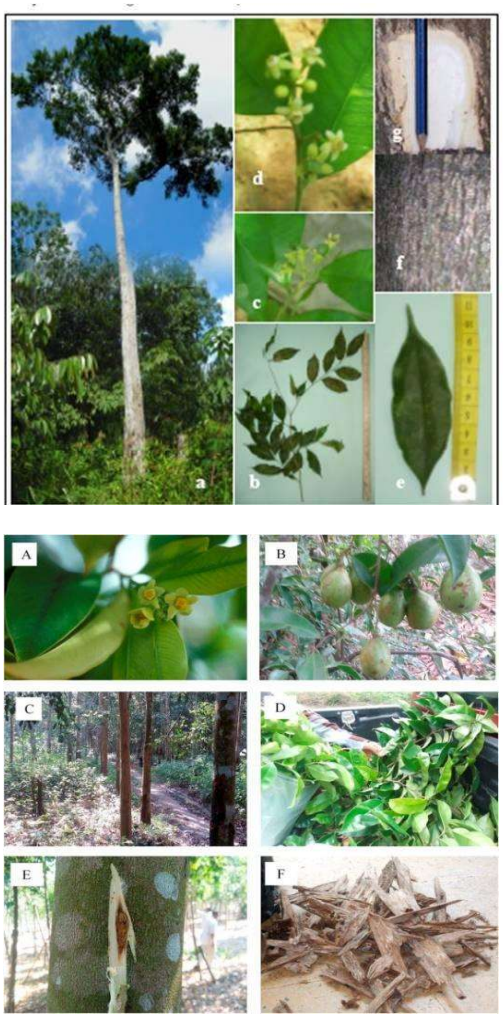

Fig. 1. Tree *Aquilaria*

Fig. 2. Tree Gaharu Aetoxylon

2.2.3 Gonystylus

The regional names of this type of gaharu are karas, mengaras, garu, halim, alim, cucumber, areca nut, nio, areca nut, garu hideung, bunta, mengai, udi, makiri, and sirantih. Trees can reach a height of 45 m and a diameter of 30-120 cm. The plant canopy is thin and rooted in the

breath (swamp). Single leaf smooth. Blackish green leaf color. Leaf shape oval with a pointed tip. Length 4-15 cm and width 2-7 cm. The stem measures 8-18 mm. Flowers are at the end of a twig or leaf axillary. Two-layered panicle-shaped flower with yellow color. The length of the flower stalk is about 1.5 cm. The fruit is ovoid and hard-textured with a tapered tip and has three segments. The fruit is about 4-5 cm long and 3-4 cm wide [3]. The following picture ofshown *Gonyitylus is* in picture 3 of theagarwood tree *Gonystylus.*

Fig. 3. Tree Gaharu Gonystylus

2.2.4 Gyrinops

This type of agarwood plant is almost the same as other groups of members of thefamily *Thymeleaceae*. The trunk is brownish-brown with many branches, the tree can reach 30 m in height and about 50 cm in diameter. Elongated oblong leaves are dark green. Leaf edges evenly with a tapered tip. The leaves are about 8 cm long and about 5-6 cm wide. The fruit is yellow-reddish in color with an oval shape [9]. Here's a picture *Gyrinops there* is in picture 4aloes tree *Gyrinops.*

Fig. 4. Tree Gaharu Gyrinops

2.2.5 Wikstroemia

agarwood tree is characterized by a shrub-shaped tree. This type of agarwood is known as a region, including viable, pelanduk tree, linggu wood, menameng, and jerked. The tree is about 7 m high and about 7.5 cm in diameter. The branches are reddish or brownish in color. The leaves are ovoid or elliptical. Thin leaves with a smooth surface. Leaves about 4-12 cm long. And about 4 cm wide. The length of the petiole is about 3 cm.
Flowers are at the end of a twig or leaf axillary yellow, greenish white, or white with a red crown. The crown is oval or ovoid with a length of 8 mm and a width of 5 mm. The length of the flower stalk is about 1 mm [3]. The following picture is *Wikstroemia* in picture 5 of thealoes tree *Wikstroemia.*

Fig. 5. Tree Gaharu Wikstromia

2.2.6 Enkleia

The group that produces aloes of this type is in the form of climbing plants. Plant up to 30 m tall with a diameter of about 10 cm. The trunk looks reddish, has branches, and has a hook. The flower is at the end of a branch with a flower stem up to 30 cm in length. White or yellowish flower color. The fruit is ovoid with a length of more than 1 cm and a width of 0.5 cm. This type has regional names, namely root tirap, dian root, black root, cempaka garu, areca nut, medang karang, mengai, udi makiri, and bunta. The following picture of *Enkleia is* in picture 6 ofaloe trees *Enkleia.*

Fig. 6. Tree Gaharu Enkleia

2.2.7 Dalbergia

is one of the products of agarwood that is not widely liked. *Dalbergia* belongs to the *Leguminoceae family*. Its species, namely *Dalbergia Parvifolia* which is a climbing plant. The following picture of *Dalbergia is* in the picture of 7aloes trees *Dalbergia.*

Fig. 7. Tree Gaharu Dalbergia

2.2.8 Excoccaria agarwood tree

Excoccaria agloccha is one type of member of thefamily *Euphorbiaceae* including higher plants. The tree has a height of 10-20 m with a diameter of 40 cm. This tree agarwood is less attractive to the market. The following is a picture of *Excoccaria* found in figure 8 of thealoes tree *Excoccaria.*

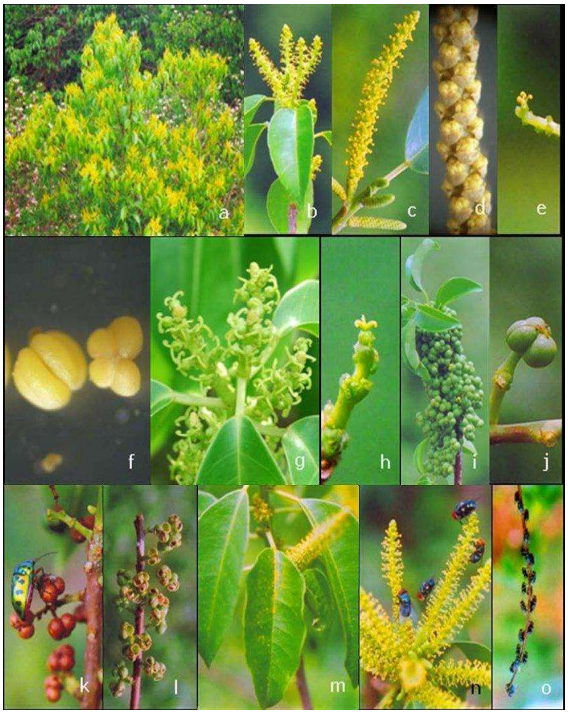

Fig. 8. Tree Gaharu Excoccaria

2.3 Data on the conditions for Growing Agarwood Trees

For the requirements for growing agarwood trees. following are the data for the requirements for growing agarwood trees. Explanation of the table, there is table 2.3 of the data table of the requirements for growing agarwood trees.

Table. 2. Data on the Conditions for Growing Agarwood Trees

Spesies Aquilaria	Type of soil	Soil PH	Climate	Rainfall	Humidity	Temperature	Height
Hirta	Hillside		Dry		20%		300 m asl
Beccariana van Tiegh	Sandy clay		Dry	1.500 mm/th	20%		700-1.000 m asl
cumingiana (Decne) Ridl	Primary forest		Dry		20%		270 m asl
malaccensis Lamk	Soft and sandy clay type	4,0 - 6,0	Damp	2.000 mm	70%	320°C	750 m asl
microcarpa Baill	Sandy soil		Wet				200 m asl
filaria (Oken) Merr	Marshy land		Wet		50%		150 m asl

2.4 Suitable Land Criteria

Example of land characteristics data in Merauke Regency where agarwood trees have been planted in the Muting area. The explanation of the table is in table 4. the criteria for suitable land.

Table 3. Criteria for land according to

Criteria	Description of
soil type	Selmat mud, rocks, and peat
soil pH	6.0-7.0
altitude	starting from 15 m above sea level onwards
Rainfall	1,500-200 mm / year
Temperature	20-30 º C
Climate	Wet tropics
Humidity	78-81%
Slope rate	8-12%

2.5 Decision Support Systems Decision

Support systems are a set of model-based procedures for processing and scoring data to help managers make decisions [10]. A decision support system is defined as a computer-based system

consisting of three interacting components, namely: a language system (a mechanism for providing communication between users and other components of the DSS), a knowledge system (a knowledge repository of problem domains that exist in DSS either as data or as a procedure), and the problem processing system (the relationship between the other two components, consisting of one or more general problem manipulation capabilities required for decision making).

2.6 Information System

This information system consists of the word system and information. The system originates from Latin (*systema*) and Greek (sustema) is a unit consisting of components or elements that work together or are connected in certain ways so as to form a single unit to carry out a function in order to achieve a goal. Meanwhile, the word information comes from the ancient French word informacion which is taken from the Latin informationem which means "outline, concept, idea". Information is data that is processed into a form that is more useful and more meaningful for those who receive it. The source of information is data [11].

3 Methodology and System Design

3.1 Simple Additive Weighting (SAW)

Method Themethod is *Simple Additive Weighting* often known as the weighted addition method. [12] The basic concept of SAW is to find a weighted summation of the performance of each alternative for all. The SAW method requires a decision matrix normalization process (X) to a scale that can be compared with all available alternative ratings.

Rij	=value normalized performance rating
Xij	=value attribute possessed of every criterion
Max xij	=largest value of each criterion
Max xij	= smallest value of each criterion
Ben efit	=if the greatest value is the best
Cost	=if the smallest value is best

where *rij* is the performance rating normalized from the alternatives Ai at attribute *Cj*: i = 1, 2,…, m and j = 1, 2,…, n. The preference value for each alternative (Vi) is given as follows:

$$Vi = \sum_{j=1}^{n} wj\, rij \quad (1)$$

Information:

Vi = ranking for each alternative

wj = weight value of each criterion

rij = normalized performance rating

value A larger Vi value indicates that the alternative Ai is preferred.

The completion steps in using the SAW method are:

1. Determining the criteria that will be used as a reference in making decisions, namely Ci.
2. Determine the suitability rating of each alternative on each criterion.
3. Making a decision matrix based on the criteria (Ci), then normalizing the matrix based on the equation that is adjusted to the type of attribute (profit attribute and cost attribute) in order to obtain a normalized matrix R.
4. The final result is obtained from each ranking process, namely the sum of the multiplication of normalized matrix R with a weight vector so that the largest value is selected as the best alternative (Ai) as the solution of the largest value selected as the best alternative (Ai) as a solution.

3.2 Information Systems Framework Information

Systems framework is data that has been processed into a form that has meaning for the recipient and can be in the form of facts of a useful value. Systems framework is also defined as a form of elaboration of process inputs and outputs. The following describes the information systems framework in this study [13]. The description of the image is in the following image.

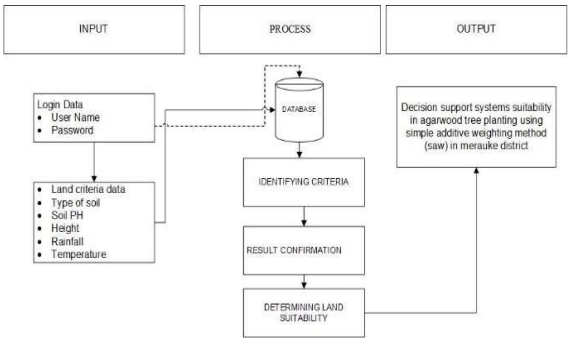

Fig. 9. Framework Information System

4 Results and Discussion

4.1 Results

Based on the research results, this web-based decision support system for agarwood tree planting is able to support the agarwood cultivation community in determining the appropriate land suitability. So that in determining land suitability, the agarwood cultivation community no longer uses manual methods, but can use a system in order to obtain accurate results about the suitability of the land.

4.1.1 Page Login Admin

Page *login* adminis a home page while running the system used to open or operate the system, thus allowing the security of other rights follow irregularities. Explanation of the image is in Figure 4.1Page *Login* Admin.

Fig. 10. Login Form The

4.1.2 Admin Main Page

Admin main page will appear after the *login is* admincomplete, which contains menus including:

1. The agarwood tree type menu contains the names of the agarwood tree species.
2. The field name menu contains the name of the land.
3. The criteria menu contains the criteria used as well as the nature of the criteria.
4. The sub criteria menu contains the characteristics of the criteria, the weight value of a criterion, and a description of the sub criteria.
5. The weight menu contains the weights of each criterion.
6. The assessment menu contains the values that have been inputted.
7. The results menu contains the calculation results or the SPK process for each input value.
8. The report print menu contains all the calculation results for which the report will be printed.

Fig. 11. Admin Interface

4.1.3 Page Result

Result results of research conducted using the Simple Additive Weighting (SAW) method with a sample of three fields and the type of gaharu to be planted is *Aquilaria Malaccensis*, which refers to several indicators including soil type, soil pH, altitude, rainfall, and temperature. obtained the best results on land C with a value of 0.42.

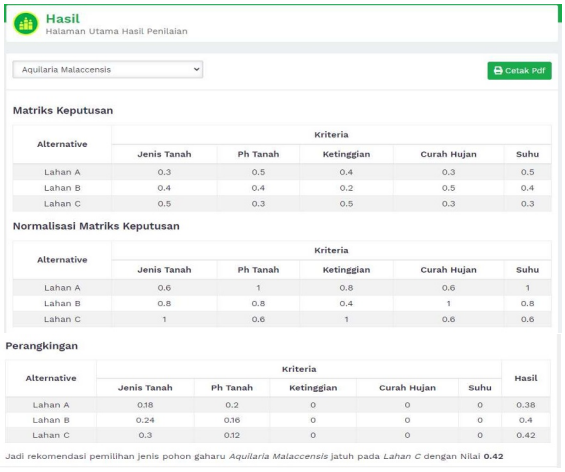

Fig. 12. Interface Results

4.2 Discussion

4.2.1 Black Box Testing

Application of the land suitability decision support system in planting agarwood trees based on this web in the testing process uses the Black Box method as a method to test the system in entering

its input and output, whether the function of the software is running as expected. The following are the results of the tests that have been carried out on the system. Explanation of the image is in table 4.1 of thetest results table Black Box

Table 4. Black Box Testing

Tested form	Testing Scenario	Test result	Information
Main forms	Then the main menu page will appear		[√]be accepted [ ] ditolak
Agarwood tree species data form	Showing the type of aloe tree		[√]be accepted [ ] ditolak
Land name data form	Display land names		[√]be accepted [ ] rejected
Criteria data form	Showing criteria		[√]be accepted [ ] rejected
Sub-criteria form	Showing sub criteria		[√] diterima [ ] rejected
Sub-criteria form	Showing page weights		[√]be accepted [ ] rejected
Scoring form	Show ratings		[√]be accepted [ ] rejected
Result form	Show calculation results hasil		[√]be accepted [ ] rejected

5 Conlusion

From the results of system testing using thevalidation testing technique, *Black Box* it can be concluded that the support system for land suitability decisions in web-based agarwood tree planting shows that all system functions can run well, can help determine the suitability of land for agarwood tree species in order to optimize pen Sustainable land use. The system was built only as a tool to provide information and aids to determine the suitability of agarwood planting land to the Gaharu Cultivation Community as a consideration in determining the suitability of land suitable for agarwood planting land.

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