Plant diversity in agroforestry system and its traditional use by three different ethnics in Central Sulawesi Indonesia

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Abstract. This paper discusses the result of the study on plant diversity in the Agroforestry system and its traditional uses by the three different ethnicsities in Banggai Regency, Central Sulawesi, Indonesia. The basic data of traditional plants used by each of the ethnic groups in the research site were collected through an in-depth interview initiated by an informed consent using a questionnaire containing open-ended questions—fifty (50) respondents from each of the ethnic groups representing different jobs. The result showed that the highest number of plant species was found in research site B, but the highest number of individual plants was noted in research site A. The highest Important Value Index (IVI) of tree, poles, sapling and seedling level of plant species differed among the three research sites. When viewed from the perspective of traditional plant use, the highest ICS of plants utilized by the three ethnics was “coconut” (Cocos Nucifera L). The number of the utiliplantslant was different among the three ethnics. Tao Taa Wana people have utilized about 43 plant species, 27 of which were used for medicines, 20 for foods, 2 for natural dying, 18 for fuels, 6 for building materials, 5 for ritual ceremonies. In research site B (Singkoyo), 52 plant species have been extensively used by Javanese people for a wide range of culturally related activities, 28 species were used as medicine, 32 for food, 17 for fuel, 7 for building materials, and 10 for ornaments. Unlikely, in site C (Mentawa, 39 plant species were used traditionally by Balinese people; 18 of which were used for medicines, 18 for food, and 13 for ritual ceremonies).
1. Introduction

Central Sulawesi is one of the provinces in Indonesia, located in Sulawesi Island (previously known as Celebes)—the main island in the “Wallacean region” that possesses exhibitst unique biodiversity [1]. Like other areas in Indonesia, Central Sulawesi has a large tropical forest area. The tropical rainforest is arguably the most urgent terrestrial ecosystem [2]. It is important as a carbon sink, house of world’s biodiversity, provide economic benefits through ecotourism, non-timber forest products [3–5]. Apart from this, much of the forest area in Sulawesi has been damaged due to human activities and converted into different land uses such as lightly disturbed primary forests, degraded forests, home gardens, plantations, and agroforestry systems [6,7].

Agroforestry, a very simple term, may be referred to a deliberate growing of woody perennials on the same area and, at the same time, as agricultural crops and/or fodder plants in the form of a spatial mixture and/or a temporal sequence [8]. Tropical agroforestry systems are often complex associations of multi-functional and uneven-aged trees and crops [9]. Many people in developing tropical countries depend on agroforestry systems for subsistence, economic income, in order to maintain watershed functions, retain carbon in the plant-soil system, and conserve biological diversity [10–16]. Greater attention is now being paid to those co-complex tree-based traditional practices that are so widespread in traditional tropical land use. In addition to generating timber and firewood, agroforestry can also provide supplementary income from associated tree crops [17].

In Banggai regency of Central Sulawesi, many forested areas are inhabited by different ethnic communities, both indigenous and immigrants, who live in harmony with their environment strongly uphold their local wisdom, customs, and cultures. Tao Taa Wana tribe is one of the indigenous people of Sulawesi who live traditionally in the area, in addition to the two other transmigrating ethnic groups (i.e. Javanese people, the largest ethnic group in Indonesia, who are considered culturally and politically dominant and Balinese people, who are famous with their Hinduism faith, often use plants or plant parts to make offerings to ancestors, spirits and supernatural forces [1,18–20]. Both Javanese and Balinese, who have lived for a few years, still practice their own culture and knowledge system in maintaining their agroforestry systems.

This study intends to: (1) assessing the species richness of plants grown under traditional agroforestry systems and (2) investigating the traditional use of plant diversity by three different ethnicities in the studied area.

2. Materials and methods

2.1. Study sites

The study was conducted in Banggai Regency, Central Sula, si Indonesia (Figure 1). Three (3) different locations and ethnicities were chofor resecharceserach sites: Menyo’e, Singkoyo, and Mentawa. The description of each agroforestry system in the research site is provided in Table 1.

| No | Parameter          | Research Site       |
|----|--------------------|---------------------|
|    |                    | Menyo’e (A)  | Singkoyo (B)  | Mentawa (C)  |
| 1  | Ethnic             | Tao Taa Wana  | Javanese      | Balinese     |
|    | Indigenous         | Indigenous        | Migrants   | Migrants |
| 2  | Administration     | Momosolato district, North Morowali Regency | Toili district, Banggai regency | West Toili district, Banggai regency |
| 3  | Geographical position | Altitude (m a.s.l) | Montane area 1.234 | Lowland 10 | Lowland 15 |

Table 1. Description of agroforestry system
Latitude: 1° 21' 0" - 1° 22' 0" S, 1° 24' 0" S - 1° 25' 0" S, 0° 55' 0" - 1° 45' 0" S
Longitude: 121° 48' 0" E – 121° 49' 0" E, 121° 17' 0" E – 121° 18' 0" E, 21° 35' 0.00" – 122° 50' 0" E

| Climate | Temperature | Annual Precipitation |
|---------|-------------|----------------------|
|         | 27°C        | 2200 mm/year         |
|         | 32°C        | 1880 mm/year         |
|         | 32°C        | 1850 mm/year         |

Figure 1. Map of Research sites—1. Desa Menyo’e, (Momosalato district, inhabited by Tao Taa Wana ethnic group), 2. Desa Singkoyo, Toili District (Javanese ethnic group), and 3. Desa Mentawa, Toili barat district (Balinese ethnic group).

2.2. Vegetation analyses
The structure and composition of vegetation were studied using double plots methods [1,6]. A total of five main plots of 20x20m were placed purposively in each research site. Five plots of 20x20m in size were used for tree level sampling (dbh ≥ 20 cm). In the plot of 20 x20m, some plots of 10x10m were established for pole level sampling (10 cm ≤ dbh < 20 cm). In some plots of 10x10m, some plots of 5x5m were made for sampling analysis (2cm < dbh< 10cm) and 2x2m for seedling and understorey (dbh < 2 cm). All plant species found in each plot were collected following Bridson and Forman (1999) [21]. The information recorded from the field included locality, vernacular names, uses, habits, trunk diameter, trunk height, and clear bole, as well as a cover percentage for seedlings and understorey. Processing and identification of samples were conducted at the Laboratory of Plant Biosystematics, Faculty of Mathematics and Natural Sciences, and at the Herbarium Celebense (CEB) Tadulako University Palu. Vouchers specimens were deposited in CEB.

2.3. Ethnobotanical data
The basic data on the traditional plants used by each of the ethnic groups in the research site has been collected by using in-depth interviews initiated with informed consent using an open-ended quequestionnaire snowball technique was used to obtain prapropriateespondents beginning from the village leader [22]. Fifty (50) respondents from each of the ethnic groups different jobs such as village leaders, custom (adat) leaders, religious leaders, traditional healers, foresters (i.e. rattan and dammar
collectors), farmers, laborers, traders, and craft people, etc., were asked a series of questions related to perceptions of the traditional use of plants [23].

2.4. Data analyses
The data collected were then tabulated and analyzed to determine the value of density, relative density, frequency, relative frequency, dominance, relative dominance, and important value index [24]. To analyze alpha diversity, Shannon-Wiener diversity index and species dominance index were used [25]. The ethnobotanical data were analyzed and tabulated using Index Cultural Significance (ICS) [26].

3. Results and discussions
3.1. Number and composition of species
We recorded a total of 43 plant species from Agroforestry ecosystem at Menyo’e (research site A), which consisted of 15 tree (dbh ≥20cm), 18 poles (10cm ≤ dbh < 20cm), 22 saplings (2cm < dbh ≤10cm), 32 seedling-understory species (dbh ≤2cm) and 720 individual plant. From research site B, Singkoyo, there were 52 plant species recorded, which included 19 trees, 22 poles, 29 saplings, 30 seedling-understory with 664 total individual numbers. In Mentawai, the research site C, only 32 plant species consisting of 16 trees, 15 poles, 18 saplings, 21 seedling and understory species, and 312 individual numbers (Table 2).

Tree species (dbh ≥20cm) that have the highest Importance Value Index (IVI) in each of the research sites were Aleurites mollucana (research site A), Parkia speciosa (research site B), and Artocarpus heterophyllus (research site C), while that for pole level plants were Theobroma cacao, Cocos nucifera and Theobroma cacao in research site A, B and C respectively. The highest IVI for sapling level plants (2cm < dbh < 10cm) was Manihot esculenta (30.27%) in research site A, Leucaena leucocephala (31.64) in research site B, and Theobroma cacao C (IVI= 85.80 %) in research site C. Finally, the highest IVI for seedling and understory were Piper nigrum, Curcuma longa, and Zingiber officinale in sites A, B and C respectively (Table 3, 4, 5 and 6).

| Code | Research Site (Ethnic) | Total of Species Number | Total of Family Number | Tree / Pole / Sapling / Seedling-understory / ∑ Ind. |
|------|------------------------|-------------------------|------------------------|---------------------------------------------------|
| A    | Menyoe (Tao Ta'a Wana) | 43                      | 25                     | 15 / 102 18 / 95 22 / 171 32 / 352 720            |
| B    | Singkoyo (Javanese)    | 52                      | 28                     | 19 / 102 22 / 111 29 / 197 30 / 254 664           |
| C    | Mentawa (Balinese)     | 39                      | 28                     | 16 / 18 15 / 52 18 / 50 21 / 129 312             |
Table 3. The Fifth most important tree species (dbh ≥20cm) in the three research sites. Local name, botanical name, family, relative density (RD), relative frekuen (RF), relative dominance (RDo), Important Value Index, and Shanon-Whiener Diversity Index (H’)

| No | Local Name | Botanical Name (L.) | Family            | RD (%) | RF (%) | RDo (%) | IVI (%) | H’ |
|----|------------|---------------------|-------------------|--------|--------|---------|---------|----|
| A  | Manyo’e (Tao Taa Wana) | | | | | | | |
| 1  | Veau | Aleurites moluccana | Euphorbiaceae | 13.2   | 9.80   | 19.8    | 42.9    |     |
| 2  | Seronge | Pterocarpus indicus | Leguminosae | 13.2   | 9.80   | 11.5    | 34.6    |     |
| 3  | Kaumama | Neolamarckia cadamba (Roxb.) Bosser | Rubiaceae | 11.2   | 9.80   | 11.4    | 32.5    |     |
| 4  | Coklat | Theobroma cacao L. | Malvaceae | 12.2   | 9.80   | 8.61    | 30.7    |     |
| 5  | Jati | Tectona grandis L.f. | Lamiaceae | 8.16   | 9.80   | 10.9    | 28.9    |     |
|    | Remaining species | | | 41.8   | 50.9   | 37.5    | 130     |     |
|    | Total | | | 100    | 100    | 100     | 300     | 2.48 |
| B  | Singkoyo (Javanese) | | | | | | | |
| 1  | Pete | Parkia speciosa Hassk | Leguminosae | 12.6   | 8.89   | 13.8    | 35.3    |     |
| 2  | Jati | Tectona grandis L.f. | Lamiaceae | 8.42   | 8.89   | 11.0    | 28.4    |     |
| 3  | Duren | Durio zibethinus L. | Malvaceae | 6.32   | 11.1   | 7.77    | 25.2    |     |
| 4  | Coklat | Theobroma cacao L. | Malvaceae | 9.47   | 6.67   | 7.53    | 23.7    |     |
| 5  | Rambutan | Nephelium lappaceum L. | Sapindaceae | 8.42   | 6.67   | 7.85    | 22.9    |     |
|    | Remaining species | | | 54.7   | 57.7   | 51.9    | 164.    |     |
|    | Total | | | 100    | 100    | 100     | 300     | 2.75 |
| C  | Mentawa (Balinese) | | | | | | | |
| 1  | Nangke | Artocarpus heterophyllus Lam | Moraceae | 9.43   | 10.0   | 14.0    | 33.4    |     |
| 2  | Nyuh | Cocos nucifera L. | Areaceae | 7.55   | 10.0   | 10.7    | 28.3    |     |
| 3  | Bunga | Cananga odorata (Lam.) Hook.f. & Thomson | Annonaceae | 7.55   | 10.0   | 7.72    | 25.2    |     |
| 4  | Sandad | | | 0      | 5      | 0       | 0       |     |
| 5  | Rambutan | Nephelium lappaceum L. | Sapindaceae | 5.66   | 6.67   | 6.69    | 19.0    |     |
|    | Cengkeh | Syzygium aromaticum (L.) Merr. & L.M.Perry | Myrtaceae | 3.77   | 6.67   | 5.13    | 15.5    |     |
|    | Remaining species | | | 66.0   | 56.6   | 55.7    | 178.    |     |
|    | Total | | | 100    | 100    | 100     | 300     | 2.34 |
Table 4. The Fifth most important pole species (10cm ≤ dbh < 20cm) in three research sites. Local name, botanical name, family, relative density (RD), relative frequency (RF), relative dominance (RDo), Important Value Index (IVI) and Shannon-Whiener Diversity Index (H').

| No | Local Name     | Botanical Name     | Family   | RD (%) | RF (%) | RDo (%) | IVI (%) | H' |
|----|----------------|--------------------|----------|--------|--------|---------|---------|----|
| A  | Desa Manyoe (Tao Taa Wana) |                   |          |        |        |         |         |    |
| 1  | Coklat         | *Theobroma cacao* L. | Malvaceae| 16.4   | 11.63  | 19.7    | 47.8    |    |
|    |                |                    |          | 7      | 3      | 2       |         |    |
| 2  | Jati           | *Tectona grandis* L.f. | Lamiaceae| 12.9   | 11.63  | 15.9    | 40.5    |    |
|    |                |                    |          | 4      | 7      | 3       |         |    |
| 3  | Kayuku         | *Cocos nucifera* L. | Areceae  | 14.1   | 11.63  | 14.6    | 40.4    |    |
|    |                |                    |          | 2      | 5      | 0       |         |    |
| 4  | Seronge        | *Pterocarpus indicus* | Leguminosae| 14.1   | 11.63  | 12.8    | 38.6    |    |
|    |                |                    |          | 2      | 5      | 0       |         |    |
| 5  | Veau           | *Aleurites moluccana* (L.) Willd. | Euphorbiaceae| 10.5   | 11.63  | 10.4    | 32.6    |    |
|    |                |                    |          | 9      | 0      | 2       |         |    |
|    |                | Remaining species     |          | 31.7   | 41.86  | 26.4    | 100.0   |    |
|    |                |                    |          | 6      | 0      | 1       |         |    |
|    |                | Total               |          | 100    | 100    | 100     | 300.0   |    |
| B  | Desa Singkoyo (Javanese) |                   |          |        |        |         |         |    |
| 1  | Kelapa         | *Cocos nucifera* L. | Areceae  | 10.8   | 7.41   | 14.8    | 33.1    |    |
|    |                |                    |          | 9      | 9      | 9       |         |    |
| 2  | Jati           | *Tectona grandis* L.f. | Lamiaceae| 10.8   | 7.41   | 13.5    | 31.8    |    |
|    |                |                    |          | 9      | 3      | 3       |         |    |
| 3  | Coklat         | *Theobroma cacao* L. | Malvaceae| 7.92   | 5.56   | 8.31    | 21.7    |    |
|    |                |                    |          | 8      | 9      | 8       |         |    |
| 4  | Rambutan       | *Nephelium lappaceum* L. | Sapindaceae| 6.93   | 5.56   | 8.99    | 21.4    |    |
|    |                |                    |          | 8      | 8      | 8       |         |    |
| 5  | Talok          | *Muntingia calabura* L. | Muntingiaceae | 7.92 | 5.56 | 5.81 | 19.2 |    |
|    |                |                    |          | 9      | 3      | 9       |         |    |
|    |                | Remaining species     |          | 55.4   | 68.52  | 48.4    | 172.0   |    |
|    |                |                    |          | 5      | 7      | 4       |         |    |
|    |                | Total               |          | 100    | 100    | 100     | 300.0   |    |
| C  | Mempawa (Balinese) |                   |          |        |        |         |         |    |
| 1  | Coklat         | *Theobroma cacao* L. | Malvaceae| 34.2   | 14.81  | 32.5    | 81.5    |    |
|    |                |                    |          | 1      | 4      | 6       |         |    |
| 2  | Nyuh           | *Cocos nucifera* L. | Areceae  | 10.5   | 11.11  | 13.6    | 35.2    |    |
|    |                |                    |          | 3      | 3      | 7       |         |    |
| 3  | Bunga Sandad   | *Cananga odorata* (Lam.) Hook.f. & Thomson | Annonaceae| 10.5   | 11.11  | 12.1    | 33.7    |    |
|    |                |                    |          | 3      | 0      | 3       |         |    |
| 4  | Nangke         | *Artocarpus heterophyllus* Lam | Moraceae| 7.89   | 11.11  | 7.94    | 26.9    |    |
|    |                |                    |          | 5      | 4      | 5       |         |    |
| 5  | Sotong         | *Psidium guajava* L. | Myrtaceae| 7.89   | 11.11  | 5.66    | 24.6    |    |
|    |                |                    |          | 6      | 4      | 3       |         |    |
|    |                | Remaining species     |          | 28.9   | 40.74  | 28.1    | 97.8    |    |
|    |                |                    |          | 5      | 4      | 3       |         |    |
|    |                | Total               |          | 100    | 100    | 100     | 300.0   |    |

Table 1. The Fifth most important pole species (10cm ≤ dbh < 20cm) in three research sites. Local name, botanical name, family, relative density (RD), relative frequency (RF), relative dominance (RDo), Important Value Index (IVI) and Shannon-Whiener Diversity Index (H').
Table 5. The Fifth most important sapling species (2cm < dbh< 10cm) in the three research sites. Local name, botanical name, family, relative density (RD), relative frequency (RF), relative dominance (RDo), Important Value Index (IVI) and Shanon-Whiener Diversity Index (H’)

| No | Local Name | Botanical Name | Family                     | RD (%) | RF (%) | RDo (%) | IVI (%) | H’ |
|----|-------------|----------------|----------------------------|--------|--------|---------|---------|----|
| A  | Desa Manyoe (Tao Taa Wana) |                |                            |        |        |         |         |    |
| 1  | Kasubi      | *Manihot esculenta* Crantz | Euphorbiaceae              | 15.0   | 11.36  | 3.91    | 30.2    |    |
| 2  | Seronge     | *Pterocarpus indicus* Wild. | Leguminosae                | 10.7   | 9.09   | 10.1    | 29.9    |    |
| 3  | Bunta       | *Ficus variegata* Blume | Moraceae                   | 8.57   | 9.09   | 11.2    | 28.8    |    |
| 4  | Coklat      | *Theobroma cacao* L. | Malvaceae                  | 8.57   | 6.82   | 13.4    | 28.8    |    |
| 5  | Delima      | *Punica granatum* L. | Lythraceae                 | 6.43   | 9.09   | 12.4    | 27.9    |    |
|    | Remaining species |                |                            | 50.7   | 54.55  | 48.9    | 154.    |    |
| B  | Desa Singkoyo (Javanese) |                |                            |        |        |         |         |    |
| 1  | Klandin gan | *Leucaena leucocephala* (Lam.) de Wit | Leguminosae              | 11.7   | 6.25   | 13.6    | 31.6    |    |
| 2  | Amoxici llin| *Jatropha multifida* L. | Euphorbiaceae              | 7.65   | 4.69   | 10.2    | 22.5    |    |
| 3  | Pala        | *Myristica fragrans* Houtt. | Myristicaceae             | 7.06   | 4.69   | 9.04    | 20.7    |    |
| 4  | Jati        | *Tectona grandis* L.f. | Lamiaceae                  | 3.53   | 4.69   | 5.74    | 13.9    |    |
| 5  | Turi Putih  | *Sesbania grandiflora* (L.) Pers. | Leguminosae              | 5.88   | 6.25   | 5.65    | 17.7    |    |
|    | Remaining species |                |                            | 64.1   | 73.44  | 55.7    | 193.    |    |
| C  | Mentawa (Balinese) |                |                            |        |        |         |         |    |
| 1  | Coklat      | *Theobroma cacao* L. | Malvaceae                  | 31.2   | 15.38  | 39.1    | 85.8    |    |
| 2  | Jepun       | *Nerium oleander* L. | Apocynaceae                | 15.6   | 19.23  | 17.4    | 52.3    |    |
| 3  | Bunga Sandad| *Cananga odorata* (Lam.) Hook.f. & Thomson | Annonaceae            | 6.25   | 7.69   | 5.06    | 19.0    |    |
| 4  | Sentong     | *Psidium guajava* L. | Myrtaceae                  | 6.25   | 7.69   | 4.93    | 18.8    |    |
| 5  | Puring      | *Codiaeum variegatum* (L.) Rumph. ex A.Juss. | Euphorbiaceae | 6.25   | 7.69   | 3.54    | 17.4    |    |
|    | Remaining species |                |                            | 34.3   | 42.31  | 29.8    | 106.    |    |

Remaining species: 100% 100% 100% 300 2.67

Remaining species: 100% 100% 100% 300 3.05

Remaining species: 100% 100% 100% 300 2.27
Table 6. The Fifth most important seedling and understory species in the three research sites. Local name, botanical name, family, relative density (RD), relative frequency (RF), relative dominance (RDo), Important Value Index (IVI), and Shanon-Whiener Diversity Index (H')

| No | Local Name       | Botanical Name     | Family    | RD (%) | RF (%) | IVI (%) | H'    |
|----|------------------|--------------------|-----------|--------|--------|---------|-------|
| A  | Menyo'e (Tao Taa Wana) |                  |           |        |        |         |       |
| 1  | Marisa           | *Piper nigrum* L   | Piperaceae | 9.65   | 5.43   | 15.0    | 9     |
| 2  | Rumput tikus     | *Phyllanthus urinaria* L | Phyllanthaceae | 7.51   | 5.43   | 12.9    | 4     |
| 3  | Coklat           | *Theobroma cacao* L | Malvaceae | 5.9    | 5.43   | 11.3    | 3     |
| 4  | Yalintai         | *Mallotus mollusimus* (Geisler) Airy Shaw | Euphorbiaceae | 6.7    | 4.35   | 11.0    | 5     |
| 5  | Katumbar         | *Lantana camara* L | Verbenaceae | 6.43   | 4.35   | 10.7    | 8     |
|    | Remaining Species |                   |           | 63.8   | 1       | 138.15  | 100   |
|    |                  |                    |           | 1      | 75.0    | 8       | 200   |
| B  | Singkoyo (Javanese) |                     |           | 10.3   | 15.5    | 1.43    | 1     |
| 1  | Kunir            | *Curcuma longa* L   | Zingiberaceae | 8      | 5.13   | 1       |       |
| 2  | Jagung           | *Zea mays* L        | Poaceae   | 9.23   | 5.13   | 6       | 12.8  |
| 3  | Kemangi          | *Ocimum basilicum* L | Lamiaceae | 7.69   | 5.13   | 2       | 12.0  |
| 4  | Meniran          | *Phyllanthus urinaria* L | Phyllantaceae | 6.92   | 5.13   | 5       | 10.5  |
| 5  | Patikan kebo     | *Euphorbia hyrta* L | Euphorbiaceae | 5.38   | 5.13   | 1       | 60.3  |
|    | Remaining species |                   |           | 8      | 74.36   | 8       | 134.6 |
|    |                  |                    |           | 100    | 100     | 200     | 3.25  |
| C  | Mentawa (Balinese) |                    |           | 12.4   | 22.4    |         |       |
| 1  | Jae              | *Zingiber officinale* Roscoe | Zingiberaceae | 1      | 10.00   | 1       |       |
| 2  | Kunyit           | *Curcuma longa* L   | Zingiberaceae | 2      | 8.00   | 2       | 15.5  |
| 3  | Isen             | *Alpinia galanga* (L) Wild. | Zingiberaceae | 2      | 8.00   | 9       | 12.9  |
| 4  | Kayu manis       | *Sauprus androgynus* (L.) Merr. | Phyllantaceae | 6.9    | 6.0    | 0       | 10.7  |
| 5  | Jarak            | *Jatropha curcas* L | Euphorbiaceae | 2.76   | 8.0    | 6       | 58.6  |
|    | Remaining species |                   |           | 2      | 60.0    | 6       | 118.6 |
|    |                  |                    |           | 100    | 100     | 200     | 3.01  |
3.2. Plant utilization and Index of Cultural Significance (ICS)

The value of Index of Cultural Significance (ICS) of plants utilized by the three different ethnics in each agroforestry system in the studied area was presented in Tables 2 and 7. Tao Taa Wana people who live in Menyoe village (research site B) have utilized about 43 plant species (belonging to 23 families), 27 of which were used for medicines, 20 for foods, two for dying (coloring), 18 for firewoods, six for building materials, and five for customary rituals. Besides, they used the plants for forage, ornament, rope and botanical pesticide. In Singkoyo (research site B), 52 plant species have been extensively used by the Javanese people for a wide range of cultural uses. Twenty-eight species were used for medicines, 32 for foods, 17 for firewoods, seven for building materials, and 10 for ornaments. In research site B (Mentawa village), 39 plant species were used traditionally by Balinese people. Eighteen of them were used for medicines, 18 for foods, and 13 for ceremonial rituals.

Five species of the plants that have high Index of Cultural Significance (ICS) for the Tao Taa Wana ethnic group were coconut (Cocos nucifera), banana (Musa paradisiaca), cassava (Manihot esculenta), dammar (Agathis dammara) and sugar palm (Arenga pinnata), similar with study in South Sulawesi [27,28]. The same phenomenon of the highest value of ICS were also showed by Javanese people in Singkoyo village and Balinese people in Mentawa village respectively.

**Table 7.** Index of Culture Significance (ICS) of plants used by Tao Taa, Javanese and Balinese ethnics in the studied area.

| No | Local Name | Botanical Name                  | Family     | ICS | Uses                              |
|----|------------|--------------------------------|------------|-----|----------------------------------|
| A  | Tao Taa Wana |                                |            |     |                                  |
| 1  | Kayuku     | *Cocos nucifera* L.            | Arecales   | 116 | Medicines, foods, Ritual ceremonies, Ropes, Fuels, Building materials |
| 2  | Loka       | *Musa paradisiaca* L.          | Musaceae   | 80  | Foods, ritual ceremonies          |
| 3  | Kasubi     | *Manihot esculenta* Crantz     | Euphorbiaceae | 64  | Foods, Fuels                      |
| 4  | Soga       | *Agathis dammara* (Lamb.) Rich. & A.Rich. | Araucariaceae | 62  | Medicines, Fuels                  |
| 5  | Enau       | *Arenga pinnata* (Wurmb) Merr. | Arecales   | 61  | Foods                           |
| 6  | Kafu       | *Ceiba pentandra* (L.) Gaertn  | Malvaceae  | 57  | Medicines, Ropes, Fuels, Building materials |
| 7  | Jati       | *Tectona grandis* L.f.         | Verbenaceae | 56  | Ritual ceremonies, Fuels, Building materials |
| 8  | Lauro      | *Calamus zollingerii* Becc     | Arecales   | 52  | Foods, Ropes                      |
| 9  | Taripa     | *Mangifera indica* L.         | Anacardiacae | 44  | Foods, Fuels                      |
| 10 | Andolia    | *Cananga odorata* (Lam.) Hook.f. & Thomson | Annonaceae | 33  | Medicines, Fuels, Building materials |
| 11 | Kuni       | *Curcuma longa* L.            | Zingiberaceae | 33  | Medicines, Natural dyes, Spices, Pesticides |
| 12 | Veau       | *Aleurites moluccana* (L.) Wildl. | Euphorbiaceae | 32  | Fuels                           |
| 13 | Coklet     | *Theobroma cacao* L.          | Malvaceae  | 32  | Foods, Fuels                      |
| 14 | Bunta      | *Ficus variegata* Blume       | Moraceae   | 31.5| Medicines, Foods, Fuels           |
| 15  | Seronge | *Pterocarpus indicus* | Fabaceae | 31 | Medicines, Natural dyes, Fuels |
| 16  | Kaumama | *Neolamarckia cadamba* | Rubiaceae | 31 | Forages, Fuels, Building materials |
| 17  | Jambu biji | *Psidium guajava* | Myrtaceae | 30 | Medicines, Foods, Fuels |
| 18  | Puti mata | *Macaranga gigantea* | Euphorbiaceae | 30 | |
| 19  | Nunang | *Syzygium cumini* | Myrtaceae | 24 | Medicines, Fuels |
| 20  | Nantu | *Manilkara fasciculata* | Sapotaceae | 24 | Medicines, ritual ceremonies, Pesticides |
| 21  | Gamal | *Gliricidia sepium* | Fabaceae | 21 | Fuels, Building materials, Forage, Fuels, Soil fertilizer |
| 22  | Binongol | *Solanum melongena* | Solanaceae | 21 | Medicines, Foods |
| 23  | Yalintai | *Mallotus mollissimus* | Euphorbiaceae | 21 | Medicine, Fuel |
| 24  | Katu | *Sauropus androgynus* | Phyllanthaceae | 21 | Medicines, Foods |
| 25  | Pepaya | *Carica papaya* | Caricaceae | 18 | Medicines, Foods |
| 26  | Marisa | *Piper nigrum* | Piperaceae | 18 | Medicines, Foods |
| 27  | Jahe | *Zingiber officinale* | Zingiberaceae | 18 | Medicines, Foods, Spices |
| 28  | Salu Bugis | *Jatropha curcas* | Euphorbiaceae | 15 | Medicines, Pesticides, Medicines, ritual ceremonies |
| 29  | Timpono | *Piper sp.* | Piperaceae | 15 | |
| 30  | Katumbara | *Lantana camara* | Verbenaceae | 13 | Medicines, Ornaments |
| 31  | Jambu Air | *Syzygium aqueum* | Myrtaceae | 12 | Foods, Fuels |
| 32  | Delima | *Punica granatum* | Punicaceae | 12 | Foods |
| 33  | Tebu | *Saccharum officinarum* | Poaceae | 10 | Foods, Forage |
| 34  | Tambole | *Senna alata* | Fabaceae | 9 | Medicines |
| 35  | Ngareo | *Euphorbia hirta* | Euphorbiaceae | 9 | Medicines |
| 36  | Wayo | *Myrmecodia pendens* | Rubiaceae | 9 | Medicines |
| 37  | Patoncu | *Sellaginella doederleini* | Selaginellaceae | 9 | Medicines |
| 38  | Rumput Tikus | *Phyllanthus uncinus* | Phyllanthaceae | 9 | Medicines |
| 39  | Benalu | *Macrosolen cochinichenis* | Loranthaceae | 9 | Medicines |
| 40  | Rica | *Capsicum annuum* | Solanaceae | 9 | Foods |
| 41  | Pau | *Phaleria macrocarpa* | Thymelaceae | 8 | Medicines, Ornaments |
| 42  | Kadaka | *Asplenium nidus* | Apleniaceae | 2 | Ornaments |
| 43  | Alang-alang | *Imperata cylindrica* | Poaceae | 2 | Medicines |

**B Javanese**
| No. | Name       | Scientific Name                  | Family       | Page |
|-----|------------|----------------------------------|--------------|------|
| 1   | Kelapa     | *Cocos nucifera* L.              | Arecaceae    | 94   |
| 2   | Gedang     | *Musa paradisiaca* L. *Manihot esculenta* | Musaceae    | 82   |
| 3   | Ubi Kayu   | Crantz                          | Euphorbiaceae | 73   |
| 4   | Jati       | *Tectona grandis* L.f.           | Verbenaceae  | 69   |
| 5   | Kapuk      | *Ceiba pentandra* (L.) Gaertn     | Malvaceae    | 53   |
| 6   | Duren      | *Durio zibethinus* L. *Arenga pinnata* (Wurmb) | Malvaceae | 52   |
| 7   | Aren       | *Citrus sinensis* (L.) Merr.      | Rutaceae     | 48   |
| 8   | Jeruk      | *Colocasia esculenta* (L.) Osbeck | Araceae      | 48   |
| 9   | Bete       | *Neolamarckia cadamba* (Roxb.) Bosser | Araceae    | 45   |
| 10  | Jabon      | *Theobroma cacao* L. *Artocarpus altilis* (Parkinson ex F.A.Zorn) | Malvaceae | 32   |
| 11  | Coklat     | *Sesbania grandiflora* (L.) Fosberg | Fabaceae | 29   |
| 12  | Sukun      | *Annona muricata* L.             | Annonaceae   | 32   |
| 13  | Sabrang    | *Cananga odorata* (Lam.) Hook.f. & Thomson | Annonaceae | 32   |
| 14  | Kenanga    | *Myristica fragrans* Houtt.      | Myristicaceae | 30   |
| 15  | Pala       | *Curcuma longa* L. *Sesbania grandiflora* (L.) | Zingiberaceae | 30   |
| 16  | Kunir      | *Pers. Sesbania grandiflora* (L.) Pers. | Fabaceae | 29   |
| 17  | Turi Merah | *Leucaena leucocephala* (Lam.) de Wit | Fabaceae | 29   |
| 18  | Turi Putih | *Terminalia catappa* L. *Zea mays* L. | Combretaceae | 26   |
| 19  | Klandangan | *Alpinia galangl* L. Wild. *Zingiber officinale* Roscoe | Zingiberaceae | 24   |
| 20  | Ketapang   |                             | Poaceae      | 25   |
| 21  | Jagung     |                             | Poaceae      | 24   |
| 22  | Laos       |                             | Zingiberaceae | 24   |
| 23  | Jahe       |                             | Zingiberaceae | 24   |
| No. | Name            | Scientific Name                                      | Family     | Usage                                                                 |
|-----|-----------------|-----------------------------------------------------|------------|----------------------------------------------------------------------|
| 24  | Salam           | Syzygium polyanthum (Weight) Walp.                  | Myrtaceae  | 21 Medicines, Foods                                                   |
| 25  | Katuk           | Sauropus androgynus (L.) Merr.                      | Phyllantaceae | 21 Medicines, Foods  
|     |                 |                                                     |            | Pesticides, ritual ceremonies                                          |
| 26  | Sri Sambungnyowo | Piper betle L. Gynura procumbens                   | Piperaceae | 21 Medicines                                                        |
| 27  | Pete            | Parkia speciosa Hassk                               | Fabaceae   | 20 Foods, Fuels                                                       |
| 29  | Lombok          | Capsicum annuum L.                                  | Solanaceae | 20 Foods                                                             |
| 30  | Talok           | Muntingia calabura L. Syzygium aromaticum (L.) Merr. & L.M.Perry Mucuna pruriens (L.) | Muntingiaceae | 18 Medicines, Foods, Fuels                                           |
| 31  | Cengkeh         | DC                                                  | Fabaceae   | 18 Medicines, Foods                                                   |
| 32  | Koro            | Cymbopogon citratus (DC. Stapf)                    | Poaceae    | 18 Medicines, Foods, Forage                                           |
| 33  | Serai           |                                                     |            |                                                                      |
| 34  | Kariango        | Acorus calamus L. Archidendron pauciflorum (Benth.) | Araceae    | 17 Medicines, ritual ceremonies                                       |
| 35  | Jengkol         | I.C.Nielsen                                        | Fabaceae   | 16 Foods, Fuels                                                       |
| 36  | Amoxilin        | Jatropha multifida L.                               | Euphorbiaceae | 15 Medicines, Ornaments                                           |
| 37  | Jarak           | Jatropha curcas L. Bryophyllum pinnatum             | Euphorbiaceae | 15 Medicines, Pesticides                                      |
| 38  | Cocor Bebek     | (Lam.) Oken Piper crocatum Ruit and Pav             | Crassulaceae | 15 Medicines, Ornaments                                              |
| 39  | Sirih Merah     | Coleus scutellaroides (L.) Benth.                  | Lamiaceae  | 15 Medicines, Ornaments                                              |
| 40  | Mayana Merah    |                                                     |            |                                                                      |
| 41  | Pandan Mojo     | Dracaena sp                                        | Pandanaceae | 13 Natural dyes                                                      |
| 42  | Rambutan        | Nepheleum lappaceum L. Solanum torvum Sw           | Sapindaceae | 12 Foods, Fuels                                                      |
| 43  | Poka            |                                                     | Solanaceae | 12 Foods                                                             |
| 44  | Kemangi         | Ocimum basilicum L.                                 | Lamiaceae  | 12 Foods, Spices                                                     |
| 45  | Kenikir         | Cosmos caudatus Kunth Mahkota Phaleria macrocarpa   | Asteraceae | 12 Foods, Ornaments                                                  |
| 46  | Dewa            | (Scheff.) Boerl                                     | Thymelaceae | 10 Medicines, Ornaments                                              |
| 47  | Pace            | Morinda citrifolia L. Anredera cordifolia (Ten.) Steenis | Rubiaceae  | 9 Medicines                                                          |
| 48  | Binahong        |                                                     |            |                                                                      |
| 49  | Meniran         | Phyllanthus urinaria L.                            | Phyllantaceae | 9 Medicines                                          |
| 50  | Patikan Kebo    | Euphorbia hirta L. Orthosiphon aristatus           | Euphorbiaceae | 9 Medicines                                      |
| 51  | Kumis           | (Blume) Miq Phalaenopsis amabilis (L.) Blume        | Lamiaceae  | 9 Medicines                                                          |
| 52  | Anggrek         |                                                     | Orchidaceae | 6 Ornaments                                                          |

C Balinese
| No. | Plant Name     | Genus and Species                        | Family               | Uses                                                                 |
|-----|---------------|------------------------------------------|----------------------|----------------------------------------------------------------------|
| 1   | Nyuh          | *Cocos nucifera* L.                      | Arecaceae            | Medicines, foods, ritual ceremonies, ropes, building materials        |
| 2   | Biyu          | *Musa paradisiaca* L.                    | Musaceae             | Medicines, foods, ropes, ritual ceremonies, Medicine, ritual ceremonies, fuels |
| 3   | Bunga Sandad  | *Cananga odorata* (Lam.)                | Anonaceae            | Foods, ornamemt, ritual ceremonies                                    |
| 4   | Kladi         | *Schott*                                 | Araceae              | Foods, forage, Ornaments, ritual ceremonies                            |
| 5   | Jepun         | *Nerium oleander* L.                     | Apocynaceae          | Ornaments, ritual ceremonies, fuels                                   |
| 6   | Cempaka       | *Michelia alba* DC.                      | Magnoliaceae         | Medicines, foods, ritual ceremonies, building materials, natural dyes |
| 7   | Kunyit        | *Curcuma longa* L.                       | Zingiberaceae        | Foods, fuels, Ropes, ritual ceremonies                                |
| 8   | Coklat        | *Theobroma cacao* L.                     | Malvaceae            | Ceremonial rituals, Ropes, Ceremonial rituals, ropes                  |
| 9   | Ibung         | *Onocendera tigillarium* (Jack) Ridl.    | Arecaceae            | Ceremonial rituals, Ropes                                            |
| 10  | Janur         | *Nypa fruticans* Wurmb                   | Areaceae             | Ceremonial rituals, ropes                                            |
| 11  | Tiing         | *Bamusa maculata* Widjaja                | Bambusaceae          | Food, natural dyes, ornament, ritual ceremonies                        |
| 12  | Arrum         | *Pandanus amaryllifolius*                | Pandanaceae          | Medicines, foods, ritual ceremonies                                  |
| 13  | Sotong        | *Psidium guajava* L.                     | Myrtaceae            | Medicine, foods, ritual ceremonies                                   |
| 14  | Manas         | *Ananas comosus* (L.)                    | Bromeliaceae         | Firewood, building materials, Ornament, ritual ceremonies, Medicines  |
| 15  | Jabon         | *Ixora*                                 | Rubiaceae            | Medicine, foods, ritual ceremonies, Medicines                          |
| 16  | Sokka         | *Aciculiflora* Bremek                    | Rubiaceae            | Medicines, foods, ornaments, Medicines, ritual ceremonies             |
| 17  | Isen          | *Wild*                                  | Zingiberaceae        | Medicines, foods, foods, fuels, natural dyes, ornament, ritual ceremonies |
| 18  | Gedang        | *Carica papaya* L. *Zingiber officinale* | Caricaceae           | Foods                                                                 |
| 19  | Jae           | *Rosco*                                 | Zingiberaceae        | Medicine, spices                                                      |
| 20  | Cengkeh       | *Syzygium aromatum* (L.) Merr. & L.M.Perry | Myrtaceae            | Medicine, spices                                                      |
| 21  | Kayu Manis    | *Anacardium occidentale* (L.) Merr. Merr. | Phyllantaceae        | Medicine, foods                                                       |
| 22  | Meteh         | *L.*                                    | Anacardiaceae        | Food, fuels                                                           |
| 23  | Rambutan      | *Nephelium lappaceum* L. Manikara kauki (L.) | Sapindaceae        | Food, fuels                                                           |
| 24  | Sao           | *Bougainvillea spectabilis* P.Royen      | Sapotaceae           | Food, ornaments                                                       |
| 25  | Bunga Kertas  | *Choisy*                                | Nyctaginaceae        | Ornament, ritual ceremonies                                           |
Syzigium aromaticum, according to Kessler et al. (2002), rambutan (Nephelium lappaceum), nutmeg (Myristica fragrans), cloves (Syzygium aromaticum), rambutan (Nephelium lappaceum), sawo (Manilkara kauki), jack fruit (Artocarpus heterophyllus), corn (Zea mays), banana (Musa paradisiaca), turmeric (Curcuma longa), ginger (Zingiber officinale), and chili (Capsicum frutescens). This indicated resemblance of the plant species found in agroforestry system of Lore Lindu.

| 26 | Puring | Codiaeum variegatum (L.) Rumph. ex A.Juss. | Euphorbiaceae | 20 | Ornaments, Medicines, Pesticides, ritual ceremonies |
| 27 | Base | Piper betle L. | Piperaceae | 20 | Foods, Medicines, ritual ceremonies |
| 28 | Nangke | Artocarpus heterophyllus | Fabaceae | 17 | Medicines, pesticides |
| 29 | Dada | Erythrina variegata L. | Fabaceae | 15 | Medicines, pestsides |
| 30 | Jarak | Jatropha curcas L. | Euphorbiaceae | 12 | Foods |
| 31 | Mahkota | Solanum melongena L. | Solanaceae | 10 | Medicines, ornaments |
| 32 | Dewa | Phaleria macrocarpa | Rubiaceae | 9 | Medicines |
| 33 | Nibah | Morinda citrifolia L. | Rubiaceae | 9 | Medicines |
| 34 | Kumis | Orthosiphon aristatus | Lamiaceae | 9 | Medicines |
| 35 | Kucing | Anredera cordifolia | Lamiaceae | 9 | Medicines |
| 36 | Gendola | Digitaria abudens (Roe m. & Schult.) Veldkamp | Baselineae | 9 | Medicines |
| 37 | Suket | Cereus jamacaru DC. | Cactaceae | 8 | Ornaments |
| 38 | Kaktus | Mimosa pudica L. Imperata cylindrica (L.) | Fabaceae | 6 | Medicines |
| 39 | Putri malu | Rauensh. | Poaceae | 4.5 | Forages |

### 3.3. Discussions

There was a significant different in a number of plant species among the three agroforestry systems in the studied area. We recorded 43, 5,2 and 39 plant species in research sites A, B, and C, respectively. The species composition was also quite different among the research sites (A in Menyo’e village; B in Singkoyo; and C in Mentawa).

Menyo’e village was generally composed of mixed natural plants and cultivated plant species. Some species, such as Agathis dammara, Arenga pinnata, Calamus zollingerii, Cananga odorata, Ficus variegata, Neolamarckia cadamba, Macaranga gigantea and Manilkara fasciculata, were categorized as natural plant species of Sulawesi, while coconut (Cocos nucifera), banana (Musa paradisiaca), kapok (Ceiba pentandra), Aleurites mollucca, teak (Tectona grandis), gamal (Glyricidia sepium), cacao (Theobroma cacao), cassava (Manihot esculenta), Pterocarpus indicus, Syzygium cumini belonged to cultivated species. According to Kessler et al., 2002, there are 2100 (about 120 families) natural woody plant species in Sulawesi and many of them are endemic Sulawesi [29]. Henderson and Pitopang (2018) pointed out that seventy-eight (78) percent of Wallacea rattans are endemic to the region, including Calamus zollingerii Becc [30]. Pitopang and Safaruddin (2012) also discovered that “Tao Taa Wana” people who live around Morowali Nature Reserve rely on “baratan” (collecting rattan) and “badamar” (tapping resin tree/Agathis spp.) as their main livelihood [31]. Rattan means Lauro (in Tao Taa Language). Some rattans species collected by them included “lauro vata” (Calamus zollingerii), lauro toiti (Calamus inops), and lauro jarmasi.

The plant species mostly cultivated by the people in Singkoyo and Mentawa villages included coconut (Cocos nucifera), durian (Durio zibethinus), teak (Tectona grandis), coklat (Theobroma cacao), breadfruit (Artocarpus elasticus), lemon (Citrus chinensis), aren (Arenga pinnata), soursop (Annona muricata), nutmeg (Myristica fragrans), clove (Syzygium aromaticum), rambutan (Nephelium lappaceum), sawo (Manilkara kauki), jack fruit (Artocarpus heterophyllus), corn (Zea mays), banana (Musa paradisiaca), turmeric (Curcuma longa), ginger (Zingiber officinale), and chili (Capsicum frutescens). This indicated resemblance of the plant species found in agroforestry system of Lore Lindu.
National Park (Gradstein et al., 2007) which included species, such as *Durio zibethinus*, *Artocarpus heterophyllus*, *Nepheleinum lappaceum* and *Artocarpus elasticus*, were also recorded in the agroforestry “Tembawang” at Sekadau Hulu, West Kalimantan [32,33].

In the perspective of traditional utilization of plants, “coconut” (*Cocos nucifera* L) has the highest Index of Cultural Significant (ICS) among the three different ethnicities. Index of Cultural Significance (ICS) is the result of quantitative ethnobotany analysis to determine utilization of plant diversity and its importance for the people [26]. *C.nucifera* is pantropical medium-sized to large palm, which is believed to have originated from the Melanesian region (Rehm and Espig, 1991) as a result of human activities of dispersion on tropical and subtropical shores throughout the world [34]. This species is one of the most useful trees in the world—it has multitvarious utilities. The water is drinkable, the fleshy seed (endosperm) can be eaten raw, and the coconut milk can be used for cooking. Copra (dried form of endosperm) is processed for soap manufacturing, coconut oil, and other useful products [35]. Many parts of the coconut tree are used for utensils, handy crafts, fuels, building materials and for medicines [35–37]. The constituents of *C. nucifera* have some biological effects such as anti-helmintic, anti-inflammatory, anti-nociceptive, anti-oxidant, anti-fungal, anti-microbial and anti-tumor activities [38].

The traditional plant usage by the three different ethnicities in the agroforestry ecosystems is different, although they are generally used for food, medicine, natural coloring, botanical pesticide, ornament, forage, customary rituals, rope, firewood, and building material (construction).

### 3.3.1. Food plants.

Javanese community has utilized many of the plant species for their daily need. We noted as many as thirty-two species were used for food. These comprised “kelapa” (*Cocos nucifera*), “gedang” (*Musa paradisiaca*), “ubi kayu” (*Manihot esculenta*), “jagung” (*Zea mays*), “duren” (*Durio zibethinus*), “sukun” (*Artocapus elasticus*), “aren” (*Arenga pinnata*), “jeruk” (*Citrus sinensis*), “bete” (*Colacasia esculenta*), “coklat” (*Theobroma cacao*), “nangka sebrang” (*Annona muricata*), “turi merah” (*Sesbania grandiflora*), “klandangan” (*Leucaena leucocephala*), “kemangi” (*Ocinum basilicum*), “lombok” (*Capsicum annuum*), “petai” (*Parkia timoriana*), “jengkol” (*Archidendron pauciflorum*) and “rambutan” (*Nephelium lappaceum*).

Twenty species of the plants have been made use by the Tao Taa wana people for food such as “taripa” (*Mangifera indica*), “loka” (*Musa paradisica*), “papaya” (*Carica papaya*), “jambu air” (*Syzygium aqueum*), “tebu” (*Saccharum officinarum*), “kasubi” (*Manihot esculenta*), “kayuku” (*Cocos nucifera*), and “delima” (*Punica granatum*).

In Mentawa village, Balinese people have utilized 18 plant species for food which included “kladi” (*Colacasia esculenta*), “gedang” (*Carica papaya*), “coklat” (*Theobroma cacao* L), “nangke” (*Artocarpus heterophyllus*), “terong” (*Solanum melongena*), “meth” (*Anacardium occidentale*), “rambutan” (*Nephelium lappaceum*), and “biyu” (*Musa paradisiaca*). According to Rivera et al., (2010), those foods have positive physiological effects beyond their nutritional function of providing nutrients [39]. Verheij and Coronel (1992) also noted about 400 plant species are used as food in southeast Asia including edible fruits, nuts or seeds [40]. Meanwhile, Siemonsma and Piluek (1994) reported more than 1000 species in Southeast Asia are known to yield vegetable products, although only 50 of them have been developed into highly commercialized crops [41].

### 3.3.2. Medicinal plants.

Indonesian people in general and some indigenous communities including Javanese, Balinese and Kailinese have long been utilizing plants as traditional medicine to maintain their health. Fathurrühman et al., (2016) reported 62 plant species were used by Kaili Inde tribe in Central Sulawesi as medicine, while Paik et al.,(2013) recorded 165 medicinal plants in Lore Lindu National Park, Sulawesi Indonesia [23,42]. Such tradition of making use of plants for healing in Indonesia dates back to prehistoric times.

In this study, we recorded a large number of medicinal plants being used by the three ethnicities in the studied area. Twenty-seven species were used by Tao Taa Wana, 28 by the Javanese and 18 by the Balinese community. The knowledge and art of utilizing plants as medicine have been handed down from generation to generation. Some plants, such as *Borassus flabellifer*, *Calophyllum*
inophyllum, Datura metel and Syzygium cumini, are still used in traditional medicine, which can be found in varied reliefs as portrayed on the wall of temples in Java (i.e. Borobudur, Prambanan and Sukuh [43].

In Javanese community, utilizing herbal plants for the purpose of medication (called “Jamu”) has been noted down for a long time. The so-called “Jamu”, which has now been adopted into the Indonesian language, may consist of a single or a mixture of some medicinal plants. Sumarni et al., (2019) reveals that the knowledge of traditional “jamu” formula was preserved and disseminated orally throughout generations [44]. This is in line with the definition of traditional medicine delivered by the World Health Organization (WHO). Like the Javanese community, Balinese people also used plants as medicine. Sujarwo et al. (2020) recorded 50 species of plants were used in traditional system of medicinal use called "Usada" in Bali island [20].

3.3.3. Plants for traditional rituals. There was a difference in the perspective of traditional use of plants as ceremonial or customary rituals by the three different ethnics. The Balinese people in Mentawa have used more plants as traditional rituals (15 species) than those used by the other two ethnics: Tao Taa Wana (5 species) and the Javanese people (6 species). The Balinese people, which are identical with Hinduism, have given incredibly important attention to plants and forests. Sujarwo et al., (2020) recorded 125 species (112 genera, 49 families) of plants are used for the sake of religious offerings in Bali, most of which belong to the wild ethnoflora of Bali [45]. In Bali, too, traditional and religious ceremonies are more frequent than in any other places in the wider Hindu world [46].

3.3.4. Plant for fuels and building materials. The Tao Taa Wana community have used 18 species of plants for firewood and 6 others for building materials. Similarly, the Javanese have used 17 species for firewood and seven others for building materials. Unlike these two ethnics, the Balinese have only used 8 species for fuels and 4 others for building materials. All these plants belong to woody plants. The plants that were used for fuels included “jambu biji” (Psyidium guajava), “kayuku” (Cocos nucifera), “coklat” (Theobroma cacao), “pete” (Parkia timorensis), and “rambutan” (Nephelium lappaceum)—some of them are categorized as wild plants such as “andolia” (Cananga odorata), “puti mata” (Macaranga gigantea), “bunta” (Ficus variegata), and “soga” (Agathis dammara). The tree species used for building materials included “jati” (Tectona grandis), “nantu” (Manilkara fassculata), “andolia (Cananga odorata), “durian” (Durio zibethinus), and “jabon” (Neolamarckia cadamba). Kessler et al, (2005) noted that there are 2100 woody plant species in Sulawesi [6].

3.3.5. Plants for botanical pesticides, forages, natural dyes and ornaments. The three ethnic groups in the studied areas have also used some of the plant species for botanical pesticides, forages, ornamental plants and natural dyes. Turmeric (Curcuma longa) and jatropha curcas were used for natural dyes and botanical pesticides respectively by the three ethnics. Unlike the Javanese people have used more of the plants for forages and ornaments than those used by the Tao Taa wana and Balinese people. Mannetje and Jones (1992) reported that there are 115 major forage species in southeast Asia [47]. Rahayu et al, (2020) recorded 22 plants species are used by Lombok people as dying and natural color in traditional Pringgasela woven fabric, East Lombok, Nusa Tenggara, Indonesia [48].

4. Conclusions

In conclusion, the highest number of plant species is found in research site B, but the highest number of individuals is noted in research site A. The highest Important Value Index (IVI) of tree, poles, sapling and seedling level plant species differ among the three research sites. In the perspective of traditional plant use, the highest of Index of Cultural Significat (ICS) of plants among the three ethnics is “coconut” (Cocos nucifera L.), but the number of plant used and its utilization are different among the ethnics. The Tao Taa Wana people have utilized about 43 plant species—27 are used as medicines, 20 for foods, two for natural dyes, 18 as fuels, six for building materials, and five for ritual ceremonies. In research site B (Singkoyo), 52 plant species have been extensively used by the Javanese people for a variety of culture uses—28 of them are used as medicines, 32 for foods, 17 for fuels, seven for building
materials, and 10 for ornamental purposes. Quite similarly, in research site C (Mentawa), as many as 39 plant species are used traditionally by the Balinese people—18 are used as medicine, 18 for food, and 13 for ritual ceremonies.

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