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## Knowledge, Perception and Attitude towards Agroforestry Contribution to Environmental Conservation among Tambunan Community of North Borneo in Malaysia

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## ABSTRACT

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The integration approach between trees with crops and livestock in systematic land management through Agroforestry practices contribute to climate-smart agriculture for food security and climate change sustainability. Agroforestry system support crop diversification, which reduce farmer's vulnerability and increase rural livelihood. The rural communities residing in the Sunsuron division in Tambunan district, North Borneo's knowledge degree of Agroforestry and Agroforestry practices, contribution perception were assessed by conducting a random survey, visual aids, interview and observation. The questionnaire was randomly distributed to 167 residents, mainly from eight villages which are Sunsuron, Kinabaan, Tontolob, Pantai, Tombotuon, Kapayan Baru, Kipaku and Kapayan Lama. The majority of the respondents belong to the Dusun ethnic group. Most of the respondents practiced Agroforestry and only half of the respondents had heard the term Agroforestry. Although, Agroforestry practitioner knowledge on Agroforestry was at the moderate level, a third quarter of the practitioners have been practicing Agroforestry more than ten years. Majorities were practicing agrosilvopastoral including home garden, which maximize soil utilization and crop yield through crop diversification. Other Agroforestry systems that were applied at Sunsuron were silvopastoral and agrisilvicultural. Agroforestry practices contributions, which were selected by respondents, were determined by Factor Analysis and Principal Component Analysis (PCA) showed that ecological factors had the highest eigenvalues, 1.82 and followed by economic factors (1.28) and social factors (1.18). Respondents perceived that Agroforestry practices contribute towards sustainable land management in conserving environmental protection more than socioeconomic. Income from Agroforestry practices was not a significant contribution in the socioeconomic development of local communities in Tambunan because edible crops were mostly for their own consumption and only excess was sold to supplement their income. Agroforestry contributions ensure sustainable development in Tambunan by preventing environmental degradation, achieving food security and poverty alleviation.

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### Introduction

Recently, deforestation is a critical issue happening throughout the world and had caused unproductivity of forest goods and impact ecosystem services to communities (Gama *et al.*, 2013). One of the strategies for sustainable land use systems as a solution to the disadvantageous impact of forest degradation is the adoption of Agroforestry practices (Irshad *et al.*, 2011; Luumi *et al.*, 2016). Generally, the implementation of Agroforestry practices had progressed over the years around the world. Agroforestry practices play a vital role in providing various ecosystem services and indirectly having a positive impact on the environment (Jose, 2009;

Nair *et al.*, 2009). The combination approach between woody trees, crops, and livestock in well-organized management through Agroforestry practices could be conducive to climate-smart agriculture. Agroforestry is an agricultural production method that enhances the farmer resilience of prolonged climate change on the environment by utilization of trees for intensification, diversification, and supporting of farming systems (Nyaruai *et al.*, 2018).

The benefit of Agroforestry practices can classify into two category's value: tangible (economic and life-supporting) and non-tangible (sociocultural, ethical,

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spiritual, and aesthetic) (Islam *et al.*, 2015). This practice is a synonym or well known among rural communities to enhance their livelihood, poverty alleviation and also environmental stability (Hogarth *et al.*, 2013; Banyal *et al.*, 2015; Farooq *et al.*, 2018). The Agroforestry practices also contribute in terms of providing food resources for humans and animals, timber for firewood, medicinal plants, and soil enrichment (Sanchez, 2000; Kwesiga *et al.*, 2003).

Even though Agroforestry system is being practiced among rural communities in Borneo, Malaysia, they are unaware that they are actually practicing Agroforestry system (Aminuddin *et al.*, 2008; Azmy *et al.*, 2013). This scenario happens because most of the communities in the rural areas having unfavorable attitudes, less knowledge, and financial issues towards the Agroforestry practice (Farooq *et al.*, 2018). Education level is key-driven among rural communities in ensuring successful adoption of Agroforestry practices (Tian & Shi, 2017; Musa *et al.*, 2019). In ensuring a successful Agroforestry practice management, communities' support (Islam *et al.*, 2015) with cooperation by the government and local authorities is eminent. The governments and stakeholders should establish mechanisms for sharing knowledge by providing training or consultation on Agroforestry practices to enhance rural community understanding of Agroforestry implementation (Nyaruai *et al.*, 2018). The rural communities' knowledge can contribute in the decision making of forest resource management in terms of integration ecological, economic, and psychological decisions that related to Agroforestry practices (Reddy, 2011; Mukherjee, 2013).

In this context, knowledge, perceptions, and attitude have a significant role in adopting Agroforestry practices among communities (Meijer *et al.*, 2015). This study aims to determine the perception of communities' attitudes and knowledge towards Agroforestry contribution to environmental conservation in Tambunan, Borneo Island, Malaysia.

## Materials and Methods

### Study area

This study was conducted in the Tambunan district of Sunsuron division (5° 40' 26.47" N 116° 21' 53.58" E) and the study site area distance from Kota Kinabalu, the state capital of Sabah, Malaysia is approximately 80 kilometers. Tambunan is an area where it is a part of Crocker Range and has a mild tropical climate with the average lowest temperature is 19°C, and the average highest temperature is 31°C. Tambunan Valley is famous for the scenic terrace paddy fields that had inspired local people to reminisce Tambunan Valley as "Switzerland of

the East". The Crocker Range is the highest mountain range in Sabah with an average height of 1,800 meters that separate the west and east coast of Sabah (Geml *et al.* 2017). The highest point is Mount Alab at 1,964 meters located outside the protected park area, Crocker Range Park, where it is a very important water catchment for the west coast and the interior plain of Sabah (Geml *et al.* 2017). Crocker Range Park stretched over eight administrative districts, which are Beaufort, Keningau, Papar, Penampang, Ranau, Tambunan, Tenom, and Tuaran district.

The Department of Statistic Malaysia (2019) reported that the population in Tambunan was estimated at approximately 42,600 people in the year 2018. The majority of the local communities in Tambunan belong to the Dusun ethnic group. There are 7 Divisions (*Mukim*) in Tambunan: Lintuhun, Monsorulung, Sunsuron, Toboh, Nambayan, Patau, and Kirokot. However, only eight villages in Sunsuron Division were selected for this study: Sunsuron, Kinabaan, Tontolob, Pantai, Tombotuon, Kapayan Baru, Kipaku, and Kapayan Lama. Based on the conducted preliminary observation, Sunsuron Division was selected for this study because local communities residing in Sunsuron division had been identified practicing Agroforestry systems compared to other divisions. Local communities at the Sunsuron division were engaged in agricultural and husbandry activities to support their daily life. Besides, local communities in Sunsuron division are composed of rubber tappers that grow rubber trees on the hill slopes as a source of income to enhance their socioeconomic.

### Data collection

Solvin's formula had been used to determine the number of respondents selected based on the population of the study area (Sevilla, 1998). A total of 167 local communities had been chosen as respondents among a total of population, 602 people in Sunsuron division (Valerie, personal communication 2018). Solvin's formula as follows:

$$n = N/(1+Ne^2)$$

where, n = sample size, N = size of population, e = margin error

The data collections had conducted observation, interviews and random surveys with the assistance of visual aid regarding Agroforestry practices between July and August 2018. The purpose of visual aids is to enhance a better understanding of a conceptualization of Agroforestry practices to the respondents before answering the questionnaire. There are four sections in the questionnaire comprising of the sociodemographic

of the household, Agroforestry level of knowledge, Agroforestry contribution perception, and problem on Agroforestry practices. The questionnaire was written in the Malay Language.

#### Data analysis

The data obtained from the data collected were analyzed using IBM SPSS Statistics software version 25. The data were analyzed based on descriptive and statistical analysis. The factor analysis was used as a technique in items statement analysis for an attitudinal index to determine the perception's local communities towards the contribution of Agroforestry practices and Principal Component Analysis (PCA) was used as a factor extraction method (Luumi *et al.*, 2016). It can identify the eigenvectors that contributed most of the underlying factors on the eight itemized statement in this study. Principal Components Analysis (PCA) used as a factor extraction method in factor analysis. The eigenvalue of the extracted factors was determined the selection of the item/variables. The determination of the score for the attitudinal concept/latent variable was based on the relative factor loading of the items when items were falling under the factor with the highest eigenvalue, which is usually more than 1.0 (Luumi *et al.*, 2016). Items were contributed significantly to the total score of that factor when the factor loading had a higher value. A value greater than 0.3 for factor loading of the statement was assumed to be a significant factor in the determination and selection of index variables (Simon *et al.*, 2011).

## Results

#### Respondent's sociodemographic

The respondents were male (58.1 percent) and women, 41.9 percent in this study (Table 1). The survey participants' genders were almost equal in male and female numbers. This study finding was consistent with previous studies that men were more involved in Agroforestry activities compared to women (Keat *et al.*, 2018; Nyaruai *et al.*, 2018). Most of the local communities at Sunsuron division are Dusun ethnic groups and Christian faith (Table 1) where they work in harmony with the environment and agricultural activities (Augustine & Dolinting, 2016). More than half of the respondents were between 20 to 49 years old. This age group is crucial as influential practitioners to develop a good awareness and an attitude among communities in setting up competence in Agroforestry practices (Nyaruai *et al.*, 2018). The majority of respondents had at least completed secondary school, whereby the percentage respondents had completed secondary school (46.7 percent) and tertiary education (33.5 percent). The age and education of the respondents played a vital role and had a significant relationship with

their awareness regarding Agroforestry practices (Nawaz *et al.*, 2016). Based on the results, not surprisingly, the communities of the Sunsuron division were working as government workers because they had a good education. The majority of respondents were married and also having side jobs as farmers and run a small business to supplement their socioeconomic. Out of 167 respondents, only 15 respondents were not involved with Agroforestry practices. The Agroforestry practitioners (71.1 percent) have a monthly income more than RM1, 000. Most of the income from Agroforestry revenue was below RM500 because the produce harvested by respondents who were involved in Agroforestry practices were mainly for personal use only as food resources to the local communities (Susila *et al.*, 2012).

#### Agroforestry knowledges' level

Previous literatures revealed that rural communities were unaware or have not heard the term "Agroforestry"; even though they practice Agroforestry system in their daily life (Musa *et al.*, 2019). The Dusun ethnic group is traditionally involved in agriculture sector in Crocker Range and Tambunan Valley is renowned for rice subsistence farming with not only paddy field cultivation but hill paddy cultivation (Augustine & Dolinting, 2016). Half of the respondents (59 percent) at Sunsuron division, Tambunan had heard the term Agroforestry (Figure 1a). Although Agroforestry practitioners' knowledge of Agroforestry was at a moderate level (Figure 1b), a third quarter of the practitioners have been practicing Agroforestry for more than ten years. This scenario happens because of the lack of knowledge among the local communities on Agroforestry practices due to less exposure and involvement of communities towards Agroforestry practices (Molua, 2005; Islam *et al.*, 2015). Their involvement in the adoption of the Agroforestry practices could fulfill the current issues between demand and supply in food production (Franzel *et al.*, 2001; Banyal *et al.*, 2015).

#### Agroforestry system and practices

Most of the respondents in this study were practicing agrosilvopastoral (Figure 2) that can maximize land use and enrich revenue compared to the other Agroforestry systems (Franzel *et al.*, 2001). The agrosilvopastoral system is a combination of three components, namely tree, crop, and livestock. The local communities at Tontolob Village grew mango tree, paddy fields, and poultry at their home's surroundings (Figure 3a). Meanwhile, the agrisilvicultural system at Kipaku Village is a combination of trees and crops, where rubber trees are grown in hilly areas and paddy fields on flat lands (Figure 3b).

Table 1. Respondent's sociodemographic at Sunsuron division, Tambunan, Sabah

Variables		Frequency	Percentage (%)
Gender	Male	97	58.1
	Female	70	41.9
Ethnic	Kadazan	31	18.6
	Dusun	124	74.3
	Murut	7	4.2
	Malay	3	1.8
	India	1	0.6
	Bugis	1	0.6
Religion	Islam	16	9.6
	Christian	151	90.4
Age	≤ 19 years	3	1.8
	20-29 years	46	27.5
	30-39 years	44	26.3
	40-49 years	43	25.7
	50-59 years	28	16.8
	≥ 60 years	3	1.8
Education Status	No Formal Education	16	9.6
	Primary School	17	10.2
	Secondary School	78	46.7
	Cert./Diploma/Degree	56	33.5
Marital Status	Single	34	20.4
	Married	108	64.7
	Divorced/Widowed	25	15.0
Job	Public Servant	43	25.7
	Private Sector	39	23.4
	Self-employment	27	16.2
	Retired	18	10.8
	Not working	40	24.0
Side Occupation	Farmer	89	53.3
	Small Business	32	19.2
	Others	46	27.5
Monthly Income from Agroforestry Practitioners	≤ RM999	44	28.9
	RM1, 000 - RM1, 999	34	22.4
	RM2, 000 - RM2, 999	40	26.3
	RM3, 000 - RM3, 999	28	18.4
	≥ RM4, 000	6	3.9
Income from Agroforestry revenue	≤ RM499	141	92.8
	RM500 - RM999	5	3.3
	RM1, 000 - RM1, 499	4	2.6
	RM1, 500 - RM1, 999	1	0.7
	≥ RM2, 000	1	0.7

Table 2. Factor analysis of agroforestry practices contribution

Items	Factor Loadings	Mean	Standard deviation	Eigenvalue	Variance	Cronbach's Alpha
<b>Factor 1: Ecology</b>				1.82	20.29	0.45
Agroforestry practices can reduce maintenance costs at crops area like the weeding cost.	0.77	3.25	1.36			
Agroforestry practices can maximize the use of land.	0.72	3.4	1.3			
Agroforestry practices can diversify crops.	0.49	3.23	1.27			
<b>Factor 2: Economic</b>				1.28	14.27	0.24
Agroforestry practices can generate income.	0.81	3.37	1.24			
Agroforestry practices can enrich the soil.	0.57	3.37	1.32			
<b>Factor 3: Social</b>				1.18	13.15	0.36
Agroforestry practices can maintain the environment quality.	0.82	3.43	1.25			
Agroforestry practices can provide a food resources.	0.63	3.46	1.2			

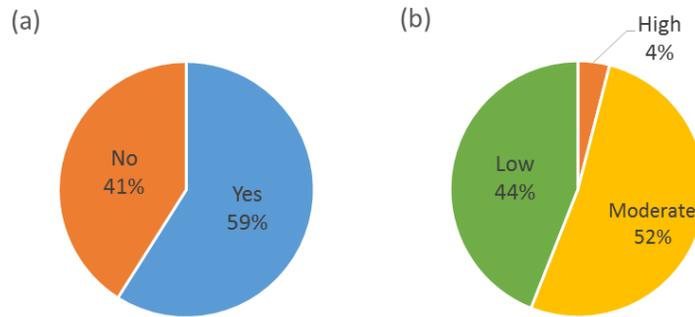


Figure 1. (a) Respondents awareness on the word "agroforestry", (b) Knowledge level on agroforestry practices

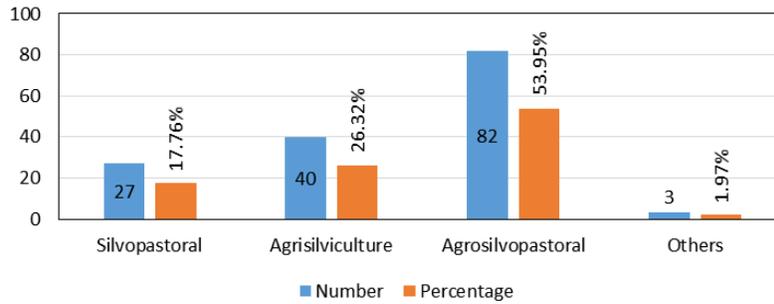


Figure 2. Agroforestry system at Sunsuron division, Tambunan, Sabah

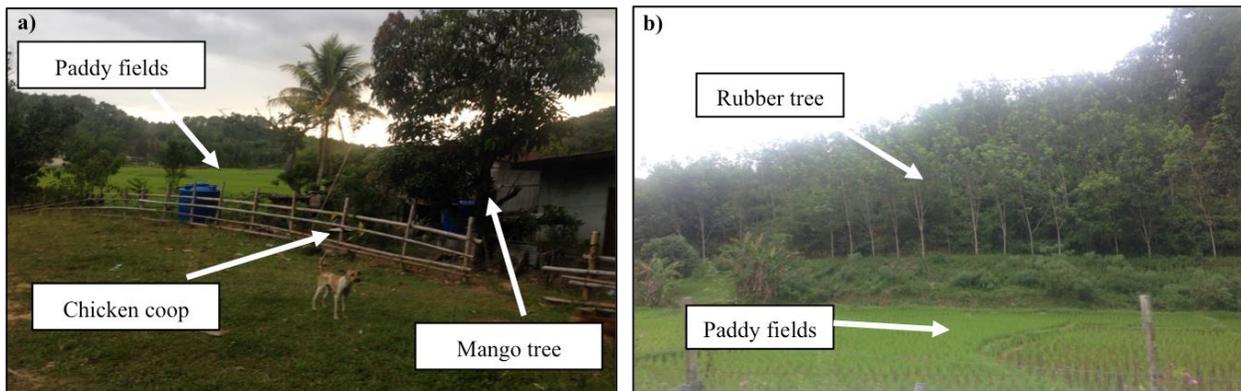


Figure 3. (a) Agrosilvopastoral system at Tontolob Village, (b) Agrisilvicultural system at Kipaku Village

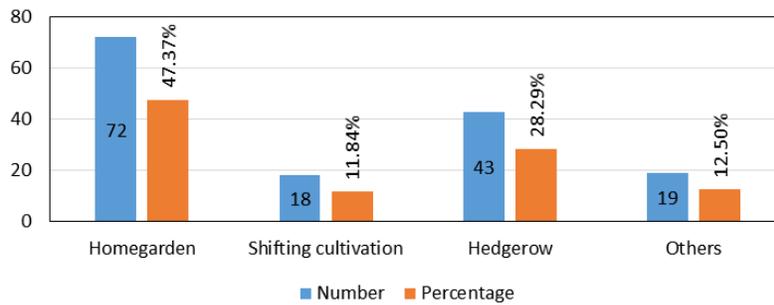


Figure 4. Agroforestry practices that were exercised by local communities at Sunsuron division, Tambunan



Figure 5. Homegarden at Kipaku Village

These findings contrast with previous study conducted by Musa *et al.* (2019) in which the agrisilvicultural were more applied by the Agroforestry practitioners in Merotai Besar, Sabah because it can increase the source of income and more practical to manage compared to the other systems. The Dusun ethnic group in Tambunan Valley engaged in agricultural activities generate extra income in a very creative way by selling surplus crops at the local farmers' market more known as 'Tamu' by the locals. Most of the respondents were practicing home gardens followed by hedgerow, shifting cultivation, and other systems (Figure 4). Tambunan communities practiced home gardens (Figure 5) because it is easier to practice at their homes compared to shifting cultivation, which requires the communities to open new areas for agricultural activities. Paembonan *et al.* (2018) reported that the home gardens practiced around the house could generate income to the rural communities in the range of 43.2 to 49.06 percent. The other Agroforestry practices in this study refer to aquaforestry (the combination of trees and aquaculture), apiculture (the cultivation of bees on a commercial scale for the production of honey) and Taungya (combines the production of both arable and forest tree cops simultaneously on a piece of land). For promoting Agroforestry practices, Taungya was also practiced in Tombotuon Village, where *Acacia mangium* were planted by locals in combination with bananas and *rambutan* trees on their farmland.

#### *Perception of local communities towards agroforestry practices contribution*

Factor Analysis determined Agroforestry practices, contributions, which were selected by respondents, and Principal Component Analysis (PCA) showed that ecological factors had the highest eigenvalues, 1.82 and followed by economic factors (1.28) and social factors (1.18) (Table 2). The type of factor selected based on the majority of behaviors found in each section (Suziana, 2017). Respondents perceived that Agroforestry practices contribute towards sustainable land

management in conserving environmental protection more than socioeconomic (Nawaz *et al.*, 2016). The rural communities' perceptions towards agroforestry contribution were more focusing on the ecology factor that these practices could highly utilization of unproductive lands (Franzel *et al.*, 2001; Banyal *et al.*, 2015) besides reducing the maintenance cost at crop area and diversify crops. The rural community's attitude towards land resource and forest conservation (McGinty *et al.*, 2008; Luumi *et al.*, 2016) was positively related to adoption Agroforestry practices to achieve climate-smart agriculture (Table 2). Besides, the rural community discovered economic factors in generating their income are contributing to adoption Agroforestry practices (Islam *et al.*, 2015; Luumi *et al.*, 2016; Farooq *et al.*, 2018). Respondents observed had a positive attitude towards commercialization with selling the crop yields rather than for home consumption (Luumi *et al.*, 2016).

#### **Conclusion**

Agroforestry practices is one of the agricultural activities that are contributing to environmental, economic, and social benefit to rural communities. This study discovers the perception and level of knowledge of rural communities towards Agroforestry contribution to environmental conservation. Poor dissemination of Agroforestry information and lack of awareness among rural communities cause the adoption of Agroforestry not able to be fully implemented even though they acknowledge the Agroforestry contribution to their livelihood. Government and policymakers should play the role of highlighting these issues through the development of Agroforestry training program to rural communities in the future. The success of Agroforestry adoption requires community support because the perception, awareness, and knowledge would have a significant impact. In conclusion, smart climate agriculture through Agroforestry practices can ensure the sustainability of environment conservation in Borneo, Malaysia.

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## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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