Universitas Sumatera Utara Arboretum of Deli Serdang, North Sumatra, Indonesia: Revealing the potency

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Abstract. Growth, development, and structural changes within the Universitas Sumatera Utara Arboretum since its establishment in 2005 should be recognized, observed, and investigated. Previously, the site of this arboretum was oil palm plantation. The objective of this study is to map, classify, identify, and calculate the potency of the vegetation within the arboretum. Method of this research is combination of literature study and field work. In this research, literature study, site visit, and inventory work were reported. Results of literature study revealed that at least 56 species of forestry plants were found in 2008 and increased up to 77 species of tree were found in 2023. Present research conducted in 2024 using a systematic sampling with random start with 36 plots revealed only 53 species of tree. The result was lower due to differ in method. To promote climate change mitigation, it is still necessary to optimize the potency as a source of bio-energy, food and feed, herbal medicine, carbon reserves, and creative economy (natural dyes and craft materials).

1 Introduction

Arboretum is defined as the collection of trees or some selected species, native of introduction from around the world, established in specific area for research purposes (scientific objective), education, and exhibition [1]. In some countries, the arboreta were dedicated for research purposes and the outputs and outcomes have been published in international scientific reputable journals such as in Tanzania [2], in Canada [3], in UK [4], in Poland [5],[6], and in USA [7]. In Indonesia, several campuses have been utilized their arboreta as the research objects, for instances Universitas Riau in Sumatra [8], Universitas Tanjungpura [9] and Universitas Lambung Mangkurat in Kalimantan [10], Universitas

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Padjadjaran [11] and Universitas Gadjah Mada in Java [12], and Universitas Negeri Papua in Papua [13].

Universitas Sumatera Utara or USU has been constructed its Arboretum at land concession of national estate of Nusantara Plantation Limited or PTPN II since 2005. The site was the oil palm plantation at Kwala Bekala Village, Pancur Batu Subdistrict, Deli Serdang Regency, North Sumatra Province. The USU Arboretum was established according to land rehabilitation by implementing an agroforestry system [11]. After stated officially by Ministry of Forestry Republic of Indonesia in 2006, the USU Arboretum was developed not only its area but also its function. At the first planning, the area of the USU Arboretum was only 55 hectares, nowadays it occupied into 64.81 hectares [11]. Rules of the USU Arboretum have been supporting researches specifically which related to Sustainable Development Goals (SDGs) number 15 namely to protect, to restore and to utilize the land ecosystem, to manage the forest with sustainability, to stop deplantation, to rehabilitate land degradation, and to prevent loss of biodiversity.

In this study, potency of the USU Arboretum was revealed as the bioenergy sources, food and feed, herbal medicine, carbon stock, and creative economy like natural dyes and craft purposes. All of these potencies were classified, identified, and calculated their potencies.

2 Material and methods

Since this experiment was combination of literature study and field work, the materials of this study were references which related to arboreta, particularly USU Arboretum literatures, GPS (Geographic Positioning System), maps, and other surveying complements such as tally sheets, stationery, tree diameter tape and body protection (boot shoes, hat, glove, etc).

Methods of this experiment was included literature study, site visit, and inventory. Literature study was limited into references which related the USU Arboretum such as books, reports, journal articles, presented paper or thesis (both undergraduate and master thesis). Site visit was conducted only to the area with heterogeneous vegetation. In other words, the area of nonoil palm plantation which have been converting to USU Arboretum. Inventory was carried out using a systematic sampling with random start with 38 plots as described in Fig.1. Every plot measured 100 m by 100 m, except for those that had adjustments made due to wall and street borders. Each plot was then made into a sized plot of 20 m x 20 m (for tree inventory), 10 m x 10 m (for pole inventory), 5 m x 5 m (for sapling inventory), and 2 m x 2 m (for seedling and understory inventory).

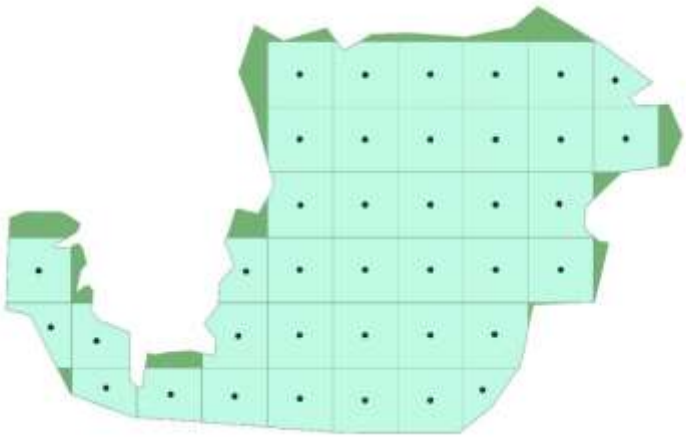

Fig. 1. Area study in USU Arboretum which divided into 38 plots.

3 Results and discussions

3.1 Literature study

The oldest reference which related to USU Arboretum was a book written by Professor Abdul Rauf, one of pioneer who designed it [14]. In this book, the vegetation within the USU Arboretum was classified into 4 (four) categories which composed of 57 species. After carefully listed and checked, oil palm (*Elaeis guineensis*), a species belonged to plantation and industry, was removed from the list since it was not belonging to forestry plant [15],[16]. Therefore, the number of species after correction was only 56 as depicted in Table 1.

Table 1. Four categories and the origin of the vegetation within the USU Arboretum at the first stage establishment based on [14]

No	Category of plants	Number of Spesies	Origin
1	Forestry	32	Native or existing 17.54% (10 spesies) and introduction 82.14% (46 spesies)
2	Plantation and industry	8	
3	Fruits (durian, manggo, rambutan, avocado)	12	
4	Compliament for vegetables	4	
	Total	56	100%

Recent study conducted by student and their supervisors [17] reported that the USU Arboretum nowadays composed 77 species of trees. After 15 years of development of the USU arboretum, there has been an increase not only to the number of species of the tree but also the number of individuals of the trees as shown in Table 2.

Table 2. Comparison of the condition of the vegetation (tree) in USU Arboretum after 15 years (year of 2008 and 2023)

Year	Data source	Method to obtain data	Number of species	Number of individual trees	Δ Increase			
					Number of tree species	% tree spesies	Number of individual trees	% individual trees
2008	[14]	Existing condition, 3 years after planted (2005-2008)	55*	5851**	22	40%	8868	151.56%
2023	[17]	Survey by census	77	14719				

Remarks:
* from data 57 species minus 2 species that are not trees (oil palm and sugar palm, both monocots)
** from data of 6473 individuals minus the number of non-tree individuals (2 and 620) = 5851 number of tree individuals

Both oil palm and sugar palm were included to monocots [18],[19]. The palms are monocotyledon that consist of parenchyma tissue and vascular bundles. Because they lack a cambium, they cannot be compared to gymnosperms and dicotyledons in terms of how wood develops. In fact, palm is not wood; hardwood and softwood are tree-derived materials.

3.2 Site visit

When conducting a cross-check in the field nearby the Faculty of Forestry, USU, as depicted in Fig. 2, the 38 plots were reduced into only 36 plots since the 2 plots were blocked by a wall of the USU Arboretum and the vegetation was limited without trees. Therefore, the study area for inventory was carried out in remaining 36 plots as described in Fig. 3.

Fig. 2. Area study in USU Arboretum which reduce with 2 plots and remains 36 plots.

Fig. 3. Remaining 36 plots within USU Arboretum for area of this study.

3.3 Inventory

Table 3 showed number of species at level of tree, pole, sapling, and seedling and understory. Since this work is still on going, the tabulated data showed only the number of each level.

Table 3. Number of species found in USU Arboretum by systematic sampling with random start method in 2024

No	Level	Number of species	Remarks
1	Tree	53	Validation is ongoing as tree, pole, sapling, and seedling may overlap the species.
2	Pole	10	
3	Sapling	15	
4	Seedling	14	
5	Understory	tbc*	Due to the small differences between seeds and undergrowth

Remarks:
* The number of species of understory has been confirming since the differences between seedlings and understory was very subtle.

The number of trees was only 53 species less than result of survey conducted in 2023 [17]. This is probably due to differences in method used. Previous work was using census while present work was using systematic sampling. There are two significant issues with the systematic sampling [20]. First, the actual sample size will be determined at random if the population size is not an integral multiple of the intended sample size. Secondly, an impartial estimator of the sampling variance cannot be obtained from a single systematic sample.

3.4 Potency of the USU Arboretum for source of bioenergy, food and feed, herbal medicine, carbon reserves, and creative economy

In order to promote the function of the USU Arboretum as well as supporting SDGs particularly number 15, the potency of the arboretum should be revealed. In line with proposal for development of the USU Arboretum, it can be utilized as source of bio-energy, food and feed, herbal medicine, carbon reserves, and creative economy (natural dyes and craft materials).

Research on bio-energy was not limited to solid biofuel such as firewood, charcoal, and the derivatives like briquette and pellet but also liquid form like alcohol. The sap of sugar palm can be processed into bio-ethanol [19]. For food and feed, generally these commodities contribute to the sustainable income to the society because of their economic value [21]. Further, long term utilization of arboretum could result in carbon reserves derive from not only the trees but also the understory [8], [13]. Research on herbal medicine and creative economy could utilize the portion of the plants such as leaves, flower, bark, and twigs. The plants should contain bioactive compound for herbal medicine [22] and pigment for natural colorant and craft materials.

4 Conclusions

This study is still classified as the preliminary experiment since the complete data still needs validation. Even though the field work has been finished, confirmation was still required to reveal the potency of the vegetation within USU Arboretum such as source of bio-energy, food and feed, carbon reserves, herbal medicine, and creative economy (natural dyes and craft materials).

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