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Research Article
Diversity of MPTS (Multi Purpose Tree Species) in the Forest Area with Special Purpose (KHDTK)

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Abstract

Background and Objective: Forests are a unity of ecosystems of land containing natural resources that are dominated by trees in the communion of their natural environments, which are inseparable from each other. The MPTS (Multi-Purpose Tree Species) is a multi-purpose tree plant because it is beneficial in terms of ecology and economics as well as producing wood and non-wood commodities. This research aims to analyze the level of diversity of MPTS plants in the forest area with special purposes as well as analyzing the benefits of planting MPTS for the community so that the community can participate in protecting the area. **Materials and Methods:** The tools used are GPS (Global Positioning System) to know the coordinates of the point of observation activities, camera phone, writing tools, haga meters, Phi bands, measurement bands, machete and forest ecosystem identification guidelines. The materials used in the research are natural forest vegetation in the forest area with special purposes (KHDTK) Pondok Buluh, raffia rope and a tally sheet. Data collection in this study was through vegetation analysis using a linear method with a 2% sampling intensity. Then calculate the Species diversity index, Species Richness Index and Species Evenness Index. **Results:** There are eight types of alpukat: *Persea americana*, Nangka (*Artocarpus heterophyllus*), Kemiri (*Aleurites moluccanus*) and Petai (*Parkia speciosa*), Durian (*Durio zibethinus*), Sweetwood (*Cinnamomum burmannii*), Jengkol (*Archidendron pauciflorum*) and Glugur Acid (*Garcinia atroviridis*), which occupies a type A climate and is called the tropical rainforest. The types of Jengkol (*Archidendron pauciflorum*) and Durian (*Durio zibethinus*) plants dominate. This can provide an increase in income for local residents because Jengkol (*Archidendron pauciflorum*) and durian can produce 6.6 and 17 ton of fruit every 6 months. **Conclusion:** So that people are enthusiastic about planting MPTS plants, especially jengkol and Durian (*Durio zibethinus*) with the aim of improving the community's economy while protecting forest areas.

Key words: Agronomy, KHDTK Pondok Buluh, MPTS, vegetation analysis, crossed path method, species abundance

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Forests are a complex natural resource. The existence of forests is always beneficial to life around them and their diversity provides a variety of benefits both directly and indirectly. A land management method called Multi Purpose Tree Species (MPTS) plants and manages several kinds of wood in order to generate timber as well as leaves and fruits that may be fed to animals or consumed as food[1]. A vegetation is a group of plants, usually consisting of several species, that live together somewhere. In a protected area, the analysis aims to find out and understand the conditions, structure, development and dynamics of vegetation and other biota. You can also know the various abiotic factors that are associated with time and spatial distribution factors[2].

Thus, it is possible to study and estimate the environmental support and biotic potential, the quality and conditions of wild habitats, the sufficient availability of nutrients and feed resources and the productivity of such flora and fauna. The MPTS is a type of plant that produces wood but not wood (rubber, fruit, leaves, flowers, fibers, food and others). So you can get more than one benefit from these MPTS plants, which are economically worthwhile[3]. There are many benefits that can be obtained from MPTS plants. The community uses the fruits of the MPTS plants harvested each season, adding to the economy. In addition, MPTS plants also have ecological benefits. For this, it is necessary to carry out activities of MPTS plant vegetation analysis to find out the structure and composition of MPTS plants at the research site[4].

MATERIALS AND METHODS

This research was carried out from January, 2021 until February, 2021 in the Forest Area with Special Purposes (KHDTK) of Pondok Buluh Desa Bandar Dolok, the Dolok Panribuan District of Simalungun Province in North Sumatera. It has an area of 1,272 ha.

Tools and materials: The tools used are GPS (Global Positioning System) to know the coordinates of the point of observation activities, iPhone × camera from California, writing tools, haga meters, phi bands, measurement bands, machete and forest ecosystem identification guidelines.

The materials used in the research are natural forest vegetation in the Forest Area with Special Purposes (KHDTK) Pondok Buluh, raffia rope and a tally sheet.

Research procedure

Determination of sample plots and observation plots: A modified version of the path technique and the plotted line method were used to conduct sampling and measurements at each place, utilizing primary data that was gathered directly from the field.

Method of collecting data: Collecting data for this study using primary data. Primary data is data obtained from the field in the form of data on vegetation type, diameter and height, which is then analyzed using the grid path method. The grid path method is a way of collecting data where each element is viewed and several sample plots are made with sizes of 2×2, 5×5, 10×10 and 20×20 m) (Fig. 1). State that sample intensity for forest groups with an area of 1,000 ha or more should be 2%, while for groups with an area less than 1,000 ha, it should be 5-10%. Because the Pondok Buluh Special Purpose Forest (KHDTK) covers 1272 ha, a sample intensity of 2% was employed in accordance with the aforementioned regulations. The sampling intensity (IS) used was 2%. Study area sample: 1272×2% = 25.44 ha (254,400 m^2). Observation plot area: 20×20 m = 400 m^2. The number of sample plots used was 636.

Data analysis: Vegetation analysis is a way to determine the species composition and structure of vegetation in an ecosystem[5]. Data obtained from measurements in the field is calculated to determine the following variables.

Important value index: The important value index is used to determine the dominance of a type of vegetation. The Important Value Index is obtained from the following calculation[6]:

- **For seedling and sampling:** Important value index (%) = Density+Frequence
- **For tree:** Important value index (%) = Density+Frequence +Dominance

Relative density, relative frequency and relative dominance can be calculated using the following formula:

Species density:

$$\text{Density} = \frac{\Sigma\text{Individual of a species}}{\text{Area of sample plots}}$$

$$\text{Relative density (\%)} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

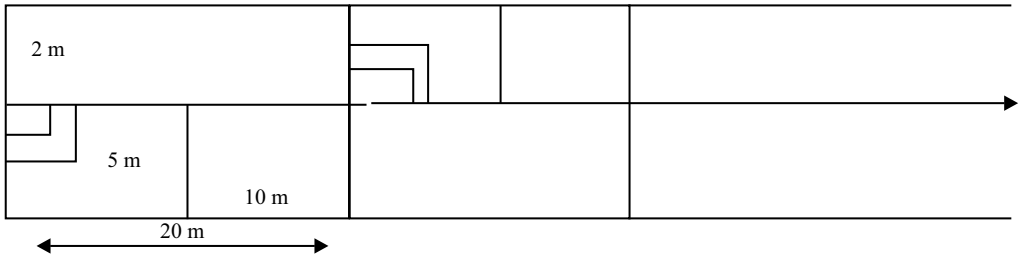

Fig. 1: Layout of observation plots

Frequency:

$$\text{Frequency} = \frac{\text{Number of plots found of a type}}{\text{Total sample plot area}}$$

$$\text{Relative frequency (\%)} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$$

Domination:

$$\text{Dominance} = \frac{\text{Basal area of a species}}{\text{Area of sample plots}}$$

$$\text{Relative dominance (\%)} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100$$

Species diversity index (H'):

$$H' = \sum_{i=1}^{S} Pi\ (\text{In pi})$$

Where:
H' = Index shannon wiener
Pi = Relative abundance of species = (ni/N)
ni = Number of individuals of a kind
N = Total amount for all individuals

The H' value with the criteria H'1 low diversity, 1H3 medium diversity and H'>3 high diversity. The higher the value diversity, the better. Each species plays an important role in ecological processes. On the other hand, a smaller value indicates that the ecosystem is very vulnerable to pest and disease disturbances.

Species richness index (R'): Species richness in a habitat can be determined using the margalef richness index[6]:

$$R' = \frac{S-1}{\ln (N)}$$

Where:
R = Indices of species richness
S = Species per habitat
N = Individual per habitat

Species evenness index (E'): The evenness at each point can be calculated using the evenness index as follows[7]:

$$E' = \frac{H'}{H'\ \max}$$

Where:
E = Evenness index
H' = Diversity index
H' max = ln S (S is number of species found)

RESULTS AND DISCUSSION

Identification of MPTS types in KHDTK Pondok Buluh: The MPTS is a land management system where different types of wood are planted and managed, not only to produce wood but also leaves and fruits that can be used as food or livestock feed. The MPTS plants have dual functions since entering the productive age; except for non-wood forests such as fruit, rubber, nira, sabut and so on, after they are mature and unproductive, the trees can be cut and used for sale.

As for the types of MPTS plants that exist, the Pondok Buluh is alpukat (*Persea americana*), Nangka (*Artocarpus heterophyllus*), Kemiri (*Aleurites moluccanus*), Petai (*Parkia speciosa*), Durian (*Durio zibethinus*), Sweetwood (*Cinnamomum burmannii*, Bl), Beech (*Archidendron pauciflorum*) and Glugur Acid (*Garcinia atroviridis*).

Composition, diversity and richness of the MPTS type in KHDTK Pondok Buluh: Pondok buluh has an area of 1272 ha and a sampling intensity of 2%. Vegetation analysis is carried out in the area of KHDTK Buluh with a total of 600 plots to determine the abundance of MPTS plant types that have

Table 1: Results of the calculation of the important value index on seedling growth rate for MPTS type

Species	Ind	Den	RDen%	Fre	RFre%	IVI
Kayu manis (*Cinnamomum burmannii*)	4	16.6	0.7	0.006	50	50.7
Jengkol (*Archidendron pauciflorum*)	2	8.3	0.3	0.003	25	25.3
Nangka (*Artocarpus heterophyllus*)	1	4.1	0.2	0.002	12.5	12.6
Durian (*Durio zibethinus*)	1	4.1	0.2	0.002	12.5	12.7
Total	8	33.3	1.4	0.013	100	101.4

Ind: Individual, Den: Density, RDen: Relative density, Fre: Frequency, Rfre: Relative frequency and IVI: Importance value index

Table 2: Results of the index of important values on the sapling growth rate

Species	Ind	Den	RDen%	Fre	RFre%	IVI
Durian (*Durio zibethinus*)	86	57.3	17.7	0.1	81.9	99.6
Jengkol (*Archidendron pauciflorum*)	10	6.6	2.1	0.06	9.5	11.6
Kayu manis (*Cinnamomum burmannii*)	3	2	0.6	0.005	2.8	3.5
Alpukat (*Persea americana*)	3	2	0.6	0.005	2.8	3.5
Nangka (*Artocarpus heterophyllus*)	1	0.6	0.2	0.0016	0.9	1.1
Asam Gelugur (*Garcinia atroviridis*)	1	0.6	0.2	0.0016	0.9	1.1
Petai (*Parkia speciosa*)	1	0.6	0.2	0.0016	0.9	1.1
Total	105	70	21.649	0.175	100	121.6

Ind: Individual, Den: Density, RDen: Relative density, Fre: Frequency, Rfre: Relative frequency and IVI: Importance value index

benefits and high potential. The MPTS is part of the vegetation that exists in KHDTK Pondoks Buluh, but the vegetation is recorded as having eight types that dominate at the level of seedling, sapling, poles and trees[8]. To find out the values of the density calculations, the relative density, frequency, relativity and index of important values at the rate of growth of semai can be seen in Table 1.

Table 1 shows the highest important values of the MPTS type found in *Cinnamomum burmannii*, with a value of 50:695, indicating the number or number of individuals of a broad type of association. The greater the density of a species, the more individuals of the species per unit of area[9]. The lowest estimated important values were obtained in the species *Artocarpus heterophyllus* and Durian (*Durio zibethinus*), with a value of 12:673. The Important Value Index of a plant type in a community is one of the variables that indicates the role of the plant type and its high level of dominance in the community[10].

The total number of important values at the Semai level is 101.39, with the *Cinnamomum burmannii* species dominating the area due to obtaining the highest important value. An important value is used to determine the dominance of a species and a higher important value will indicate that the species is the dominant species in an area. The difference in important values in each type of plant occurs due to several factors. The diversity of important values indicates the influence of the environment where it grows, temperature, humidity, the ability of the species to compete in the competition of the elements of heaven, sunlight and growing space with other species that greatly influence the growth of the diameter of vegetation and human activity in direct contact with the forest[11]. Most of the plants found in the Forests for Special Purposes Area (PHDTK) are dominated by forest plants and MPTS are part of the vegetation in the PHDTK[12]. To find out the values of the density calculations, the relative density, frequency, relativity and index of important values at the rate of growth of the scale can be seen in Table 2.

The magnitude of the important value of a type is influenced by density values, relative density and relative frequency. Explained that the relative density indicates the number of individuals that form a plant community in the area of study, whereas the relative frequency is the ratio between the absolute frequencies of a species and the total frequencies of the entire species in the entire area of research. In Table 2, the highest important value is found in important (*Durio zibethinus*), with a value of 99.63[13].

Durian (*Durio zibethinus*) can grow both in lowlands up to 600 sq/m, which have a wet climate with rainfall between 1500 and 2500 mm/year and evenly throughout the year. The appropriate air temperature is 200-300°C with a pH between 5.5-7. Durian plants are more likely to be exposed to full sunlight, so it is better to plant in open areas. However, at a time when the plant was still small, it was less resistant to direct sunlight, so it needed to get shade. The growth and productivity of plants are influenced by their surroundings[14]. Sunlight is the wrong factor affecting plant productivity because not all plants require the same intensity of light in the process of photosynthesis[15]. The existence of animals such as monkeys, butterflies and birds plays a major role in forest regeneration. Butterflies have an important role in the ecosystem[16]. Frogs serve as seed transmitters for plants in tropical forests. Eating behavior and the ability to fly long distances cause the grain-seedling power to go far. Other functions are as pollinators and insect population controllers, so butterflies have ecologically important significance. There are about 300 tropical plant species whose pollination and emissions are carried out by butterflies[17].

Table 3: Results of the index of important values on the pole growth rate

Species	Ind	Den	RDen%	Fre	RF%	Dom	Rdom%	IVI
Jengkol (*Archidendron pauciflorum*)	49	8.1	9.9	0.08	45.3	0.3	1.4	56.7
Durian (*Durio zibethinus*)	44	7.3	8.9	0.07	40.7	0.3	1.4	51
Alpukat (*Persea americana*)	6	1	1.2	0.01	5.5	0.2	1.1	7.9
Nangka (*Artocarpus heterophyllus*)	3	0.5	0.6	0.005	2.8	0.3	1.3	4.7
Petai (*Parkia speciosa*)	3	0.5	0.6	0.005	2.8	0.2	1	4.3
Asam gelugur (*Garcinia atroviridis*)	2	0.03	0.4	0.003	1.8	0.3	1.3	3.5
Kemiri (*Aleurites moluccana*)	1	0.16	0.2	0.001	0.9	0.3	1.5	26
Total	108	18	21.9	0.18	100	2.03	9.01	130.9

Ind: Individual, Den: Density, RDen: Relative density, Fre: Frequency, Rfre: Relative frequency and IVI: Importance value index

Table 4: Results of the index of important values on tree growth rate

Species	Ind	K	KR	F	FR	D	DR	INP
Jengkol (*Archidendron pauciflorum*)	44	1.8	9	0.07	44.9	0.2	0.02	53.8
Durian (*Durio zibethinus*)	32	1.3	6.5	0.05	32.7	0.1	0.01	39.1
Alpukat (*Persea americana*)	13	0.5	2.6	0.02	13.2	0.1	0.009	15.9
Nangka (*Artocarpus heterophyllus*)	3	0.1	0.6	0.005	3.1	0.05	0.005	3.6
Asam glugur (*Garcinia atroviridis*)	1	0.04	0.2	0.001	1	0.005	0.0005	1.2
Total	93	3.9	18.9	0.15	94.9	0.541	0.052	113.8

Examples of economically valuable plants assisted by pollination by butterflies are durian (*Durio zibethinus*), aren (*Arenga* sp.), petai (*Parkia speciosa*), Kapuk Randu (*Ceiba pentandra*), bananas (*Musa* sp.) and coconut (*Cocos nucifera*)[18,19]. To find out the results of relative density calculations, frequencies, relative frequencies[20] and index values important to the rate of growth of the poles can be seen in Table 3.

Table 3 shows the difference in important value for each species, with the highest density of 56.744 in *Archidendron pauciflorum* and the lowest INP in Kemi (*Aleurites moluccana*) at 2.610. According to Uhvits[24] differences in density due to verticality can be caused by the vertical character of the respective species, where the character is related to the physiology of vertical in responding to environmental changes. The density values of each type vary from the highest to the lowest[21]. Differences in density values of each type are due to differences in spreadability and adaptability to the environment. The density value of a type indicates the number of individuals of each type concerned at a given unit of area.

Stated that an important value for the level of vegetation can be calculated based on the aggregation of relative density, relative dominance and relative frequency[22]. Because important value describes the magnitude of influence given by a plant species on its community, If there is a species with a high important value, it indicates that the species has a dominant number. However, many tree species have a low number but a large diameter, resulting in a relative dominance so that the important value is higher. Plants are a source of food for animals and animals are very beneficial to plants. The seeds of certain plants are seeded by animals such as birds, monkeys, sharks and frogs through their dirt[23]. Natural forest regeneration is greatly assisted by animals that swallow seeds that are then spread through their dirt. It's in line with the statement of Uhivits[24]. The seeds that are removed through the dirt are generally able to germinate and grow faster than the seeds that fall directly from the parent tree. The seed from the wild animal dirt germinates faster with the help of a gastric fluid that has a pH of 2 and is acidic so that it can help soften the skin of the hard seed[25]. To find out the results of relative density calculations, frequencies, relative frequencies and important values index to the tree growth rate can be seen in Table 4.

From the data presented, it is evident that the species that dominate at one growth rate do not necessarily dominate at the other growth rate. The highest important value was obtained for the beard type (*Archidendron pauciflorum*) with a value of 53.84, while the lowest important value was found in the species *Garcinia atroviridis* with a value of 1.223. Variations of dominant and codominant species at each stage of growth gives an understanding that the dominant type at one level of growth does not necessarily dominate the other stage[26]. Compared to the important value index of each existing type, the type categorized as the dominant type is the type that has the highest important value. A species that plays a role and dominates a habitat in a community is one with a high Opening value index[27].

Judging from the 8 types of plants, durian and jengkol are the most abundant and dominant plants in the area. These 2 plants can increase the income of the local community. Jengkol can bear fruit twice a year. One tree can produce 150 kg per harvest. The spacing for planting jengkol is 15×15 m. In 1 ha, 44 trees can be planted, meaning the community can produce 6.6 ton of jengkol every 6 months. The price of jengkol is IDR 50,000 per kg. That is the calculation if people plant jengkol on 1 ha of land, if they plant more

Table 5: Results of the calculation of the diversity index, the type wealth index and the excellence index

Growth rate	Species diversity index (H')	Species evenness index (E')	Species richness index (R')
Semai	0.07	0.03	0.055
Pancang	0.48	0.10	0.05
Tiang	0.59	0.12	0.06
Pohon	0.34	0.21	1.10

than that, their income will also increase. This really helps to improve the economy of the surrounding community[28].

Durian can bear fruit once a year. The 1 tree can produce 170 kg per harvest. Durian planting distance 10×10 m. In 1 ha, 100 trees can be planted, meaning that people can produce 17 ton of durian fruit once a year. The price of durian fruit is IDR 100,000 per kg[29]. That is the calculation that if people plant durian on 1 ha of land, the same as jengkol, if they plant more than that, their income will be even greater. Of course, this can encourage people to plant MPTS plants, especially jengkol and durian, especially since these two plants are very adaptable to tropical forest areas like Indonesia[30].

The number of plant species is closely related to the values of the type richness index (R'), type diversity (H) and type hardness (E'). To determine the level of stability of the species diversity, the type Diversity index to determine the level of stability of species diversity, the type Diversity Index (H') can be used. The higher the H', the higher the level of stability of the forest vegetation community. The redness index describes the individual spread of the type of organism that forms the community and the stability of the community. The number of species in an area will form a forest community, so the more species there are, the higher the level of diversity[31]. To find out the results of the calculation of the diversity index, the wealth index of the type and the redness index (Table 5).

Table 5 shows the diverse values of different species at each growth rate. The growth rate of semai has the lowest variability value, with a value of 0.07 (H'1). Whereas at the rate of growth of the shovel, the tree poles each obtain the values of 0.48, 0.59 and 0.34. Whereas at the rate of growth of the shovel, the tree poles each obtain the values of 0.48, 0.59 and 0.34 (H'1), where they belong to the lower category[32]. That the variability index value of type H'1 indicates a low degree of variability and on the diversity index criterion, it is said to be low if the value. That the variability index value of the type H'1 indicates a low degree of variability and on the diversity index criterion, it is said to be low if the value H'1 is obtained. The high and low diversity of plant species is due to a variety of factors, including soil type, rocks and geology, climate, altitude variation, protected areas and so on.

The richness of each rate of growth of the MPTS type in the Pondok Buluh area can be said to be almost the same as the overall rate of spread growth, which is still low. With richness index values of this type, the growth rate of the semai gains a value of 0.03, a threshold of 0.10, a pillar of 0.12 and a tree of 1.10. Redness values have a range of 0-1 and if the value of the obtained index is close to one, the spread is more even[16]. The richness index shows the degree of richness of individual abundance among each species. If each type has the same number of individuals, then the community has the maximum equality value. On the contrary, if the richness value is small, then in the community there are dominant, sub-dominant and dominant types and that community has a minimum equivalence.

The wealth index has a low value (R<3.5), whereas the R value at the level of the pillar and tree has a high value (R>5.0). If the value of R1 is less than 3.5, it indicates wealth of the type that belongs to the lowest level[33]. It also suggests that normally, in a community or ecosystem that has many species, there will be a small number of individuals in each of those species. The very small quantity of species in the field determines the great smallness of the wealth index. The Margalef wealth index divides the number of species by the natural logarithm function, which means that the increase in the quantity of the species is inversely proportional to the increase in the individual quantity. Generally, communities and ecosystems with abundant species will have a small amount of individuality in each species.

Based on the three components of the index, it can be generally concluded that the variety of types of MPTS in the area of KHDTK Pondok Buluh has a variety of species, wealth of types and redness of types that are moderate to high at the rate of growth of shrubs, poles and trees, while the growth rate of semai still belongs to the low category. The high and low diversity of plant species is due to various factors, including soil type, rocks and geology, climate, variation in altitude, protected areas[33].

CONCLUSION

There are 8 types of MPTS varieties that grow in the KHDTK Pondok Buluh area, namely avocado (*Persea americana*), jackfruit (*Artocarpus heterophyllus*), pine (*Aleurites moluccanus*), beetle (*Parkia speciosa*), durian

(*Durio zibethinus*) and cinnamon (*Cinnamomum verum*), Bark (*Archidendron pauciflorum*) and Glucuronic acid (*Garcinia atroviridis*). The most dominant types are jengkol and durian. Jengkol and Durian can produce 6.6 and 17 ton of fruit every 6 months and that can influence the community to plant MPTS at KHDTK Pondok Buluh. So that in the next few years further research can be carried out to see the development of MPTS in the KHDTK Pondok Buluh area.

SIGNIFICANCE STATEMENT

The MPTS plants are very important in the forest reforestation process. The diversity of MPTS plants makes people want to plant MPTS to help forest reforestation. This research provides information that there are 8 species of MPTS plants that can be planted in this area and it turns out these plants can also help the community's economy, such as Jengkol and Durian. These 2 plants can produce expensive fruit. These 2 plants grow well, knowledge like this can influence people to continue planting MPTS around the forest.

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