

EXAMINING AGRICULTURAL COMMUNITIES' VIEWS ON PROVISIONING ECOSYSTEM SERVICES FROM THE BATANG TORU FOREST

*(Kajian Persepsi Masyarakat Pertanian terhadap Penyediaan Jasa Ekosistem di
Hutan Batang Toru)*

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Abstract. *Our study investigates the significance of ecosystem services for agricultural production and rural livelihoods, specifically focusing on the Batang Toru forest in North Sumatera. Through household surveys and descriptive analysis, we gather data on farmers' preferences for specific ecosystem services and examine their benefits for agriculture. Our findings highlight the crucial role of provisioning services, including food crops and non-timber forest products, in sustaining farmers' livelihoods within the study area. We also underscore the prevalence of agroforestry practices and stress the necessity for targeted interventions to enhance sustainability and productivity. Furthermore, our study provides valuable insights into the intricate relationship between farmers' perceptions of ecosystem services and various influencing factors in the Batang Toru forest context. Positive correlations are observed between land size, frequency of interactions with forested areas, benzoin farmers, and farmers engaged in other non-timber forest products, signifying the importance of these factors in shaping farmers' recognition of the forest's contributions. By understanding these factors, policymakers and practitioners can develop effective strategies to promote the sustainable management and utilization of ecosystem services in the Batang Toru forest region, benefiting both farmers and the surrounding environment.*

Keywords: *Ecosystem services, agriculture, Batang Toru forest, rural livelihoods, sustainability*

Abstrak. Penelitian ini mengkaji peran jasa ekosistem hutan terhadap produksi komoditas pertanian dan kehidupan pedesaan, secara khusus difokuskan pada lokasi Hutan Batang Toru di Sumatera Utara. Melalui survei terhadap rumah tangga dan analisis deskriptif, data dikumpulkan terhadap preferensi petani terhadap jasa-jasa ekosistem khusus dan menguji manfaatnya untuk kegiatan pertanian. Hasil penelitian ini menemukan bahwa peran jasa ekosistem hutan menjadi penting, termasuk tanaman pertanian, hasil hutan bukan kayu, mendorong kehidupan berkelanjutan kepada petani di sekitar wilayah studi. Hasil penelitian ini juga menegaskan preferensi terhadap kegiatan-kegiatan berbasis wana tani dan menekankan juga terhadap kebutuhan target keterlibatan guna meningkatkan produktivitas dan keberlanjutan. Selanjutnya, hasil penelitian ini juga memberikan nilai penting

hubungan yang kompleks antara persepsi petani terhadap jasa ekosistem hutan dan beragam faktor-faktor yang berpengaruh dalam konteks pemanfaatan kawasan Hutan Batang Toru. Hubungan positif terlihat antara ukuran lahan, intensitas interaksi terhadap areal hutan, petani kemenyaan dan keterlibatan petani dalam pemanfaatan komoditas hasil hutan bukan kayu lainnya, memperlihatkan derajat signifikansi terhadap pentingnya faktor-faktor tersebut dalam pembentukan pemahaman terhadap kontribusi hutan untuk kehidupan petani disekitar hutan. Dengan memahami faktor-faktor tersebut, pengambil kebijakan, praktisi dapat mengembangkan strategi yang efektif, untuk mempromosi manajemen keberlanjutan dan pemanfaatan jasa ekosistem di kawasan Hutan Batang Toru memberikan manfaat, baik kepada petani maupun lingkungan sekitar.

Kata kunci: Jasa ekosistem, pertanian, Hutan Batang Toru, kehidupan pedesaan, keberlanjutan

INTRODUCTION

Ecosystem services ranging from regulating water management, and land formation, providing material benefits to non-material benefits for human welfare and health such as spiritual and cultural values (Bhatta et al., 2015; Cooper et al., 2016; Dolisca et al., 2007; FAO, 2013; Silvano et al., 2005; Marwa et al., 2019). Millennium Ecosystem Assessment (2005) found that human actions impact the Earth's natural capital and ecosystem services on a diminishing scale on a global scale. However, most of the assessment literature on ecosystem services and agriculture aims to assess managed agricultural landscapes that can provide ecosystem services to the whole community.

The literature on ecosystem services and agriculture has resulted in numerous publications analyzing the impact of agricultural activities on ecosystems or publications assessing the ecosystem services that agricultural landscapes can (Dale & Polasky, 2007; Nelson et al., 2009; Porter-Bolland et al., 2012). Most of the existing studies focus on the impact of agriculture on ecosystem conditions, or agriculture as a source of supply of ecosystem services. However, ecosystem services also provide important services for agricultural production, for example through

soil structure and fertility; nutrition cycle; soil retention; plant pollination; food sources; water supply and purification, etc. Agricultural activities and rural life activities are the main beneficiaries of environmental services in rural areas. For example, agriculture communities around the Batang Toru forest enjoys the important ecosystem services for their livelihoods. The majority of the people living around the Batang Toru forest depend on the ecosystem services from this forest. The economy of the local community around the Batang Toru forest is dominated by agriculture and agroforestry, with plant species depending on local conditions. However, the high level of forest fragmentation threatening the sustainability of ecosystem services, and it mainly occurs in the lower reaches of the watershed (Samsuri et al., 2019).

The Batang Toru forest in Indonesia have declined mainly due to anthropogenic activities. Central to anthropogenic activity is industrialization and people's dependence on goods and services from forests for rural livelihoods. This human disturbance has threatened the future functioning of biodiversity and forest ecosystems as well as their livelihoods. The negative impacts of deforestation on ecosystem services lead to

ecological conflict, Costanza et al., (2017) states that there are two sources of ecological conflict: (1) scarcity and limitations on the number of ecosystem services that can be provided and (2) the distribution of costs and benefits of providing ecosystem services. Studies have found that the relationship between socioeconomic and external factors in forest resource dependence is debatable (Dougill et al., 2012). Although ecosystem services are important as a source of livelihood for local communities and livelihoods in Batang Toru, there is insufficient information on the

ecosystem services, both the direct and indirect use values. To address the information gaps described above, it is necessary to conduct an assessment of forest ecosystem services in the Batang Toru forest and to understand community preferences for forest services that support agriculture.

RESEARCH METHODOLOGY

Our research was conducted in the villages around the Batang Toru forest, which spans across three distinct districts: North Tapanuli, Central Tapanuli, and South Tapanuli.

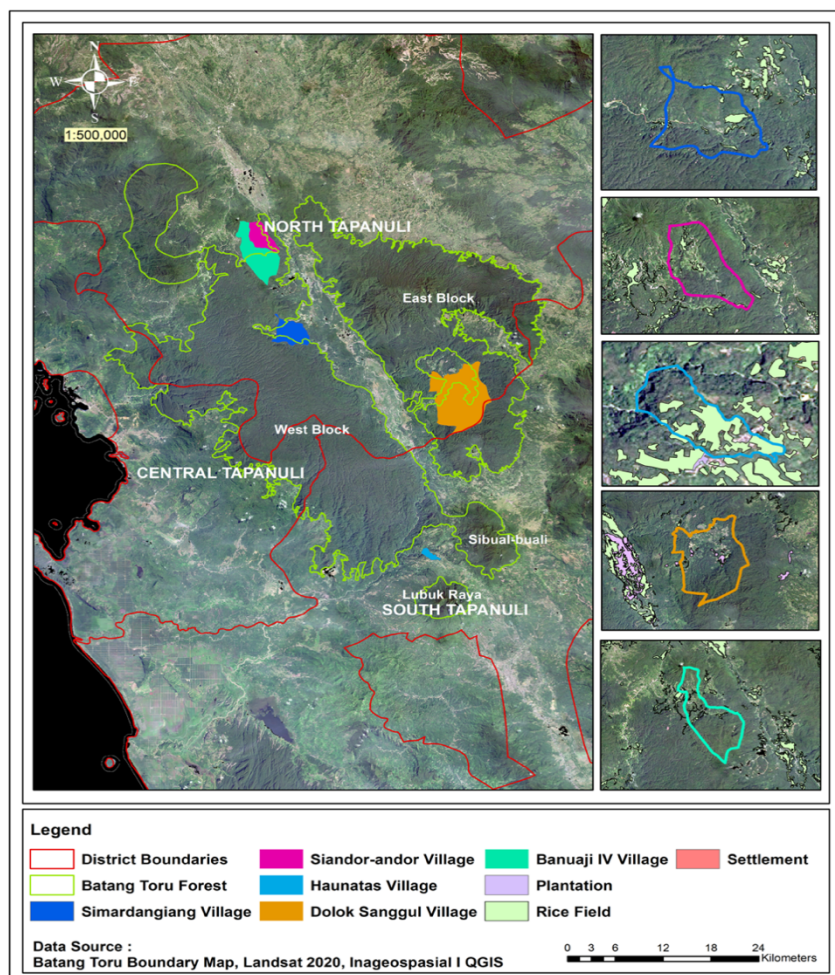


Figure 1. selected study villages around the Batang Toru forest

These districts share common historical, demographic, livelihood, and economic attributes. They are characterized by significant rural populations, with population densities ranging from 126 individuals per square kilometer in Central Tapanuli, 69 individuals per square kilometer in North Tapanuli, to 54 individuals per square kilometer in South Tapanuli. The specific research site can be visualized on the accompanying map (refer to figure 1).

Hence, the research location was chosen to primarily focus on the villages surrounding the Batang Toru forest, where the community had a strong reliance on the ecosystem services

provided by the forest for their agricultural activities. The proximity of the villages to the Batang Toru forest played a crucial role in determining which villages were selected for the study, considering their agricultural dependency on forest services. Moreover, these villages were representative of the communities situated at the forest's periphery, situated along the upstream of the Batang Toru watershed (DAS Batang Toru), which held significant importance for conserving forest ecosystem services for agriculture within the region. The data pertaining to the research village is presented in the following table.

Table 1. Research village

No.	Village	Sub-district	District	Total population
1	Simardangiang	Pahae Julu	Tapanuli Utara	188
2	Dolok Sanggul	Simangumban	Tapanuli Utara	140
3	Haunatas	Marancar	Tapanuli Selatan	50
4	Siandor-andor	Tarutung	Tapanuli Utara	130
5	Banuaji IV	Adiankoting	Tapanuli Utara	167
Total				675

The study population consisted of the research village communities selected based on their utilization of ecosystem services in the Batang Toru forest, totaling approximately 675 household heads across the four villages. The sample size for the study was determined using the Slovin Method with a 95% confidence level and an 8% margin of error. By applying the formula, the calculated sample size was 123 respondents, which was rounded up to 125 respondents. Household surveys were employed as a conventional data collection method in social sciences and economics research, aimed at gathering data on demographics, socio-economic status, consumption patterns, and behaviors. These surveys involved the administration of questionnaires or interviews to

households either in-person, over the phone, or online. The objective was to obtain information regarding farmers' preferences for specific ecosystem services, as well as their socio-economic and demographic characteristics. In the pursuit of the first research objective, which was to explore ecosystem services among farmers in the Batang Toru forest, researchers conducted descriptive analysis. This analysis provided an overview of the results and data analysis pertaining to how respondents perceived the benefits of ecosystem services for agriculture. To ensure the data's validity, interviews were complemented by questionnaires. The questionnaire responses were subjected to descriptive statistics, involving the tabulation of frequency counts and

conversion into percentages. Additionally, data analysis employed SPSS tools such as frequency analysis, exploration, and correlation.

RESULTS AND DISCUSSIONS

Smallholder farming system and ecosystem services assessed

Batang Toru forest has experienced degradation, especially in the lowlands, as a result of land conversion for various uses, including agriculture, plantation, and mining, which can pose a threat to the survival and sustainability of the Batang Toru ecosystem. There is still encroachment, illegal logging by migrants, illegal hunting and trading of wild

animals, as well as the use of the area for other reasons (such as mining, geothermal utilization, hydropower, and plantations) which require restoration and protection of the ecosystem in the area. The results showed that there are two types of utilization of provisioning services from farmers as their primary or side source of livelihood: food crops and the collection of non-timber forest products (see fig 2). The food crops themselves identified are paddy, banana, and peanuts. Meanwhile, 11 NTFPs were identified: benzoin gum, durian, candlenut, bitter bean, sugar palm, honey, bat, wild boar, rattan, and firewood. The purpose of utilization of all forest products is divided into household use, sale, or both.

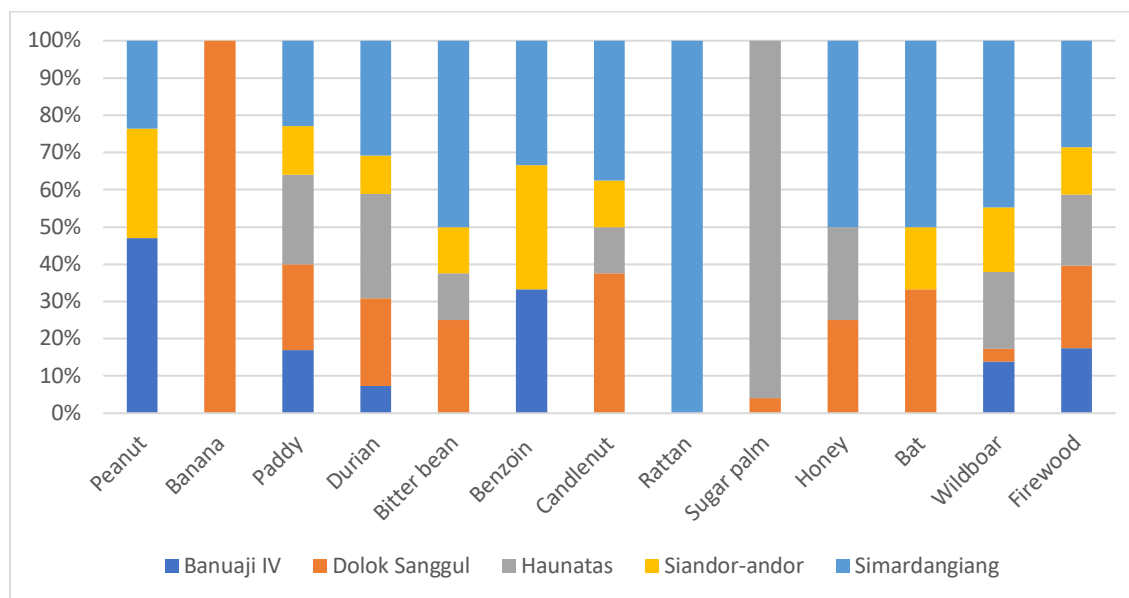


Figure 2. List of provisioning services surveyed

The system including monoculture farming, agroforestry, and rice fields. The majority of the farms visited are agroforestry systems with a variety of crop components, including both timber and non-timber forest products. In a brief, agroforestry is the incorporation of trees on a farm. Several farmers failed to indicate

agroforestry as a land use throughout the interviews. This suggests that farmers may not be aware that what they are doing is agroforestry or that they are concentrating on their crop-related activities. The farm's scattered with trees is the most typical pattern for the households who were studied (often the logged-

over areas). Several of these trees are dipterocarps, and it is against the law to cut them down. In other instances, the farmers had already planted wood trees, such as mahogany, Araucariaceae, and Podocarpaceae, as well as fruit (such as durian and bitterbeans), before deciding to cultivate agricultural crops. Agriculture is dominated by rice field and agroforest system including: 1) Benzoin-agroforestry system; 2) durian-bitter bean agroforestry system; 3) Sugar palm-candle nut-salacca agroforestry system, 4) banana monoculture system and 5) land rice-banana-peanut system. The main products of this system include rice (*Oryza sativa*), frankincense or benzoin (*Styrax benzoin*), sugar palm

(*Arenga pinnata*), durian (*Durio zibethinus*), petai (*Parkia speciosa*), candlenut (*Aleurites moluccana*), and banana (*Musa sp.*). Other fruits, medicinal plants, and wood are also produced in this system. Rice, medicinal plants, and wood were mainly produced for home use. None of the agroforestry systems is managed intensively because farmers do not have access to high-quality germplasm, technical support, infrastructure, and market information.

Farmer's perception on ES

The study examined the correlation between various variables and farmers perception on Batang Toru forest supporting ES for smallholders farmers.

Table 2. Factor influences Smallholders farmer;s perception with ES

Correlations		
Variable		Perception on ES
Land size	Pearson Correlation	.265**
	Sig. (2-tailed)	.003
Frequency to forest	Pearson Correlation	.264**
	Sig. (2-tailed)	.003
Farmer organization	Pearson Correlation	-.245**
	Sig. (2-tailed)	.006
Paddy farmers	Pearson Correlation	-.452**
	Sig. (2-tailed)	.000
Benzoin farmers	Pearson Correlation	.487**
	Sig. (2-tailed)	.000
Banana farmers	Pearson Correlation	-.168
	Sig. (2-tailed)	.061
Other NTFPs farmers	Pearson Correlation	.194*
	Sig. (2-tailed)	.030

** . Correlation is significant at the 0.01 level (2-tailed).
 * . Correlation is significant at the 0.05 level (2-tailed).

The question is “**Do you recognize the importance of Batang Toru forest delivering ES for smallholders farmers?**”. According to a Pearson correlation coefficient of .265** (see table 15), the results demonstrate a significant positive link between land size and farmers' perceptions on ES. The statistical significance

of this link is indicated by the ** symbol (p .01), indicating that it is unlikely that it happened by chance. According to a Pearson correlation value of .264**, variable frequency to forests is favourably connected with farmers' perceptions on ES. This correlation is also statistically significant (p < .01). Variable

farmer organization is negatively correlated with farmers perception. The Pearson correlation coefficient is $-.245^{**}$, indicating a statistically significant ($p < .01$) negative correlation between the two variables. Variable paddy farmers are negatively correlated with farmers perception. The Pearson correlation coefficient is $-.452^{**}$, indicating a statistically significant ($p < .01$) negative correlation. Variable benzoin farmers are positively correlated with farmer's perception, as indicated by a Pearson correlation coefficient of $.487^{**}$. This correlation is also statistically significant ($p < .01$). Variable banana farmers are weakly negatively correlated with farmers perception with a Pearson correlation coefficient of $-.168$. However, this correlation is not statistically significant ($p > .05$). Variable Other NTFPs farmers are weakly positively correlated with farmers perception, with a Pearson correlation coefficient of $.194^{*}$. The * symbol indicates that this correlation is statistically significant ($p < .05$). The statistical significance of this correlation is also .01 or more. Farmers' perception has a negative relationship with variable farmer organisation. Indicating a statistically significant ($p .01$) negative correlation between the two variables, the Pearson correlation coefficient is $-.245^{**}$. Farmers' perceptions and variable paddy farmers are negatively connected. Indicating a statistically significant ($p .01$) adverse connection, the Pearson correlation value is $-.452^{**}$. A Pearson correlation coefficient of $.487^{**}$ shows a favourable link between farmers of variable benzoin and their perception. In conclusion, the study suggests that farmer perceptions of Batang Toru forest's support for smallholders through ES are positively correlated with land size, frequency of forested areas, benzoin farmers, and farmers of other NTFPs, while farmer perceptions of ES

are negatively correlated with farmer organisation and paddy farmers. Furthermore, there is a weakly negative correlation between banana farmers and the perception of Batang Toru forest farmers on ES.

Farmer's view on Ecosystem Services for their agriculture

The findings of this study demonstrate the significant role of provisioning services in supporting the livelihoods of farmers in the Batang Toru forest area. The utilization of both food crops and non-timber forest products (NTFPs) was observed as primary or secondary sources of livelihood. These products were utilized for household consumption, sale, or both, reflecting their importance in fulfilling the needs and generating income for local communities. The agricultural systems observed in the study encompassed monoculture farming, agroforestry, and rice fields. Notably, most of the visited farms were practicing agroforestry systems, incorporating a diverse range of crop components, including both timber and non-timber forest products. Agroforestry, which involves the integration of trees within farming systems, has been recognized as a sustainable land use practice that provides various ecosystem services (Achmad et al., 2022; Benjamin & Sauer, 2018; El Tahir & Vishwanath, 2015; Yuliani et al., 2015). However, it is noteworthy that some farmers did not explicitly recognize their farming practices as agroforestry, possibly indicating a lack of awareness or a primary focus on crop-related activities. Previous studies have emphasized the challenges faced by farmers in adopting sustainable and intensive management practices, which require support from extension services, market linkages, and capacity-building programs (Dave et al., 2017; Garratt et al., 2019; Krause et al., 2013; Rawlins & Westby, 2013; Thi et al., 2016). Therefore,

improving farmers' access to these resources and support systems is crucial for enhancing the sustainability and productivity of agroforestry systems. Our findings highlight the significance of provisioning services, encompassing food crops and non-timber forest products, in supporting the livelihoods of farmers in the Batang Toru forest area. Agroforestry practices were prevalent among the studied farms, showcasing the integration of both timber and non-timber forest products within agricultural landscapes. However, the lack of intensive management practices in these agroforestry systems underscores the need for targeted interventions and support.

The results of this study contribute to the growing body of literature on farmers' perceptions of ecosystem services (ES) and their relationship with various variables. Consistent with previous research from Armenteras & Orlando Vargas, 2017; Dolisca et al., 2007; Jha & Gupta, 2021; Logsdon et al., 2015), our findings reveal a significant positive correlation between land size and farmers' perceptions of ES. Farmers with larger land sizes are more likely to recognize the importance of the Batang Toru forest in delivering ecosystem services. This association can be attributed to the larger resource base available to farmers with larger land sizes, allowing them to witness and benefit from a wider range of ecosystem services. Furthermore, our study emphasizes the role of direct experiences and interactions with natural resources in shaping farmers' perceptions of ES, aligning with previous research (Dewille et al., 2021). Farmers who frequently engage with forest resources exhibit more positive perceptions of the ecosystem services provided by the Batang Toru forest. These interactions likely enhance farmers' awareness of the ecological benefits derived from the forest and strengthen their recognition of the forest's

contributions to their well-being. In contrast, farmer organization displayed a negative correlation with farmers' perceptions of ES. This finding suggests that farmers who are part of organized groups or cooperatives may have differing perceptions regarding the forest's contributions to their well-being. The variations in perspectives, priorities, or access to information within these organized farmer groups may account for this negative relationship. Further exploration of the underlying factors influencing this association would provide valuable insights for designing targeted interventions and policies that promote a shared understanding of the forest's ecosystem services. Hence, our study provides insights into the complex relationship between farmers' perceptions of ecosystem services and various variables in the context of the Batang Toru forest. The positive correlations observed between land size, frequency of interactions with forested areas, benzoin farmers, and farmers engaged in other NTFPs emphasize the importance of these factors in shaping farmers' recognition of the forest's contributions. Conversely, negative correlations with farmer organization and paddy farmers indicate the need for targeted interventions and improved understanding within these groups. By comprehending the factors influencing farmers' perceptions, policymakers and practitioners can develop strategies to promote sustainable management and utilization of ecosystem services in the Batang Toru forest region, benefiting both farmers and the surrounding environment.

CONCLUSION AND RECOMMENDATION

In conclusion, our study underscores the pivotal role of provisioning services, specifically food crops and non-timber forest

products, in sustaining farmers' livelihoods in the Batang Toru forest area. The prevalence of agroforestry practices highlights the integration of timber and non-timber forest products within agricultural landscapes, while signaling the need for targeted interventions to enhance sustainability and productivity. Our findings reveal that farmers' perceptions of ecosystem services are influenced by factors such as land size, frequency of interactions with forested areas, and engagement in specific agricultural activities. Understanding these factors is vital for devising strategies to promote the sustainable management and utilization of ecosystem services in the region. Based on our study, we recommend bolstering support and resources for farmers practicing agroforestry, encompassing the provision of extension services, facilitation of market linkages, and implementation of capacity-building programs. It is crucial to raise awareness among farmers about the benefits of agroforestry and foster a shared understanding of ecosystem services within organized farmer groups and cooperatives. By implementing these recommendations, we can contribute to the sustainable utilization of ecosystem services, ultimately benefiting both farmers and the environment in the Batang Toru forest region.

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