

## **Indigenous Management and Sustainability of Forest Gardens in Peninsular Malaysia: Implications for Conservation**

### **Abstract**

Forest gardens in Malaysia have been practiced by the indigenous communities for generations. However, limited study has been conducted on forest gardens in Malaysia especially on the indigenous management and its sustainability. This study examined the indigenous management and sustainability of forest garden in peninsular Malaysia specifically in Selangor. Data were collected from seven indigenous villages practising forest gardens using 86 household surveys, seven focus group discussions, and four key informants' interviews. Indigenous management was explored following story telling approach while sustainability was assessed by using the five major criteria of Globally Important Agricultural Heritage Systems (GIAHS). Results show that the main activities conducted on the forest gardens were maintenance (87% of the participants) whereby 64% of the participants did not utilise chemical fertilizers or pesticides. It was also found that 62% of the participants that maintain the forest gardens were found to be men. Moreover, 72% of the participants independently maintain the forest gardens as they did not receive any support from government or NGO for the forest gardens. Fruit harvests were found to be used for sale (66%) whereby Durian was the popular fruit since 95% of the participants cultivate it. Forest gardens were found to be the main source of their food and livelihood security whereby 44% of the indigenous communities rely on forest garden for income. The forest gardens provide various harvests whereby 63% were inherited from their families. The forest gardens also supported agrobiodiversity due to the mixed cropping approach of the participants. The forest garden practices are preserved by local and traditional knowledge of the indigenous communities as it is passed down verbally and practically through generations. The culture and social values of the indigenous communities are impacted by the practices of the forest gardens via taboo and rules. Ultimately, these practices make the forest gardens a unique landscape. Main challenges of the preservation of forest gardens were discovered to be the abandonment of forest gardens due to younger generations not taking over the forest gardens which also led to a loss of the traditional agricultural knowledge. Moreover, the forest gardens constantly faced developmental encroachment due to land ownership issues whereby the indigenous communities do not have grants on the forest garden lands. This led to the destruction of forest gardens by organizations that bought the land. There is a need for strong collaboration between indigenous communities and governmental agencies for the sustainability of forest gardens. Moreover, awareness on the harvests and benefits of forest gardens are vital for not just the indigenous communities but also the public via media exposure to conserve the forest gardens.

## Chapter 1: Introduction

Globally, a unique gardening and management of forest resources were utilised to enhance economic, social, and environmental benefits with less degradation to the environment. This gardening system is commonly known as the forest gardens ("FG") or agroforestry (i.e., a cross between low-managed forests and specialized tree crop plantations), and was practiced by rural households, especially by the indigenous communities (Wartman, Acker and Martin, 2018). It is also described as a land-use system that combines woody elements with agricultural cropping and livestock systems (Mupepele and Dorman, 2022). FG expands the agroforestry application by including land-use and life systems created mainly with diverse, multi-layered perennials and self-sowing annuals that mimic the structure of natural forest, woodland, and savannah ecosystems which provide multiple services to help humans meet their needs locally for food, medicine, shelter, recreation, fibres, dyes, fodder for animals, fuel, and more (Wartman et al, 2016).

Tropical regions such as Indonesia, Brazil, Africa, Malaysia, etc have been using the FG for millennia whereby communities in certain countries have been relying on this system to form part of their major economic activity (Belcher et al, 2005). In fact, FG are customary to communities who adapted in forest ecosystems all over the world and are not new (Wartman, Acker and Martin, 2018). The FG creation used the knowledge of the local communities ensuring the conservation of plants, land and water is achieved as their livelihood depends on it. For instance, in Indonesia, the Dayak community (a local indigenous community) utilizes FG as their food production for consumption (mainly fruits), medicines, firewood, timber, commodities for trade, and other products required for local ceremonies or rituals (Mulyoutami, Rismawan and Joshi, 2009). There are multiple ways to construct an FG such as 1. A modified wild forest (a process of modifying the environment of the forest in favour of the production of valuable products), 2. Forest garden within a forest ecosystem (long-term interaction between the natural forest cycles within an existing forest and human agricultural practices), 3. Permanent forest culture (domesticated forests are utilized with multiple productions and economic functions managed in a long term), and 4. Rotational systems (land is used for seasonal agriculture purposes by clearing originally forested land) (Belcher et al, 2005). FG concentrates on the needs of humans by acquiring abundant and diverse crop productions. Moreover, FG land self-fertilizes, self-maintains, and self-renews each time it experiences yields and degradation (Wiersum, 2004). Not only that, but FG shows potential to restore food supply chain of the communities in mutual symbiotic relationship with it due to its framework of prioritising people, land and water. The structure of FG could improve via practices that are environmentally renewable, fitting to the regional ecology, adaptable to pests, diseases, and drought as well as economic changes (Wartman, Acker and Martin, 2018).

Indigenous communities or locally known as *Orang Asli* are the natives that roam the remote areas in Malaysia which comprises 18 ethnically and linguistically distinct sub-groups (Lin, 2008). The 2020 Population Survey of the Jabatan Kemajuan Orang Asli ("JAKOA") estimated the total population of

Orang Asli in Peninsular Malaysia at 206,777. The indigenous communities in Peninsular Malaysia are categorised into three main ethnicities which are Senoi (55.09% of the population), Melayu-Proto (41.97% of the population) and Negrito (2.94% of the population) (JAKOA, 2022). The cultures of these indigenous communities are based on close relations to nature, shared ownership of land and water resources, mutual interdependence, and strong kinship structures. However, there is a general association of indigenous minorities with low socio-economic status, especially in terms of income and education due to the combination of both state interventions and disruption from wider economic changes (Mat Dong et al., 2022). Agroforestry practices such as forest gardens are often linked with indigenous communities to maintain their subsistence-based livelihood (Ng, Nath and Jose, 2018). Thus, this research paper provides a study in understanding the indigenous management and sustainability of forest garden systems in Selangor, Peninsular Malaysia as well as the implications for conservation.

### **Objectives of this study**

The literature review shows that limited study on FG were conducted in Malaysia as well as on the indigenous management and sustainability of forest gardens in Malaysia. One of the few available studies reported on indigenous management and sustainability of FG was in Sarawak whereby the research focused on the impact of forest gardens at community levels. It was found that FG assisted the people to overcome poverty and marginalization by building capacity via agroforestry programmes in collaboration with the Forest department. In the study, the agroforestry project was conducted at Sabal Forest Reserve whereby residents of 6 longhouses participated in the integration of but not limited to cash crops, livestock, fishpond and poultry with existing tree crops or forest trees. The agroforestry programmes were designed to reduce shifting cultivation inside a permanent forest which was achieved and increase the income of the participating local community which was partially met (Kendawang, 2009). A study discovered that the seedlings of the tropical tree, *S. laxa* was greatly impacted by the management of the local community in the pulau as it had fewer predation from small mammals, lower pollination rate and higher mortality due to forest fragmentation in the pulau compared to the forest system. The study was conducted on the reproductive and regeneration processes in a tropical tree at a pulau managed by local communities and in a primary forest (Takeuchi et al, 2013). Another study focused on the management, sustainability and contribution of indigenous agroforestry practices to household economy whereby it was discovered that FG have a positive effect on their economy as it brought them income based on their productivity and the FG is sustainable since it does not use any chemical fertilizers and has been adapted to their culture and tradition for generations (Ng, Nath and Jose, 2018). Other researches conducted also discovered that agroforestry practices reduced surface erosion as it incorporates cover crops with trees compared to monoculture plantations with no ground cover (Sidle et al, 2006) while agroforestry practices provide food security for the wellbeing of the local communities despite them not knowing that their methods were agroforestry practices (Musa, Lile and Mohd Hamdan, 2019). Moreover, it was discovered that FG have a higher carbon stock compared to monoculture plantation albeit lower than natural forest system (Awang Besar et al, 2020) while FG with timber trees have a higher carbon stock

compared to forest gardens with smaller trees or crops planted as understory crops (James et al, 2022). However, the communities conducting FG with timber lack formal timber market access due to legal constraints, limited capacity building and lack of market information (Ngu and Bahar, 2022). Furthermore, FG were able to provide habitats for some rainforest mammals provided there is sustainable hunting (Cheok Ka Yi et al, 2021) while traditional forest-related knowledge faced rapid erosion due to expanding market economies influence, media influences and other policies that limits traditional opportunities for traditional forms of agricultural management (Parotta et al, 2009). From the various studies mentioned, the compiled findings shows that FG has an impact on the economy, social and environmental aspects of the communities in Malaysia despite facing multiple issues. Hence, this research study is vital to discover whether FG managed by the indigenous community and its sustainability greatly benefits local communities, especially indigenous communities in Malaysia and the implications of its conservation.

The objectives of the research are to: (1) Understand the indigenous management of forest garden and, (2) Assess the sustainability of forest gardens in Peninsular Malaysia. The findings from this research study can be useful for the conservation of sustainable agricultural system in Malaysia.

## **Chapter 2: Literature Review**

### ***Forest gardens in Malaysia***

In Malaysia, the forests have a high richness of flora and fauna species and are the most biodiverse and complex ecosystems (MyBIS, 2023). Even though commercial agroforestry known as the Taungya system was introduced as a method to control shifting cultivation in the 1950s (Fauzi et al, 2006), extensive and intensive clearance of forest land for mono-culture agricultural development since the 1960s has led to the environmental degradation and the loss of timber resources as well as the indigenous biodiversity of flora and fauna. Not only that but the rapid increase in population, industrial mono-cropping and urban development led to the significant decrease of land availability for forest farming and small-scale agricultural food production (Ibrahim, 2010). This shows that mono-culture agricultural practices are unsustainable in the long run without an increased input investment. It is also burdensome to small-agricultural farmers who has a significant contribution to the agricultural sector despite constituting most low-income groups and face challenges due to production inefficiency caused by uneconomic land size, fluctuation in price of commodities (e.g: rubber, pepper, cocoa and oil palm), escalating cost of production, continuous low productivity and household income (Ahmad, 2001). Thus, agroforestry is often a suitable alternative land use system for agricultural smallholders (Noor, 2012). In Malaysia, forest gardens are considered an integrated productive-protective ecosystem of land use and has been practiced for centuries. Coffee plantations integrated with rubber trees were the first commodity crop of forest gardens introduced in Malaysia in the 1920s (Ahmad, 2001). For the indigenous community, this agroforestry system is inclusive of forest gardens, home gardening, shifting cultivation, gathering and trading of forest products especially non-timber forest products (NTFPs), fishing and hunting activities (Ng, Nath and Jose, 2018).

### ***The importance of Forest Garden ("FG")***

Even though FG offers benefits at local and global levels, this management model is continuously ignored by developers and policymakers for several reasons (Wiersum, 2004). One of the reasons is that some question the ecological sustainability, economic and profitability of FG and argue that the agricultural system are only stages of prehistoric agricultural system transitioned from a hunting/ gathering era to current agriculture or silviculture system (Sauer 1952; Harris 1972; Purseglove 1991; Homma 1992). Moreover, FG rarely offers long-term employment opportunities and is often bested by wage employment offered by monocultural intensive plantations. The perception of indigenous practices of agricultural development and forest resources are also regarded as "primitive" or as an environmental threat which causes the values of such a system to be ignored. These perceptions led to the lack of acknowledgment from officials as well as the lack of technical support for FG. Furthermore, governmental policies, regulations, and development plans tend to favour intensive and monoculture land management systems leading to the abandonment of FG by some communities because of not benefiting from technological innovations of agriculture or forestry as well as not being aided by policy instruments (Belcher et al, 2005).

However, some researchers assert that FG can fulfil the requirements of economic, ecologic, and social criteria and are greater than other non-forest gardens systems (Padoch and Peters 1993; Mi-chon and de Foresta 1999), offers the values of productivity and biodiversity (Van Noordwijk et al. 1997), and adapt to the economies of rural households. All forest garden systems provide vital supplies and wages as well as a system for accumulation of capital, risk spreading, low labour, and even evidence of land tenure for the communities involved (Belcher et al, 2005). This is because the diverse plantations in FG offer flexibility and resilience to changing market conditions compared to intensive plantations. This is crucial for rural areas in the developing world as the diverse income sources and seasonal harvesting patterns help to overcome the difficulty of capital accumulation, undeveloped saving habits, and unavailable credits (Sharma et al, 2016; Belcher et al, 2005).

The limitation of managers of FG to accumulate capital makes them vulnerable to risk. Thus, FG's ability to produce diverse sources of income and products assists the managers to spread the risk compared to monoculture plantations which tend to have higher risk as there are no alternative products and income sources (Belcher et al, 2005). Moreover, customary rules regularly define the land ownership of individuals even though this system is rarely acknowledged in national legal systems. Based on the rules, having an FG whether it is new or inherited acknowledges the individual(s) as owners of the land used for the FG. Thus, FG is a useful tool to help indigenous communities to establish property rights over certain land areas (Belcher et al, 2005).

### ***Sustainability of forest gardens***

Sustainability is defined as meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. It is governed by three principles which are environment, social, and economy whereby a balance between the principles must be achieved to obtain

sustainability (Emas, 2015). Based on the literatures reviewed, FG has a strong positive impact on sustainability by balancing the three principles. Firstly, FG has the potential to promote reforestation. The cultural practices of the community in an FG were discovered to have the ability to restore forest habitats and promote biodiversity instead of degrading it as many believed (Kohsaka, Ito, Miyake and Uchiyama, 2021). This is because as managers of FG, the local community possesses rich knowledge of the local environment, culture, and traditions granting them the ability and experience of addressing local issues (Su, Sun, Min and Jiao, 2018; Santoro et al., 2020; Guo, García-Martín and Plieninger, 2021). FG also contribute to the species richness of the area as local communities diversify their crop productions and animal farming (Ren et al., 2018). Moreover, FG can conserve not only the original landscapes of the forested area but also the unique landscape created from long-term human and nature interaction (Min, 2021; Santoro et al., 2020; Venturi et al., 2021). Further protection of the unique landscapes can be obtained from the potential support of the government and policymakers for tourism purposes (Kohsaka, Matsuoka, Uchiyama and Rogel, 2019). Soil fertility in an FG is maintained by the natural processes of nutrient cycling, tree cover, and plant regeneration. As FG has a diverse structure and its forest cover resembles a secondary forest, FG can perform multiple forest functions such as supplying forest products, ecological function, conservation of biodiversity and soil, management of the watershed, and sequestration of carbon (Li et al., 2016, Santoro, Venturi, Bertani and Agnoletti, 2020). FG also has the potential to combat climate change as it sequesters carbon (Maharjan et al, 2021; Santoro, Venturi, Bertani and Agnoletti, 2020; Min and Zhang, 2019). Indigenous crops in an FG also have more resiliency towards climate change compared to conventional crops (Reyes, Miyazaki, Yiu and Saito, 2020; Jiao et al., 2016). Although there is a risk that decreasing opportunity for the development of FG leads to a decline in the population of the FG site. Local communities residing in the area can combat this issue by transitioning undesirable agricultural systems or farmland to the forest production of non-timber forest products (NTFP). Moreover, this transition reverses the degradation of biodiversity trend at the landscape level while also providing fundamental supporting services. The afforestation of an abandoned FG site as well as sustainable agricultural practices of an FG leads to more cultural ecosystem services, production of NTFP, and water retention (Kohsaka, Ito, Miyake and Uchiyama, 2021, Li et al., 2016; Scott Jansing, Mahichi and Dasanayake, 2020).

In terms of the social principle, FG assist in the preservation of traditional forest practices and traditional agricultural knowledge which is important to support the management of sustainable forests and maintain the cultural identity of local communities (Min, Zhang, Jiao and Sun, 2016; Jiao and Min, 2017). This prevents the further deterioration of ecosystems and the decline of rural populations and their culture. Cultural practices of an FG are also found to be the main source of communication to pass down traditional agricultural knowledge (Yuan et al, 2014). Moreover, cultural practices of an FG can attract tourists as proven when local communities in Noto and Kunisaki, Japan manage to attract tourists by promoting their cultural activities such as beetle catching and trails for forest hiking (Kohsaka, Ito, Miyake and Uchiyama, 2021). This is further evidenced in the studies of Kajihara et al (2018) who discovered that the

culture of local communities in an FG plays a large part in attracting foreign visitors. However, in the same paper, it was revealed that traditional agricultural knowledge of the local communities in the FG does not contribute at all to attracting foreign visitors. This can be because cultural practices of the local communities are in the form of entertainment such as festivals, dance, songs, theatre, etc which intrigues foreign visitors' interests as compared to traditional agricultural knowledge that may only attract environmental enthusiasts (Reyes, Miyazaki, Yiu and Saito, 2020). FG also provides equal employment opportunities to the local communities and empowers women (Zhao et al, 2021; Song, 2020) by raising their status and education level (Shen, Huang and Chou, 2021).

Not only that, but FG also provides sources of income to the local community from the diverse crop harvest and tourism potential (Wang et al., 2021; Chen, Qiu, Usio and Nakamura, 2018; Sekine, 2021). This is most evident in Japan whereby the FG provides abundant crop harvests which local communities use for self-consumption and the agricultural market (Yang et al., 2017; Liu, Min and Yang, 2018) as well as increases tourism in the area. The local community even took advantage of the tourism potential and set up various local activities such as educational environmental lectures and cultural activities to not only increase income for themselves but also to promote greater awareness of sustainability of the FG (Kohsaka, Ito, Miyake and Uchiyama, 2021). Tourism is also considered to balance development and conservation which addresses the challenges for the younger generation to continue maintaining the inherited traditional agriculture system and landscape that is threatened with urbanization and reduce rural migration (Su, Sun, Min and Jiao, 2018; Santoro, Venturi and Agnoletti, 2020). The increase in tourism to FG will also lead to an increase in the country's economy especially for developing countries as tourists do not only visit FG sites but also other touristic attractions that the country has to offer (Kajihara et al, 2018). Engaging in FG specifically on NTFP production based on locally embedded traditional knowledge in afforested forests can also be more economically efficient compared to growing crops on undesirable farmland (Kohsaka, Ito, Miyake and Uchiyama, 2021).

### ***Management of FG***

Based on various literature reviews, FG management depends on the local and traditional knowledge of the surrounding community. This is because FG's technical simplicity is supplemented with the great use of natural processes which requires the community to have a strong knowledge of natural ecosystems especially of forest dynamics (Momberg 1993; Aumee-ruddy 1994). Traditional agricultural practices are commonly used to ensure continuous crop harvests for the local communities. For instance, local communities use organic fertilizers such as cover crops or mulch to preserve the fertility of the FG soil instead of chemical fertilizers (Shobri, Sakip and Omar, 2016). This is due to the integrated management practices that prioritise the natural process of regeneration of plants resulting in a high level of forest recovery in terms of biodiversity. FG qualities and functions may be lesser in comparison to an undisturbed forest ecosystem, but the FG model is better than current models of the forestry plantation. This is because FG uses sustainable agricultural practices via renewable sources and low carbon technologies (Shobri, Sakip and Omar, 2016). This is evident when

the planting of the crops depends on the opening of land in the forest which is usually available due to disturbance or mortality of trees. Plus, the common activities conducted in a FG is weeding, pruning and mulching. Furthermore, the local community also manages both forest products and diverse crops and economic activities within the FG for the use of self-consumption or sale (Ng, Nath and Jose, 2018).

### **Chapter 3: Methodology**

#### ***Study Area***

The fieldwork was conducted from July until September 2022 in seven indigenous villages with forest gardens in Selangor, Malaysia (as shown in Figure 1). Six villages were located near the hilly forested areas and one village was located near the sea whereby their forest garden was the mangrove forest. The villages were selected based on the availability of forest gardens, easy access to villages and preservation of forest gardens. Two villages *Kg Orang Asli* (*Kg* means *kampung* or village) *Gurney* (3.420397, 101.665906) and *Kg Orang Asli Gerachi Jaya* (3.274150, 101.682849) were situated in the Hulu Selangor district and the former was approximately 1 KM away from the nearest town, Ulu Yam, while the latter was 6 KM away from the nearest town, Bandar Baru Selayang respectively. The former village consists of 93 households with forest gardens and the latter consist of 71 households with forest gardens. Both villages were located near a main road, but *Kg Orang Asli Gerachi Jaya* was also near the Batu dam. *Kg Orang Asli Gurney* had a mini market while the rest of the necessities for both villages can be found at the nearest towns.

Three villages, *Kg Orang Asli Hulu Batu* (3.313755, 101.697209), *Kg Orang Asli Batu 12* (3.293177, 101.731731) and *Kg Orang Asli Batu 16* (3.325906, 101.754776) were situated in the Gombak Petaling district and were approximately 11 KM, 14 KM and 16 KM away from the nearest town, Batu Caves respectively. *Kg Orang Asli Hulu Batu* consists of 20-25 households with forest gardens whereby most were newlyweds whose spouses migrated from the indigenous community in Pahang. The village was located near a main road and the necessities of markets and medical facilities were located at the nearest town. Meanwhile, *Kg Orang Asli Batu 12* and *Kg Orang Asli Batu 16* consisted of 150 and 36 households with forest gardens respectively. They had a designated medical facility which was Gombak Aborigines Hospital that was located 700 m and 6.4 KM from the villages respectively, while there was a mini market, bus stop and driving school approximately 1.3 KM and 6.9 KM away from the villages respectively.

One village, *Kg Orang Asli Donglai Baru* (3.115138, 101.91044) was situated in the Hulu Langat district and was approximately 15 KM away from the nearest town, Batu 14 Hulu Langat. The village consisted of 20 households with forest gardens and was located near a main road and the Semenyih dam. The necessities of markets and medical facilities were located at the nearest town. The last village, *Kg Orang Asli Pulau Ketam* (3.027197, 101.265734) was situated in the Kuala Langat Klang district and was approximately 2.8 KM away from the nearest town, Pulau Ketam. The village consisted of more than 77 households but only 2 households harvested products from the mangrove forest. The



necessities of markets and medical facilities were located at the nearest town which was only accessible by boat.

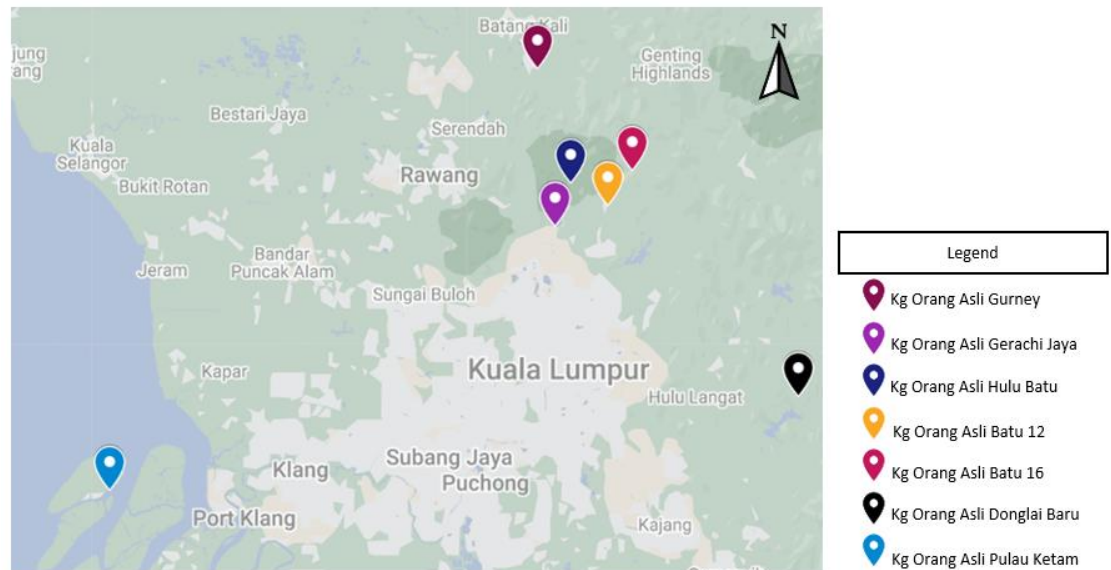


Figure 1: Map of study area with locations of villages

### ***Research Approach***

Prior to the fieldwork study, the researcher obtained the approval letter from the JAKOA headquarters in Kuala Lumpur to conduct the research study in the seven villages of the indigenous community. Then, the researcher informed the fieldwork period to each district JAKOA that was responsible for each indigenous villages and engaged with the Chairman of each indigenous villages for approval to conduct the research study as well as for the availability of participants. Convenience sampling was used for the field data collection based on the willingness and availability of the villagers to participate in the research study. This sampling method is a nonprobability-based sampling that reflects villagers who were available or that the researcher had access to during the fieldwork period. As shown in Table 1, participants were recruited from a convenient subset of the population which leads to a downside that information collected is not truly representative of the entire population (Baxter, Courage and Caine, 2015). For instance, even though *Kg Orang Asli Gurney* had 93 households with forest gardens, only 17 households were willing to participate in the research study. This bias can lead to an overrepresentation of the findings. Despite these limitations, convenience sampling is standardly used within researches as it is less expensive, easy to implement and efficient. The convenience sampling used for this study was based on the FG characteristic indicated in this research paper. Therefore, it can be a good representation of the FG system that operates in Peninsular Malaysia if the FG in other regions match the characteristic of FG indicated in this research paper. Moreover, the target participants of this study are the indigenous community which have similar socioeconomic status, technological introduction and customary lifestyle within the villages. Thus, the findings from the sample size should not significantly differ from non-participants of this study. This study was approved by the research ethics committee of the Faculty of Science and Engineering, University

of Nottingham Malaysia prior to the fieldwork study with reference number IKI210622 and each participant provided verbal consent to be a part of the study.

Table 1: Sample size obtained via convenience sampling from the seven villages

<b>No.</b>	<b>Location</b>	<b>No. of Households</b>	<b>No. of Households with Forest Gardens</b>	<b>Sample Size</b>
1	<i>Kg Orang Asli Gurney</i>	93	93	17
2	<i>Kg Orang Asli Hulu Batu</i>	35	25	8
3	<i>Kg Orang Asli Donglai Baru</i>	70	20	10
4	<i>Kg Orang Asli Gerachi Jaya</i>	91	71	18
5	<i>Kg Orang Asli Pulau Ketam</i>	20	3	3
6	<i>Kg Orang Asli Batu 12</i>	419	150	25
7	<i>Kg Orang Asli Batu 16</i>	38	36	5

#### ***Household survey and interview***

For household interviews, a semi-structured questionnaire was developed, pre-tested with seven households, and then finalized with some minor changes (Appendix 1). The interview was conducted in the homes of the participants with the aid of the Chairman or Committee member of the villages. This approach assisted in the cooperation of the participants to be interviewed as they are more comfortable. The interview sessions lasted approximately one hour for each household while consistently adhering to the questionnaire. The questionnaire consisted of questions related to sociodemographic, indigenous management of forest gardens, economic status, and participants perception on the sustainability of forest gardens and challenges faced by forest gardens. Sociodemographic and economic status were related to gender, age, education level, household size, profession, household monthly income range, income sources and forest gardens contribution to their economy. Management of forest gardens were related to years involved in the forest gardens, ownership status of the forest gardens, area

of the forest gardens, types of crops chosen and planted in the forest gardens, activities conducted to maintain the forest garden, usage of fertilizers or pesticides, gender role, support received from government, harvests obtained in the forest gardens per season, percentage of harvests used for sale or self-consumption and market value of the harvests.

Perception on forest gardens' sustainability were assessed following the criteria of the Globally Important Agricultural Heritage Systems (GIAHS). The GIAHS is a Global Partnership initiative for developed and developing countries to discuss the sustainability of agricultural heritage and practices. It is an official programme of the Food and Agriculture Organization of the United Nations (FAO) that emphasises to conserve agricultural heritage systems that utilize the symbiotic interaction between humans and nature (Yiu, 2019). FAO's definition of GIAHS is a landscape and land-use system that are not only remarkable but also rich in internationally significant biodiversity evolved from a community's co-adaptation with its environment and its requirements as well as ambition for sustainability (Reyes, Miyazaki, Yiu and Saito, 2020). The GIAHS initiative focuses on conserving and managing agricultural heritage systems responsible for the security of food production and livelihood, agrobiodiversity conservation, conservation of landscapes that are unique and vulnerable as well as preserving the local communities (such as indigenous community) agricultural knowledge and heritage of their cultures (FAO, 2023). There are five criteria of the GIAHS that can be used to assess the sustainability of any agricultural system: (1) food and livelihood security, (2) agrobiodiversity, (3) local and traditional knowledge systems and technologies, (4) cultures, values, and social organizations, and (5) landscapes and seascapes features (Reyes, Miyazaki, Yiu and Saito, 2020).

The perception of challenges faced by forest gardens were related to global warming, governmental laws, lack of younger generation to maintain the forest garden, loss of local and traditional knowledge, encroachment of forest gardens, competition with agricultural imports and no formal education, training, and partnership on forest gardens.

### ***Focus group discussions***

Seven focus group discussions were held for this study. One focus group discussion in each sampled village were held with 4-5 villagers with at least one person with position of power such as Chairman or Committee member of the indigenous community with experience in forest gardens. Each discussion lasted for one hour. A separate checklist was prepared to facilitate the discussions. The discussions focused on the issues faced by forest gardens, management techniques and benefits of forest gardens. It also touched on the importance of forest gardens' harvest, potential business ventures with forest gardens and sustainability of forest gardens. There were also discussions on the plants and animals available in forest gardens, possibility of their children following in their footsteps in maintaining forest gardens and if they ever heard of the GIAHS recognition by FAO. Further discussion focused on the possibility of forest gardens being recognized as a GIAHS site, possibility of them applying for the GIAHS recognition and the reasons for applying.

***Key informant interviews with JAKOA staff***

Four key informant interviews (KII) were conducted for this study. One KII was conducted in each JAKOA district with the respective JAKOA officer. The officer must be equipped with the knowledge on the indigenous communities and their forest gardens. The interviews focused on the livelihood of the indigenous communities, the sustainability, benefits and challenges of their forest gardens. It also touched on the support/ services provided by JAKOA for the indigenous communities and their forest gardens as well as the challenges faced by the forest gardens. Moreover, the officers were queried on whether they ever heard of the GIAHS recognition by FAO and the possibility of forest gardens being recognized as GIAHS sites. Lastly, the JAKOA officer were interviewed on the possibility of Malaysia applying for the GIAHS recognition and the reasons for applying.

***Survey implementation***

The questionnaires for the household survey, focus group discussions and key informant interviews were developed in English and translated to Bahasa Melayu as most of the participants were more comfortable speaking Bahasa Melayu. The collected data was then transcribed or translated into English. As a token of appreciation, each household of the indigenous community that participated in the research study was given a packet of salt (150g) and flour (1kg) for their time.

***Data handling and analysis***

The fieldwork data were compiled, summarized, tabulated, and frequency distribution for all the variables were obtained by the end of the fieldwork of each village. For frequency and percentage distribution of perceptions on sustainability, 5-point Likert scale was grouped into two categories such as (strongly agree and agree) and (not sure, disagree and strongly disagree). Mean scores and standard deviations of Likert scale were calculated. Non-parametric tests namely Man Whitney U test and Kruskal Wallis test were conducted to compare significant differences between various variables between sociodemographic and perceptions on sustainability of forest gardens.

**Chapter 4: Results and Discussion*****Basic demography and socioeconomic of participants***

The frequency and percentage of the participants' basic demography and socioeconomic characteristics are as shown in Table 2. 90% of the participants were more than 30 years of age. This indicates that the participants had ample knowledge on forest gardens and could provide reliable information. As of the participants' highest qualification achieved in terms of education, 60% completed the basic formal education system while only two participants went to tertiary education by completing their diploma and bachelor's degree respectively. This indicates that the knowledge on maintaining the forest gardens was not obtained from formal education channels but instead it was passed down within the communities through generations (Ng, Nath and Jose, 2018).

It was also discovered that most of the participants had more than one occupation. Agricultural work on forest gardens was found to be the highest income source followed by self-employment whereby the participants worked

odd jobs as a freelancer or contractor, fisherman, harvesting sea snails for sale, village work (odd jobs requested by the villagers in the respective village), grass cutter, village head, wood cutter and as an entrepreneur such as a saloon owner, river rafting business or landscaper. The third highest attained occupation was working in the private sector whereby the participants worked as security guards, cleaners, bus drivers, chalet workers, construction (foreman and machinery operators), in the telecommunication field and as factory workers. This was followed by occupations in the government sectors whereby they were either still employed by the government such as a general worker or they were currently receiving pension. Then, 2% of the participants worked in the agricultural field but were not on forest gardens such as rubber tapping and a gardener for an estate, while two villagers were unemployed or worked as a volunteer. This shows that 100% of the participants depended on their forest gardens for harvest for self-consumption or sale and depended on other occupations for their livelihood as the income from forest gardens fluctuates depending on the season and demand. Moreover, most of the participants tended to the forest gardens daily in the past but now they only tend to it once or twice a week due to the other commitments. This shows that various income sources are vital in indigenous community areas as they have difficulty in accumulating capital, have undeveloped saving habits and unavailable or expensive credit due to being in rural areas of a developing country (Belcher et al, 2005). The monthly household income in Table 2 does not accurately represent the income from the sale of forest gardens' harvest as these were seasonal (up to 3 months of harvest) and not monthly. Instead, these monthly household incomes were based on the estimated total income from the sale of forest gardens and income from other occupations which has an impact on the management of forest gardens.

Table 2: Basic demography and socioeconomic of participants

<b>Characteristics</b>	<b>Frequency</b>	<b>Percentage (%)</b>
<b>Gender</b>		
Male	43	50
Female	43	50
<b>Age (years)</b>		
18-30	9	10
30-50	53	62
>50	24	28
<b>Family size (no.)</b>		
Up to 3	7	8
3-5	33	38
5-7	22	26
>7	24	28
<b>Highest Qualification</b>		
None	24	28
Primary School	37	43
High School	23	27
Diploma	1	1
Bachelor's Degree	1	1
<b>Income Sources</b>		

Agriculture - FG	71	44
Agriculture - Non-FG	4	2
Self-employed	43	26
Government sector/ Pension	10	6
Private sector	33	20
Volunteerism/ Unemployed	2	1
<b>Monthly Household Income (RM)</b>		
Up to 1500	62	72
1500-3000	20	23
3000-4500	2	2
>4500	2	2

### *Management of forest gardens by the indigenous villagers*

In general, most of them have been involved with forest gardens for more than 80 years with the recent ones being more than 8 years. They have inherited the forest gardens for generations since the 1940s or 1980s. Since there was no work during the older times, the villagers' ancestors foraged the forest for food. Their ancestors discovered the fruit trees which was then utilized for self-consumption and sold to Chinese middlemen during harvesting seasons. This venture is practised until now, contributing to the indigenous communities' income. However, some of the villagers currently sell the fruits and vegetables to outsiders (people who are not a part of the village or indigenous community) by themselves if they have a place in their village which removes the middlemen. This is because the villagers report that they are often lowballed or never receive a fair price when products were sold to middlemen which is common for indigenous communities to experience (Ng, Nath and Jose, 2018). Other than that, most of the villagers have been replanting and adding additional fruit trees, vegetables and forest products using the seeds obtained from the forest. This practice is influenced by the relationship of the participants with the forest gardens and its characteristics.

### Relationship of the participants with the forest gardens and its characteristics

Relationship of the participants with the forest gardens and its characteristics are as shown in Table 3. 100% of the participants either owned or shared the forest garden land with their siblings or parents (counted as other households). This indicates that the participants followed in their parent's footsteps of maintaining their inherited forest garden despite the fluctuating income obtained from the sale of forest garden harvests compared to their other occupations. This shows that the participants regard the forest gardens as part of their heritage whether they manage to reap the benefits of the forest gardens or not as it would be their loss if the forest gardens were not managed by them. The areas of the forest garden were estimated by the participants as the design of their forest garden were in sporadic patches instead of one large area except for the forest garden in *Kg Orang Asli Pulau Ketam* which had an area of 5,664 m<sup>2</sup> since the mangrove forest covers the whole island. The participants also planted different types of crops whereby the crops were planted as crop mixtures instead of monoculture crops. They also use intercropping system (the practice of growing two or more crops in proximity) as it is the most efficient system. This indicates a high

biodiversity and species richness (number of plant species) in the forest gardens. Not only that, but the diversification of harvests produced in forest gardens assist the villagers to spread capital risk (loss of money invested in forest gardens) as it allows a range of economic choices compared to monoculture plantations which have higher capital risk (Belcher et al, 2005; Sharma et al, 2016).

Within these forest gardens, 56% of the participants stated that the crops or plants which they planted were of natural origins (crops or plants received from within the forest which they replanted). Meanwhile, 43% of the participants stated that the crops or plants which they planted were of both natural and planted origins (planted origins were defined as crops or plants bought by or given to the participants to plant in their forest gardens). Only 1% of the participants had used crops or plants of planted origins for their forest gardens. Furthermore, it was discovered that 63% of the participants' reasoning of choosing the crops or plants for their forest gardens were due to them inheriting the crops from their family. Meanwhile, 19% of the participants chose the crops due to inherited reasons and due to other reasons such as basing on the suitability of the forest garden area; following the community preference whereby the crops were usually planted by the community; crops that have a market value for sale; the crops were provided by JAKOA or RISDA representatives; the villagers were following tradition and lastly, the crops were easier or faster to harvest. The remaining 12% of the participants chose the crops due to other reasons and 6% of the villagers were thinking of their household future when they chose the crops for their forest gardens (the participants were thinking of their children's future) respectively. This indicates that the participants chose the crops based on experience of cultivation of the crops, availability of input and profitability (Saifullah et al, 2006; Ng, Nath and Jose, 2018) which is impacted by the management of forest gardens by the participants.

Table 3: The relationship of the participants with the forest gardens and its characteristics

<b>Relationship and Characteristic of Forest Gardens</b>	<b>Frequency</b>	<b>Percentage (%)</b>
<b>Years Involved with Forest Gardens</b>		
<10	10	12
10-20	5	6
21-30	28	33
31-40	24	28
>40	19	22
<b>Ownership Status of Forest Gardens</b>		
Own	65	76
Share	19	22
Both	2	2
<b>Area Forest Garden</b>		
<10	71	83
10-20	6	7
21-30	2	2
>30	7	8

<b>No. of Crops in Forest Gardens</b>		
<6	28	33
6-12	55	64
>12	3	3
<b>Nature of Crops in Forest Gardens</b>		
Natural	48	56
Planted	1	1
Both	37	43
<b>Factors Crops were Chosen for Forest Gardens</b>		
Inherited	54	63
Household future	6	7
Inherited and other reasons	16	19

#### The management of forest gardens by the participants

The management of forest gardens by the participants are as shown in Table 4 whereby regular activities conducted by the participants in their forest gardens were mostly maintenance (53% of the participants). The maintenance generally conducted by the participants comprised of them cutting down small trees in their forest gardens, pruning, weeding, trimming and cutting grass using a machete or a machine such as grass cutters. Other maintenance activities also involve clearing the area of the forest gardens for easy access to obtain their harvest during harvest season and burning the trees or grass that were cut which in turn be used as natural fertilizer. The participants were not allowed to chop down trees in their forest garden for sale under the Forestry Act 1984 but allowed for self-consumption under the Aboriginal Peoples Act 1954 (No. 134). Moreover, the Aboriginal Peoples Act 1954 (No. 134) allows the indigenous communities to obtain harvests from the forest gardens and protects them from the fines and penalties of the Forestry Act 1984 and Wildlife Conservation Act 2010 (Act No. 716) (only if they hunt animals for their own sustenance and not allowed to hunt the animals for sale). As for the regular activities in the others category (refer to Table 4), the participants would water the crops in the forest gardens. They would also put chemical or natural fertilizers or pesticides on their crops. They even plant seedlings or trees or replant trees and hoe the land of the forest garden. Furthermore, it was found that 64% of the participants did not use chemical fertilizers and pesticides, ensuring their crops are of organic nature. This is because some of the forest gardens were located close to their water supply and the participants wanted to avoid poisoning the water, while others simply did not want to use chemical fertilizers and pesticides. Out of the 64% of the participants, a small percentage used organic fertilizers on their forest gardens such as wood ash, burned grass or trees that were cleared from their land or salt which has been practiced since the previous generations. Other than that, it was discovered that gender and government play a contributing factor to the management of forest gardens.

Table 4: The management of forest gardens by the participants

<b>Management of Forest Gardens</b>	<b>Frequency</b>	<b>Percentage (%)</b>
<b>Regular Activities in Forest Gardens</b>		



Maintenance	46	53
Maintenance and other activities	29	34
Others	5	6
Harvesting	5	6
None	1	1
<b>Use of Fertilizers/ Pesticides</b>		
Fertilizers only	8	9
Pesticides only	4	5
Both	18	21
None	56	64

#### The contribution of gender and government on forest gardens

The contribution of gender on forest gardens were discovered to be men (62% of the participants) who regularly visits the forest gardens followed by the same amount of frequency by both men and women (24% of the participants). The least frequency was by women only (9% of the participants). This indicates that the activities conducted on the forest garden were dominated by the men due to their physical strength. Moreover, the indigenous community follows the patriarchal system in which men were more expected to work and provide for the family while the women were more expected to stay at home to care for the children and commit to household chores. The patriarchal system is common in Malaysian societies regardless of ethnicity, cultural backgrounds, and religious beliefs as it is deeply rooted in traditions, cultures, and customs (Lee, 2021). In terms of support from any government body or NGO received by the villagers on forest gardens, 72% of the participants stated that they did not receive any support from both government body and NGO. Meanwhile, 28% of the participants did receive support (mainly from the government) whereby they were provided chemical fertilizers, pesticides, rubber seedlings, mangosteen seeds, mango seeds, guava seeds, durian seeds and funding of RM 700 for 1 acre of rubber plantation from the government. Despite that, it was discovered that these supports were mainly provided for the participants' home garden and rubber plantation in the forest instead of their forest garden. This is because JAKOA support is limited as they depend on funding from the federal government. However, they did collaborate with FELCRA for the villagers that have grant on the forest garden land.

The support provided by JAKOA was more indirect in which they encouraged entrepreneurship for the forest gardens by conducting an Entrepreneurship Carnival for Trees. At the carnival, the indigenous communities were able to purchase trees of different species from indigenous communities of other states. The indigenous communities could also collaborate with each other to determine which plants were suitable for medicine and conducted comparison of plants as some states have more trees of quality depending on the state of the forest (virgin forest has a higher quality of plants). For instance, pitcher plant (which is normally used to make lemang) in Kelantan and Pahang were found to be abundant and bigger than pitcher plants in Selangor. Some agencies don't allow the usage of pitcher plant for food preparation as it is poisonous. However, the indigenous community have the knowledge to remove the poison from the plant for safe consumption. JAKOA has also provided funding to indigenous

communities to preserve the commercial trees and assisted the indigenous community with the application for gazettement of forest garden land to be an aboriginal reserve land under the Aboriginal Peoples Act 1954 (No. 134). If the forest garden is in a forest reserve such as the forest gardens of *Kg Orang Asli Donglai Baru* then the application is unnecessary.

Other indirect supports by JAKOA were becoming a mediator to solve issues between the indigenous communities with the Forestry department. Moreover, JAKOA provided support for chilli plants and encouraged the indigenous communities to plant Agarwood tree, bamboo, mountain Durian and Tiger milk mushroom (a type of mushroom grown with tiger's milk which is said to be a medicine for cancer). The tiger milk mushroom costs RM 500 which can contribute to the income of the indigenous community. However, the tiger milk mushroom will often be given as a souvenir to guests during formal events, showing a missed opportunity for the indigenous community. JAKOA also provided salary to the indigenous communities for replanting activities which led to the preservation of the knowledge on the plants. JAKOA also promoted the culture of indigenous communities by visiting their Tuk Aleh for advice on which plants were suitable for medicine to be promoted to the public. Doctors will also meet the Tuk Aleh for research and development programmes to transform the plants suitable for medicine into pill form for easier consumption. The JAKOA have the knowledge on the benefits of the plants in the forest gardens, but they do not know how to market the plants on behalf of the indigenous communities. Meanwhile, the NGO provided durian seedlings to the participants for their forest gardens. This indicates that there is no to minimal support provided for the maintenance and marketing of the natural crops of forest gardens. This is due to traditional agricultural practices are generally not supported by policymakers while various support is provided for the maintenance and marketing of rubber plantations or home gardens. This shows that forest gardens management is largely overlooked by policy makers and development practitioners (Wiersum, 2004; Ng, Nath and Jose, 2018) even though it fits in economies of rural households such as indigenous communities. As such, this affects the various harvests that the indigenous communities obtained from their forest gardens and the harvests' respective market value.

#### ***Harvests obtained from the forest gardens by the indigenous communities***

The harvests obtained from the forest gardens were various fruits, forest products, vegetables, and others such as animals or animal products as shown in Table 5. An average of 66% and 47% of the fruits and vegetables respectively were sold by the participants for their main income or extra income while an average of 34% and 53% of the fruits and vegetables respectively were used for the participants' self-consumption or shared with neighbours and relatives. The participants utilized the fruits and vegetables into their cooking as a side dish or it was consumed as is. In *Kg Orang Asli Pulau Ketam*, the participants consumed 100% of the harvest and shared with neighbours and relatives.

Moreover, an average of 47% of the forest products were sold by the participants for their main income or extra income. The forest products were either sold as is (wet form) or sold as a dried version of the forest products. It was discovered that the demand for the Tongkat Ali (a popular plant used for herbal medicine

specifically for men) from outsiders has ceased for some villages in which the reasoning was not known by the villagers. Meanwhile, for some villages, the sale of Tongkat Ali was ceased by the villagers as the income received was not worth the amount of physical labour experienced by the villagers to retrieve the Tongkat Ali. This is a further indication that the indigenous community are prone to be taken advantage by outsiders by the offering of unfair prices for their forest harvests. Other than that, the forest products were also made into cultural attire or items such as headgear, carpet and pillow for sale.

Meanwhile, an average of 53% of the forest products were used for the participants' self-consumption or shared with neighbours and relatives such as for medicinal purposes for mystic or physical illnesses. The plants commonly used for medicinal purposes were Tongkat Ali, Kacip Fatimah and various herbs as well as ubi jaga which was commonly used for energy replenishment. In fact, the participants will assist sick villagers in locating the appropriate medicine in the forest garden to cure them of their illnesses based on the advice of their medicine shaman referred to as Tuk Aleh. The participants even stated that there could be more medicinal plants in their forest gardens, but it is unknown to them since it is the expertise of the older generation which the participants have not mastered. This shows that knowledge that was not passed down from the older generation will be lost to the younger generation. The forest products were also used for cultural attires such as headgears, bracelets, rings, etc during events such as weddings, festivities, funeral, etc or as jewelry. Furthermore, forest products such as bamboo was commonly used as a water container, material to build houses, material to make fire, material to make crafts such as blowpipe, piggy bank, etc. Rattan was also used for various purposes such as ropes, material for basket weaving, bracelet, and *bubu* (fish trapper) for own consumption and for sale. This practice is maintained by the villagers who has interest in craftsmanship.

Other than that, a small number of participants harvest animals or animal products such as honey whereby 5% of the harvest were sold for main income or extra income and 95% of the harvests were consumed by the participants or shared with neighbours and relatives. The harvest sold by the participants were only honey as they were not allowed to hunt animals for sale under the Wildlife Conservation Act 2010 (Act No. 716) but allowed for self-consumption. The animals were hunted every two or three years or when they have cravings which was not often. The sharing of harvests with relatives and neighbours leads them to develop strong social bonds with each other leading to a direct benefit to the indigenous community (Ng, Nath and Jose, 2018). A small amount of the fruits and vegetables were not utilized (neither sold or consumed) due to damage from wild animals, no harvests during season or the harvests were stolen by people whether it was outsiders encroaching the forest gardens or people from the village itself. This affects the economy of the forest gardens.

Table 5: Harvests obtained from forest gardens and frequency of households that have the harvests.

No.	Local Name	Scientific Name	Form	Uses	Frequency n (%) of Households
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1	Durian	<i>Durio zibethinus L.</i>	Tree	Fruit	82 (95)
2	Rambutan	<i>Nephelium lappaceum</i>	Tree	Fruit	44 (51)
3	Tampoi	<i>Baccaurea macrocarpa</i>	Tree	Fruit	35 (41)
4	Kerdas	<i>Pithecellobium bubalinum</i>	Tree	Fruit	39 (45)
5	Pulasan	<i>Nephelium mutabile</i>	Tree	Fruit	26 (30)
6	Mangosteen	<i>Garcinia mangostana</i>	Tree	Fruit	39 (45)
7	Kuini	<i>Mangifera odorata</i>	Tree	Fruit	1 (1)
8	Banana	<i>Musa acuminata</i>	Tree	Fruit	7 (8)
9	Duku Langsung	<i>Lansium domesticum var duku</i>	Tree	Fruit	6 (7)
10	Cempedak	<i>Artocarpus integer</i>	Tree	Fruit	15 (17)
11	Pineapples	<i>Ananas comosus</i>	Shrub	Fruit	3 (3)
12	Langsat	<i>Lansium domesticum</i>	Tree	Fruit	24 (28)
13	Jackfruit	<i>Artocarpus heterophyllus</i>	Tree	Fruit	4 (5)
14	Mango	<i>Mangifera indica</i>	Tree	Fruit	39 (45)
15	Salak	<i>Salacca zalacca</i>	Palm	Fruit	2 (2)
16	Soursop	<i>Annona muricata</i>	Tree	Fruit	2 (2)
17	Perah	<i>Elateriospermum tapos</i>	Tree	Fruit	3 (3)
18	Rambai	<i>Baccaurea motleyana</i>	Tree	Fruit	1 (1)
19	Coconut	<i>Cocos nucifera</i>	Palm	Fruit	2 (2)
20	Palm	<i>Arecaceae</i>	Palm	Fruit	1 (1)
21	Berembang	<i>Sonneratia caseolaris</i>	Tree	Fruit	2 (2)
22	Perepat	<i>Sonneratia alba</i>	Tree	Fruit	2 (2)
23	Chestnut	<i>Castanea</i>	Tree	Fruit	1 (1)
24	Dukong	<i>Lansium parasiticum</i>	Tree	Fruit	4 (5)

25	Kacip Fatimah	<i>Labisia pumila</i>	Shrub	Forest Product	20 (23)
26	Tongkat Ali	<i>Eurycoma longifolia</i>	Tree	Forest Product	22 (26)
27	Resin	-	Tree	Forest Product	1 (1)
28	Bamboo shoots	<i>Phyllostachy s edulis</i>	Grass	Forest Product	6 (7)
29	Bamboo	<i>Schizostachy um blumei</i>	Grass	Forest Product	9 (10)
30	Rubber	<i>Hevea brasiliensis</i>	Tree	Forest Product	37 (43)
31	Ubi Jaga	<i>Smilax Myosotiflora</i>	Tree	Forest Product	2 (2)
32	Banana leaves	<i>Musa acuminata</i>	Herb	Forest Product	1 (1)
33	Jantung Pisang	<i>Musa acuminata</i>	Herb	Forest Product	1 (1)
34	Taro leaves	<i>Colocasia esculenta</i>	Herb	Forest Product	1 (1)
35	Ginger	<i>Zingiber officinale</i>	Herb	Forest Product	1 (1)
36	Palas leaves	<i>Butea monosperma</i>	Tree	Forest Product	Forest Product 1 (1)
37	Mengkuang leaves	<i>Pandanus tectorius Parkinson</i>	Tree	Forest Product	1 (1)
38	Rattan Batu	<i>Calamus penicillatus Roxb.</i>	Palm	Forest Product	6 (7)
39	Rattan Tanah	<i>Calamus balingensis Furtado</i>	Palm	Forest Product	
40	Rattan Gilang	<i>Plectocomio psis geminiflora</i>	Palm	Forest Product	
41	Kantan	<i>Etilingera elatior</i>	Herb	Forest Product	5 (6)
42	Lempit (family of dull bertam palm)	<i>Eugeissona tristis Griff</i>	Palm	Forest Product	2 (2)
43	Tunjuk Langit tree	<i>Helminthost achys zeylanica</i>	Tree	Forest Product	1 (1)
44	Areca palm	<i>Areca</i>	Palm	Forest Product	1 (1)
45	Agarwood	<i>Aquilaria malaccensis</i>	Tree	Forest Product	1 (1)

46	Meranti	<i>Shorea</i>	Tree	Forest Product	1 (1)
47	Kulim	<i>Scorodocarpus borneensis</i> Becc.	Tree	Forest Product	1 (1)
48	Betel	<i>Piper betle</i>	Vine	Forest Product	1 (1)
49	Yellow Saraca	<i>Saraca thaipingensis</i>	Tree	Forest Product	1 (1)
50	Coriander	<i>Coriandrum sativum</i>	Herb	Forest Product	1 (1)
51	Pandan	<i>Pandanus amaryllifolius</i>	Tree	Forest Product	1 (1)
52	Petai	<i>Parkia speciosa</i>	Tree	Vegetables	74 (86)
53	Jering	<i>Archidendron pauciflorum</i>	Tree	Vegetables	32 (37)
54	Areca nuts	<i>Areca catechu</i>	Palm	Forest Product	11 (13)
55	Sweet potato/ sweet potato shoots	<i>Ipomoea batatas</i> (L.)	Vine	Vegetables	9 (10)
56	Chickpeas	<i>Cicer arietinum</i>	Herb	Vegetables	1 (1)
57	Yam	<i>Dioscorea</i>	Herb	Vegetables	2 (2)
58	Turmeric	<i>Curcuma</i>	Shrub	Vegetables	1 (1)
59	Cassava	<i>Manihot esculenta</i>	Shrub	Vegetables	3 (3)
60	Chilli	<i>Capsicum frutescens</i>	Shrub	Vegetables	6 (7)
61	Wood ear fungus	<i>Auricularia auricula-judae</i>	Fungi	Vegetables	1 (1)
62	Chilli api	<i>Siling labuyo</i>	Shrub	Vegetables	1 (1)
63	Pucuk Paku (various types)	<i>Matteuccia struthiopteris</i>	Fern	Vegetables	9 (10)
64	Pucuk Chemperai	<i>Champeria manillana</i>	Fern	Vegetables	1 (1)
65	Potato	<i>Solanum tuberosum</i>	Herb	Vegetables	4 (5)
66	Mangrove mushroom/ fungi	-	Fungi	Vegetables	3 (3)
67	Splitgill mushroom	<i>Schizophyllum commune</i>	Fungi	Vegetables	1 (1)

68	Honey from Honeybees	<i>Apis cerana</i>	Animal	Sweetener	2 (2)
69	Honey from Stingless bees	<i>Meliponini</i>	Animal	Sweetener	2 (2)
70	Wildboar	<i>Sus scrofa</i>	Animal	Meat	33 (38)
71	Monkeys such as Silvery Lutung	<i>Trachypithecus cristatus</i>	Animal	Meat	22 (26)
72	Squirrels	<i>Sciuridae</i>	Animal	Meat	15 (17)
73	Porcupine	<i>Erethizontidae</i>	Animal	Meat	18 (21)
74	Armadillo	<i>Dasypodidae</i>	Animal	Meat	13 (15)
75	Deer	<i>Cervidae</i>	Animal	Meat	3 (3)
76	Snakes (various types)	<i>Serpentes</i>	Animal	Meat	4 (4)
77	Bamboo rat	<i>Rhizomyini</i>	Animal	Meat	17 (20)
78	Monitor lizard	<i>Varanus</i>	Animal	Meat	4 (5)
79	Fox	<i>Paradoxurus hermaphroditus</i>	Animal	Meat	1 (1)
80	Phyton	<i>Pythonidae sp.</i>	Animal	Meat	2 (2)
81	River fish (various types)	-	Animal	Meat	6 (7)
82	Birds (various types)	-	Animal	Meat	2 (2)
83	Mousedeer	<i>Tragulidae</i>	Animal	Meat	1 (1)
84	Junglefowl	<i>Gallus</i>	Animal	Meat	3 (3)
85	Softshell turtles	<i>Trionychidae</i>	Animal	Meat	1 (1)
86	Wood	-	Tree	Forest Product	6 (7)
87	Herbs	-	Herb	Forest Product	6 (7)

### Economy of Forest Gardens

From the study, it shows that fruits were the main source of income from the forest gardens followed by vegetables and forest products in all six villages except for *Kg Orang Asli Pulau Ketam* as the villagers have yet to sell the mangrove mushrooms. Durian was seen to be the largest source of income for the villagers who were dependent on the forest (Rahman et al, 2017). The selling price of durian fruits varied for the villages based on their location from the JAKOA district offices as shown in Table 6 whereby two villages with the shortest distance to the JAKOA district office (less than 7 KM) fetch a higher price compared to four villages with a longer distance to JAKOA district office (more than 10 KM). The crops in Table 6 are shown to be vital crops for the villagers' economy (Ng, Nath and Jose, 2018; Nath et al, 2016). Moreover, the participants created handicrafts for sale with products from the forest gardens such as headgear made from palas leaves with a sale price of RM 60 per piece

as well as carpet and pillow made from mengkuang leaves with a sale price of RM 80 per piece and RM 50 per piece respectively. The honey that they harvest from honeybee or stingless bee also has a sale price of RM 80 per cup. Overall, forest gardens do contribute to food and livelihood security for the indigenous communities.

Table 6: Mean market value and income (RM) of harvests in forest gardens.

Plant's name (Local)	Average price per kg (RM)		Mean harvest amount (kg/ harvest season)			Mean harvest income (RM/ harvest season)			Mean harvest income per household (RM)		
	>10 km	<7 km	>10 km	<7km		>10 km	<7km		>10 km	<7km	
			Basket	Basket	Pieces	Basket	Basket	Pieces	Basket	Basket	Pieces
Durian	7.52	48.65	217.63	497.02	73.31	1,636.58	24,180.02	3,566.53	34.82	1,209.00	891.63
			<b>Basket/ Sacks</b>	<b>Ikat</b>		<b>Basket/ Sacks</b>	<b>Ikat</b>		<b>Basket/ Sacks</b>	<b>Ikat</b>	
Petai	1.5 per kg		104.06	-		156.09	-		12.01	-	
	62.26 per ikat		-	12.24		-	762.06		-	31.75	
			<b>Basket</b>	<b>Pieces</b>		<b>Basket</b>	<b>Pieces</b>		<b>Basket</b>	<b>Pieces</b>	
Rambutan	5.00		698.66	26.14		3,493.30	130.70		116.44	65.35	
Tampoi	5.50		188.57	-		1,037.14	-		38.41	-	
Kerdas	5.00		546.83	27.50		2,734.15	137.50		97.65	4.15	
Pulasan	5.43		672.57	-		3,651.09	-		182.55	-	
Mango steen	5.50		525.14	1.8		2,888.27	945.25		96.28	945.25	
Kuini	5.50		78.75	-		433.13	-		433.13	-	
Banana	5.50		129.17	-		710.42	-		101.49	-	
Duku langsung	4.00		268.33	-		1,073.33	-		178.89	-	
Cempedak	5.50		176.25	53.38		969.38	293.56		26.69	146.78	
Langsat	5.00		937.27	26.14		4,686.33	130.71		246.65	65.36	
			<b>Basket</b>	<b>Sacks</b>		<b>Baskets</b>	<b>Sacks</b>		<b>Baskets</b>	<b>Sacks</b>	
Kacip Fatimah	2.55		68.94	1,225.07		175.80	3,123.93		29.3	347.10	
Tongkat Ali	7.50		49.24	2,616.25		369.32	19,621.88		73.86	41.04	
Resin	0.85		50.00	1,275.71		42.50	1,084.36		42.50	216.87	
Bambo shoots	1.20		27.08	-		32.50	-		10.83	-	
Rubber	2.85		-	86.15		-	245.54		-	35.08	
Banana leaves	2.00		-	18.75		-	37.50		-	37.50	
Jering	2.00		10.00	18.75		20.00	187.50		20.00	14.42	
Sweet potato shoots	1.50		-	18.75		-	28.13		-	9.38	



Chilli	1.50	-	18.75	-	28.13	-	28.13
Estimated total income from the forest gardens (RM)				>10km	<7km	>10km	<7km
				59,373.35	85,483.32	3,729.66	5,795.47

### ***Sustainability of the forest gardens based on GIAHS criteria***

#### **Food and livelihood security**

It is discovered that majority of the participants were in consensus that forest gardens contribute to food and livelihood security except for tourism activities as shown in Table 7. Man Whitney U test and Kruskal Wallis tests discovered that the opinion towards “The forest gardens are endowed with the necessary support to recover from external threats (e. g. natural disasters, climate change)” differed based on genders ( $U=707.5$ ,  $p<0.05$ ), income ( $H=14.15$ ,  $p<0.05$ ), area of their forest gardens ( $H=29.60$ ,  $p<0.05$ ) and income sources ( $H=20.40$ ,  $p<0.05$ ). The Kruskal Wallis test also discovered that the opinion of the indigenous villagers towards “Forest gardens has created opportunities for business towards stabilizing rural economy” differed based on education level ( $H=18.02$ ,  $p<0.05$ ) and income ( $H=11.51$ ,  $p<0.05$ ). As for the opinion on “There is tourism activities in the forest gardens thus improve local economy”, it differed based on income sources ( $H=17.32$ ,  $p<0.05$ ) as well.

The findings were due to participants recognition that the forest gardens provide economic benefits such as being a source of food for the villager’s survival and way of life by providing income, side income or limited business to the villagers during fruiting seasons as they sell the harvest from their forest gardens. From the sale of harvests, the villagers obtain capital money which were used for their savings whereby they also obtain dividends from banks. The villagers can continue this way of life since ancestral times as there have been continuous demands for the harvests of forest gardens from outsiders (people who are not residing in the village or not a part of the indigenous community). The outsiders have also expressed interest to the villagers about fruit-based tourism whereby the exposure was recently increasing. Forest gardens could also provide income to the villagers in *Kg Orang Asli Pulau Ketam* if they were able to sell the mangrove mushrooms. During the research study, the villagers were not selling the mangrove mushrooms as people were worried or scared to consume them as they fear it is poisonous.

This shows that the indigenous communities cannot be separated from their forest gardens as without the forest, they cannot live since 99% of them depended on forest for survival. There is a culture and livelihood attachment between the indigenous communities and their forest gardens whereby the land is known as customary land in which the forest garden system is always in the forest from before until now. It is the land where the indigenous communities will hunt, find forest products, find herbs for own consumption or for sale. However, they cannot sell most of the forest products due to the Forestry Act 1984 and only limited products can be sold such as Tongkat Ali and Kacip Fatimah. The forest gardens can also provide income during the fruit’s harvesting season, promote forest products to outsiders and helps to restore the environment (Ng, Nath and Jose, 2018). For now, the forest garden is mainly for their own consumption and not commercialized. The forest garden also acts as a boundary between villages that only the villagers will know.

Moreover, the participants states that forest gardens can create businesses that is owned by the villagers such as food business, craft business such as handicraft shop whereby they want to create traditional craftsmanship and musical instruments, agricultural business and agrotourism such as camping in the forest gardens whereby they can provide a package deal to local or international tourists or provide a forest menu or package the durians for sale. To achieve this, the participants need permission or permits from the federal government and state government to conduct tourism. They also need a place to conduct businesses such as a gallery or market that is only owned by the villagers with no middleman. The participants also require business training, funding, and tools such as machineries for craftsmanship items to execute work for handicraft and business independence similar to Pulau Carey's Mah Meri cultural village which should be replicated for all indigenous villages. The Pulau Carey's Mah Meri cultural village was established in 2011 to preserve the heritage of the Mah Meri indigenous community. The cultural village was supported by the Ministry of Tourism and Culture by providing the facilities while the indigenous community operated and maintained the complex (Mah Meri Cultural Village, 2021). However, the villagers in this study did receive some training or courses from the federal government such as JAKOA, but they cannot utilize the knowledge as there is no place for them to conduct a business. As for *Kg Orang Asli Pulau Ketam*, the villagers wanted trainings to replant the mangrove mushrooms and trainings for business management.

The villagers also need to have a discussion between federal and state government, villagers, JAKOA, forestry department and media to endorse and spread awareness regarding the businesses from forest gardens. This is because the villagers were worried that it would be hard for them to commercialize the harvests especially if the outsiders were not aware of the businesses from forest gardens or won't believe in the medicinal benefits of the harvests from forest gardens. Thus, the stakeholders especially media need to support the villagers by spreading the awareness and educating the outsiders about the harvest of forest gardens, and that it is safe for consumption to make it easier for the villagers to sell it. This can also promote agrotourism and other businesses for the villagers such as transportation business. This shows that the harvests in forest gardens are vital for the villagers in terms of subsistence, cash income and capital accumulation (Belcher et al, 2005; Sharma et al, 2016; Ng, Keat and Jose, 2018).

Table 7: Respondents' opinion on livelihoods and food security values of forest gardens in studied villages in Selangor, Malaysia

Statement	Extent of agreement n (%)		Mean score of Likert scale $\pm$ Sdev	Significance Results
	SA - A	NS - D - SD		
Activities such as replanting, harvesting, etc within the forest garden system and their interrelations influence positively	84 (98)	2 (2)	4.51 $\pm$ 0.64	

the food and livelihood security of the local community				
The agricultural activities provide food and livelihood security	85 (99)	1 (1)	4.55± 0.62	
The activities that have been carried out by the villagers in forest gardens are adaptive with the environment	86 (100)	-	4.63± 0.48	
The forest gardens are endowed with the necessary support to recover from external threats (e. g. natural disasters, climate change).	82 (95)	4 (5)	4.63± 0.52	Gender, U=707.500, p<0.05 Income, H=14.147, p<0.05 Area of FG, H=29.595, p<0.05 Income sources, H=20.397, p<0.05
There is tourism activities in the forest gardens thus improve local economy	17 (20)	69 (80)	2.00± 1.39	Income sources, H=17.321, p<0.05
Forest gardens has created opportunities for business towards stabilizing rural economy	79 (92)	7 (8)	4.19± 0.64	Education, H= 18.002, p<0.05 Income, H=11.505, p<0.05

Man Whitney U test, significance level p<0.05

Kruskal Wallis test, significance level p<0.05

### Agrobiodiversity

There is a consensus from the participants that forest gardens support agrobiodiversity of the environment as shown in Table 8. Kruskal Wallis test discovered that the opinion on “The forest gardens have ensured crop rotations, intercropping, crop-livestock systems, etc., which increase the resilience of the system and ensure productive viability” differed based on the ownership status (H=11.08, p<0.05), no. of crops planted in the forest gardens (H=23.67, p<0.05) and area of forest gardens (H=36.10, p<0.05). Meanwhile, the opinion on “The forest gardens support a variety of local animals, plants, and micro-organisms” differed based on the indigenous villagers’ income sources (H=18.07, p<0.05). This indicates that forest gardens support agrobiodiversity. The diverse harvests obtained in the forest gardens reduces the capital risks associated with crop

failure, allowing the participants to obtain revenue during the fruiting/ harvesting seasons and secured their dietary requirements. The diverse harvests also attract wild animals to forage (search for food) which leads to animal species diversity and dispersal of seeds (Sharma et al, 2016; Moore et al, 2016).

Table 8: Respondents' opinion on agrobiodiversity of forest gardens in studied villages in Selangor, Malaysia

Statement	Extent of agreement n (%)		Mean score of Likert scale $\pm$ Sdev	Significance Results
	SA - A	NS - D - SD		
The forest gardens support a variety of local animals, plants, and micro-organisms	84 (98)	2 (2)	4.64 $\pm$ 0.57	Income sources, H=18,065, p<0.05
Components of forest provide goods and services important for local peoples' livelihoods.	86 (100)	-	4.80 $\pm$ 0.40	
The forest gardens consist of local varieties, diversity and genetic resources that ensure the resistance of the crop	84 (98)	2 (2)	4.56 $\pm$ 0.62	
The forest gardens have ensured crop rotations, intercropping, crop-livestock systems, etc., which increase the resilience of the system and ensure productive viability	79 (92)	7 (8)	4.48 $\pm$ 0.94	Ownership of FG, H=11.084, p<0.05 No. of crops, H=23.671, p<0.05 Area of FG, H=36.101, p<0.05

Kruskal Wallis test, significance level p<0.05

#### Local and traditional knowledge

Based on Table 9, it is shown that most of the participants strongly agree or agree that local and traditional knowledge are related to forest gardens aside from "There are invaluable traditional knowledge and adaptive technology that are being practiced" which has an almost equal level of agreement and disagreement. Moreover, the research found that the opinions on "The forest gardens have practices that incorporate traditional knowledge for agricultural system to function sustainably with respect to water and soil resources" and "The system has evolved in such a way that it maintains its qualities as a reservoir of invaluable traditional knowledge and practices" differed based on the indigenous villagers' income (H=10.29, p<0.05 and H=15.66, p<0.05).

Based on focus group discussions, all knowledge on management of forest gardens came from the older generations leading to the development of taboo for

the forest gardens (Ng, Nath and Jose, 2018). They also have rules and practices from the ancestors such as offering food to the forest gardens for a good harvest. They also must ask permission from nature to enter the forest garden and must always respect the surrounding forest. The villagers must also adhere to the boundaries of their forest gardens, and they have laws whereby they cannot encroach on other people's forest garden. This could be due to traps placed in the forest gardens which can endanger their safety. There is also a tradition and taboo during the flowering season whereby villagers are not allowed to make poison (damak) for their blowpipe. If they break the taboo, then the trees in their forest garden will not bear fruits.

The villagers also preserve the environment of the forest gardens by not conducting forest burning. They also do not cut down the trees in the forest to ensure ample canopy cover whereby the trees will only be cut down if there is danger of the tree falling which is very rare. Moreover, some villagers believe that small trees cannot be cut and nothing in the forest can be cut if it is not the harvesting season and they are also not allowed to cut some plants, or it will affect their relationship with nature. Furthermore, some trees such as Rengas tree (*Gluta spp.*) and Binjai fruit (*Mangifera caesia*) cannot be cut as the villagers believe it to be poisonous as it causes allergic reaction on the skin. The villagers were also taught to not cut Wood nettles (*Laportea*) as it causes the skin to be itchy and induced pain when scratched. They also will not do forest clearing because the traditional knowledge that has been passed down through generations states that the forest health will disappear if they do so. Harvesting of the forest gardens only takes place when the crops are mature and sufficiently grown, and they never harvest for small plants. In *Kg Orang Asli Pulau Ketam*, there are no traditional rules as the whole community are muslims. Thus, there is no belief of animisme. This indicates that forest gardens are maintained using local and traditional knowledge inherited by the villagers for generations which is not only for the conservation of their livelihood but also for the conservation of the environment and biodiversity (Halim et al, 2012).

The knowledge sharing for the management of forest gardens were conducted mainly via practical teaching. The villagers brought the younger generation into the forest gardens and taught them the ways (whether on one shared plot or individual plots) until they can take over. The knowledge is also shared through verbal communication such as communicating on the ways to produce better harvests, family tradition and ideas that has been passed down and tested. With this, most of the villagers are certain that their children will follow in their footsteps in maintaining the forest gardens as it will always be passed over to their children due to tradition and the children will always go back to their roots. For some villagers, the forest gardens will be passed down and cared by sons since they have been taught on the management of forest gardens and they know that it is their heritage. It is difficult for daughters to inherit the forest gardens for some villagers as there are bad people such as drug addicts in the forest which can endanger the life of the daughters. Moreover, the indigenous communities practiced patriarchy system which depends on the men to provide for the family which led to mostly sons inheriting the forest gardens. Some children may not follow in their parents' footsteps in maintaining the forest garden as education has changed the system in the indigenous community. This led the young

generations of having the ability to find employment elsewhere. Mostly those who are uneducated/ did not go to school will maintain the forest gardens as the priority of the current young generations is to obtain gadgets by working. This leads to a drop in youth taking over forest gardens which is a loss for the indigenous community. This shows that the current system of forest gardens does not normally offer opportunities for full-time employment and can easily be outcompeted by alternative wage employment (Belcher et al, 2005). In *Kg Orang Asli Pulau Ketam*, the children might follow in their parents' footsteps of maintaining the mangrove mushroom if there is a project for it.

Table 9: Respondents' opinion on local and traditional knowledge related to forest gardens in studied villages in Selangor, Malaysia

Statement	Extent of agreement n (%)		Mean score of Likert scale $\pm$ Sdev	Significance of Results
	SA - A	NS - D - SD		
The forest gardens have practices that incorporate traditional knowledge for agricultural system to function sustainably with respect to water and soil resources.	83 (97)	3 (3)	4.70 $\pm$ 0.65	Income, H=10.294, p<0.05
There are invaluable traditional knowledge and adaptive technology that are being practiced	45 (52)	41 (48)	3.00 $\pm$ 1.43	
Forest gardens conserve traditional agricultural practices and innovations	85 (99)	1 (1)	4.69 $\pm$ 0.53	
The system has evolved in such a way that it maintains its qualities as a reservoir of invaluable traditional knowledge and practices.	85 (99)	1 (1)	4.71 $\pm$ 0.48	Income, H=15.658, p<0.05

Kruskal Wallis test, significance level p<0.05

#### Social and cultural values

As shown in Table 10, there is high level of agreement on the indigenous villagers' opinion on social and cultural values of forest gardens except for "Social organizations play a critical role in balancing environmental and socio-economic objectives of forest gardens", "Forest gardens help to form multi-stakeholders' partnership for co-management of natural resource management" and "The local social organizations have developed strategies, and practices that lead to the recognition and promotion of the diverse cultural expressions of the territory". In fact, data analysis showed that the opinion on "Social organizations play a critical role in balancing environmental and socio-economic objectives of forest gardens" differed based on age (H=8.76, p<0.05), gender roles (H=11.96, p<0.05), support received from the government (U=487.50, p<0.05) and income sources (H= 18.18, p<0.05). As for the opinion on "The traditional crop varieties grown in forest gardens satisfy the locals food preferences and the preparation of traditional dishes", the study showed that it differs based on number of crops planted (H=27.64, p<0.05). The opinions on "The festive events, rituals, and beliefs are part of cultural identity and a sense of belonging that are embedded

in and belong to the forest gardens” differed based on income sources ( $H=16.56$ ,  $p<0.05$ ). This indicates that forest gardens have an impact on the social and cultural values of the villagers.

The forest gardens provide cultural benefits as the villagers believe in nature (Wartman, Acker and Martin, 2018). Everything that is in nature is an inspiration to discover solution for sickness such as traditional healing which requires the natural resources for remedies. The forest gardens ensure that their traditional practices are preserved and act as disaster warnings for the villagers. Moreover, the culture of the indigenous communities is to live near the forest (Kardooni et al, 2014). When they have forest gardens it indicates a demonstration of ownership. Their ancestors’ gravesite also proves the same thing (Belcher et al, 2005). Moreover, the Aboriginal Peoples Act 1954 (No. 134) states that they can live anywhere if they do not damage the environment and the forest garden is also proof that they maintain the environment as it is maintained through traditional knowledge which is the belief of ancestors and environment (animisme) passed down through generations. They also believe that their ancestral spirit and spirits in the forest guide them to live their life with forest gardens. Forest gardens also preserve the faith of their ancestors such as mountain ancestor whereby they have an event like harvest festival and provide food to the mountain ancestor. The sophisticated culture of the villagers is interesting for the outsiders especially on the villagers' interaction with the environment.

The villagers also used to have a festival called *genggulang* whereby they will worship the spirits of the crops for harvest (similar to *Pesta Gawai* practised by Dayak community in Sarawak) but this festivity is no longer practised by the villagers. Now, they will do a celebration without ritual during the durian season. They will also conduct craftmanship whereby they will wear items made from forest products such as sempang and tempok during weddings, New Year, death, and welcoming guest to the villages. They also nurture the food and medicine cultural tradition that was inherited for generations for it to not be extinct and preserve the belief of ancestors and environment (animisme) through traditional knowledge. The indigenous community depend on the natural resources in the forest gardens for food, medicine and building houses (Ng, Nath and Jose, 2018). The maintenance of forest gardens ensures no pollution which can impact the villages. This is due to the indigenous community preserving their forest garden as a natural treasure since forest garden uses nature to sustain its surroundings (Armstrong et al, 2023). This prevents natural disasters caused by deforestation for development. However, development can lead to the indigenous community moving away if the surrounding forest is cleared due to loss of resources.

Furthermore, the indigenous communities preserve the plants, animals and herbs as well as their tradition in the forest garden to maintain the biodiversity. Their activities relating to the forest gardens consist of making baskets to carry the harvests from forest gardens as well as for sale, procuring Kacip Fatimah and Tongkat Ali for medicinal purposes and preserving it for cultural tradition. They also consume betel leaves during weddings or after regular meals as part of their tradition as well. Overall, the social and cultural values tied to the forest gardens are vital for the indigenous community’s lifestyle and impacts the landscape.

Table 10: Respondents' opinion on social and cultural values of forest gardens in studied villages in Selangor, Malaysia

Statement	Extent of agreement n (%)		Mean score of Likert scale $\pm$ Sdev	Significance Results
	SA - A	NS - D - SD		
The individuals, families, groups or local communities play a key role in the forest gardens conservation	86 (100)	-	4.90 $\pm$ 0.31	
Social organizations play a critical role in balancing environmental and socio-economic objectives of forest gardens	18 (21)	68 (79)	2.16 $\pm$ 1.29	Age, H=8.759, p<0.05 Gender, H=11.975, p<0.05 Support from government, U=487.500, p<0.05 Income sources, H=17.184, p<0.05
Forest gardens help to form social relations through collective farming, sharing of knowledge, and social cohesiveness.	77 (90)	9 (10)	4.40 $\pm$ 0.97	
Forest gardens help to form multi-stakeholders' partnership for co-management of natural resource management	24 (28)	62 (72)	2.41 $\pm$ 1.32	
The festive events, rituals, and beliefs are part of cultural identity and a sense of belonging that are embedded in and belong to the forest gardens	69 (80)	17 (20)	4.13 $\pm$ 1.26	Income sources, H=16.561, p<0.05
The traditional crop varieties grown in forest gardens satisfy the locals food preferences and the preparation of traditional dishes	85 (99)	1 (1)	4.76 $\pm$ 0.50	No. of crops, H=27.640, p<0.05
The traditional medicine culture is part of cultural identity and a sense of belonging that are embedded in and belong to the forest gardens	80 (93)	6 (7)	4.52 $\pm$ 0.86	



The local social organizations have developed strategies, and practices that lead to the recognition and promotion of the diverse cultural expressions of the territory	24 (28)	62 (72)	2.40± 1.38	
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Man Whitney U test, significance level  $p < 0.05$

Kruskal Wallis test, significance level  $p < 0.05$

### Landscape features

As shown in Table 11, most of the participants agreed that on the contribution of forest gardens to landscape features except for “The local social organizations have developed strategies, rules, and practices that allow and ensure the maintenance of the territory potentialities and landscape quality” whereby it differed based on education level ( $H = 9.91$ ,  $p < 0.05$ ) and income sources ( $H = 16.55$ ,  $p < 0.05$ ). As for the opinion on “Forest gardens can contribute to the preservation of a mosaic of landscapes in this region”, it also differs based on income sources ( $H = 17.95$ ,  $p < 0.05$ ). This indicates that forest gardens have unique landscape features.

Based on the focus group discussions, the participants recognized the environmental benefits of forest gardens such as its importance to the forest as it balances the climate and weather. In essence, forest gardens regulate temperature leading to cooler climate. The forest gardens are also important for all life (human and animals) as well as acting as a natural lifecycle. In a way, it preserves the environment for the animals. Since the forest gardens is in a primary forest, it is a forest system that cannot be obtained outside the indigenous village which makes it unique and can attract tourism. The river near the forest gardens is also important for their livelihood. There are certain lands of the indigenous community classified as *sekarisme* which means that they have grant on the land, preserving the forest gardens from development.

Table 11: Respondents’ opinion on landscapes features of forest gardens in studied villages in Selangor, Malaysia

Statement	Extent of agreement n (%)		Mean score of Liker scale ± Sdev	Significance of Results
	SA - A	NS - D - SD		
Forest gardens can contribute to the preservation of a mosaic of landscapes in this region	86 (100)	-	4.80± 0.40	Income sources, $H = 16.545$ , $p < 0.05$
The forest gardens present landscapes that have been developed over time through the interaction between humans and the environment.	86 (100)	-	4.76± 0.43	

The infrastructure and settlements within forest gardens reflect the interconnection between the human and environmental sphere	86 (100)	-	4.74± 0.44	
The local social organizations have developed strategies, rules, and practices that allow and ensure the maintenance of the territory potentialities and landscape quality.	7 (8)	79 (92)	1.78± 1.02	Education, H=9.909, p<0.05 Income sources, H=17.955, p<0.05

Kruskal Wallis test, significance level  $p < 0.05$

### ***Challenges faced by forest gardens threatening its sustainability***

#### **Challenges identified through household survey**

As shown in Table 12, there is a mixed consensus from the indigenous villagers that forest gardens face challenges to thrive in the current period whereby the highest agreement level were on the challenge of younger generation not following in their footsteps to maintain forest gardens resulting in loss of local and traditional knowledge as well as lack of formal education, trainings, monitoring, and partnerships on maintaining forest gardens. The villagers mostly disagreed that “One of the challenges of forest gardens is to deal with adverse environmental impacts such as climate change” and it differed based on education level ( $H=10.37$ ,  $p < 0.05$ ).

Moreover, most of the participants did not know the meaning of climate change. For them, forest garden and the forest have stabilized the temperature around them since their existence of ancestral generation. They also defined that the knowledge pertaining to temperature regulation within the forest was passed through generation to generation by preserving forest. This shows a big difference when it comes to the environmental stewardship behaviour of the indigenous community in comparison to the alarming behaviour of climate change from the selected elite folks. This discovery shows climate change as an alarming agenda that is being pushed to multiple communities which ultimately can prove to be harmful. This is because climate policies can severely affect the livelihood of the indigenous communities in particular, due to inflation from the implementation of carbon pricing and other expensive climate change policies. Poor households such as theirs are already experiencing the inflation brought by recent increase of food and energy prices which is broadly stable due to blanket fuel subsidies and price controls from the federal government (World Bank, 2023). The possible increase in inflation due to climate change policies can exacerbate the issue by stagnating their improvement to economic utility. At the same time their sale price of forest garden harvests remains the same due to lack of coverage from government and middleman taking advantage. The possible implementation of carbon pricing to mitigate emissions from fossil fuels is expensive and a smarter approach is to invest in the research and development of cheaper, low carbon energy to promote towards low carbon economy (Galiana, 2014; Lomborg, 2020). Thus, governmental policies and laws can impact the livelihood and forest gardens of indigenous communities and implementation of the policies and laws have to be considerate to them.

The villager's almost equal agreement level on "The traditional practices in forest gardens are affected by changes in governmental policies and laws" differed based on gender role ( $H= 6.70, p<0.05$ ). It is known that the Aboriginal Peoples Act 1954 (No. 134) has and always will protect the indigenous communities from fines and prosecution of other Malaysian acts (provided they harvest animals and most of the forest products for self-consumption) nor can it be override by other Malaysian acts. Thus, their traditional agricultural practices will not be affected by changes in governmental policies and laws as stated in the Forestry Act 1984 and Wildlife Conservation Act 2010 (Act No. 716).

Meanwhile, the villagers had an almost equal agreement on "Forest gardens are faced with encroachment of human and economic development into farmlands" which differed based on age ( $H=15.73, p<0.05$ ), education level ( $H= 10.15, p<0.05$ ), number of crops planted ( $H=22.93, p<0.05$ ), area of forest gardens ( $H= 32.52, p<0.05$ ) and income sources ( $H=19.68, p<0.05$ ). This is because indigenous communities seldom have grants on their forest garden land which is classified as forest reserve and is subject to the discretion of the state government to preserve or develop the forest land. In fact, the Aboriginal Peoples Act 1954 (No. 134) does not provide them a grant on the land and they are considered as tenant at will on the inherited housing and forest garden lands (Wan Daud, Mohsin and Abdul Rahman, 2020). However, their traditional practices of maintaining the forest gardens remains protected by the Aboriginal Peoples Act 1954 (No. 134). This is because the development by state government concerns on the land ownership and not on their customs. The only approach that the indigenous community can venture to protect their forest gardens is to apply for grant on the forest garden land from the state government.

The participants mostly disagreed on "Dependency on imports of agricultural produces may discourage local farming and thus farmers abandon traditional agricultural practices" which differed based on age ( $H=7.09, p<0.05$ ), support received from government ( $U=508.50, p<0.05$ ) and income sources ( $H=17.33, p<0.05$ ). This is because local harvest such as the ones offered by the participants are organic, cheaper, and tastier which will always be in demand owing to the growing demand for organic food in Malaysia (Somasundram, Razali and Santhirasegaram, 2016). Thus, agricultural imports do not affect the sale of harvests for the indigenous communities.

Other than that, the opinion on "The inheritance of traditional knowledge in forest gardens is jeopardized by aging farming populations and depopulation of younger generation" differed based on the use of fertilizers or pesticides ( $H= 11.60, p<0.05$ ) and income sources ( $H=15.71, p<0.05$ ) while the opinion on "Forest gardens are experiencing a decrease in production, poor maintenance and the imminent disappearance of traditional techniques due to fewer people to take over the family farms and continue the traditional practices" differed based on the use of fertilizers or pesticides ( $H= 9.32, p<0.05$ ), support received from government ( $U= 535.50, p<0.05$ ) and income sources ( $H= 18.68, p<0.05$ ). This indicates that the forest garden practices are threatened by modernization as the younger generation do not continue the maintenance of inherited forest gardens leading to poor maintenance or abandonment of forest gardens. The reasoning is

that the younger generations are influenced by technology which changes their priorities compared to the older generation (Au-Yong-Oliveira et al, 2018).

Lastly, the villager’s opinion on “Other challenges faced by forest gardens are lack of education, trainings, monitoring, and partnerships on forest gardens” differed based on income sources ( $H=17.66$   $p<0.05$ ). This indicates that the younger generation in schools were taught on mainstream knowledge which does not align with their local and traditional knowledge. This causes the younger generation to stray from forest gardens as they had to prioritise their formal education. If the maintenance of forest gardens is taught in schools via forest schools as a supplement to their home teachings, then they would maintain the local and traditional knowledge. Moreover, inclusion of indigenous knowledge language, traditions, music, handicrafts, folk stories, flora and fauna in the elementary education can attract the younger attraction to learn and master their indigenous practices for survival of the forest (Abdul Wahab et al, 2020). There is also no clear partnership on forest gardens as the priority of the indigenous community is to preserve and benefit from their forest gardens while the priorities of the government agencies such as Forestry department is to preserve the forest reserve. This shows that both parties interest clashes with each other.

Table 12: Respondents’ opinion on challenges of forest gardens in studied villager in Selangor, Malaysia

Statement	Extent of agreement n (%)		Mean score of Likert scale $\pm$ Sdev	Significance of Results
	SA - A	NS - D - SD		
One of the challenges of forest gardens is to deal with adverse environmental impacts such as climate change	7 (8)	79 (92)	1.84 $\pm$ 0.90	Education, $H=10.370$ , $p<0.05$
The traditional practices in forest gardens are affected by changes in governmental policies and laws	46 (53)	40 (47)	3.20 $\pm$ 1.42	Gender, $H=6.695$ , $p<0.05$
The inheritance of traditional knowledge in forest gardens is jeopardized by aging farming populations and depopulation of younger generation	81 (94)	5 (6)	4.41 $\pm$ 0.80	Usage of fertilizers or pesticides, $H=11.600$ , $p<0.05$ Sources of income, $H=15.708$ , $p<0.05$
Forest gardens are experiencing a decrease in production, poor maintenance and the imminent disappearance of traditional techniques due to fewer people to	80 (93)	6 (7)	4.42 $\pm$ 0.80	Usage of fertilizers or pesticides, $H=9.321$ , $p<0.05$

take over the family farms and continue the traditional practices				Sources of income, H=18.682, p<0.05
Forest gardens are faced with encroachment of human and economic development into farmlands	42 (49)	44 (51)	3.19± 1.51	Age, H=15.727, p<0.05 Education, H=10.154, p<0.05 Support from government, U=535.500, p<0.05 No. of crops, H=22.930, p<0.05 Area of FG, H=32.518, p<0.05 Sources of income, H=19.680, p<0.05
Dependency on imports of agricultural produces may discourage local farming and thus farmers abandon traditional agricultural practices	34 (40)	52 (60)	2.65± 1.40	Age, H=7.092, p<0.05 Support from government, U=508.500, p<0.05 Sources of income, H=17.326, p<0.05
Other challenges faced by forest gardens are lack of education, trainings, monitoring, and partnerships on forest gardens	77 (90)	9 (10)	4.23± 0.90	Sources of income, H=17.685 p<0.05

Man Whitney U test, significance level p<0.05

Kruskal Wallis test, significance level p<0.05

### Challenges identified through KII and FGDs

#### 1. Developmental encroachment

It is known that the indigenous community and their forest garden land cannot be separated. The forest garden land is a customary land which is a place for

them to search for forest products and hunt, and most forest garden land is not gazetted as a reserve land for the indigenous communities. Instead, the forest garden land will be included as government land or a forest reserve. This causes forest gardens often faced with encroachment which occurs when the government reclaim the forest gardens land and its surrounding under the ownership of the government for development (Ng, Nath and Jose, 2018). This often occurs as the indigenous community do not have legal ownership on the forest garden land even though the forest gardens are proof that they have owned the land for generations (Belcher et al, 2005) whereby the Forestry department assists them in the verification of ownership by measuring the years of the forest garden trees existence in the forest. Their ancestors are also buried at the land. The villagers never receive sufficient compensation for the reclamation of the forest garden land as companies take advantage to the fact that the indigenous community does not have grant for the land. This can be seen in case studies such as:

- i) *Kg Orang Asli Songkok's* land whereby hundreds of acres of forest garden and housing land was bought by a property developer/ company without discussion with the villagers even though the law states that land inhabited by indigenous community cannot be sold without the signature of all villagers.
- ii) Two of the villages in the study, *Kg Orang Asli Batu 12* and *Kg Orang Asli Batu 16* faced threat of losing their forest gardens and housing lands to the East Coast Railway (ECRL) development which will cause displacement to some of the indigenous communities, noise pollution and high electrical power. These villages were also located near highways which made it easier for outsiders to encroach their forest gardens, making it dangerous for the villagers especially women to maintain their forest gardens.
- iii) A villager in *Kg Orang Asli Gurney* had three acres of land stolen by Malay people from cheating as the villager's ancestor was illiterate. The case was forwarded to JAKOA for a solution, but the case has never been resolved.
- iv) The villagers in *Kg Orang Asli Gerachi Jaya* were displaced due to the development of the Batu dam which took hundreds of acres of their forest gardens and housing land.

Furthermore, the Association of Indigenous community gave permission for outsiders to log the forest housing the indigenous communities' forest gardens. Moreover, corporates that encroach the forest garden land were known to destroy the surrounding nature as they used heavy machinery for development even though the indigenous communities were always slandered as being the responsible stakeholders that ruin nature (Krech, 1999). It is quite rare for the indigenous community to ruin nature as they are bound by their cultural practices

and Forestry Act 1984 whereby, they are not allowed to cut down the trees in and near the forest gardens for sale.

Other than that, the road leading to their forest gardens were not suitable for cars or bikes to transport goods and the forest gardens are always located far from their village. Most often, they will walk to and from the forest gardens approximately three times a day to maintain and monitor it especially when outsiders encroach in their forest gardens in case of anything such as accidents. This shows that the practices of the indigenous community do not degrade nature although it takes time and energy to harvest from the forest gardens. It is also hard to materialize a formal forest garden for commercialization due to many challenges such as financial resources and rapid development causing lesser trees for their consumption (in example, depletion of betel trees). This is the reason the participants of indigenous communities and JAKOA officers were in favour of having an international recognition such as GIAHS recognition for forest gardens as it can help preserve and protect the forest garden land from encroachment despite that most of them have never heard of the GIAHS recognition by FAO.

## 2. Challenges due to governmental laws

The indigenous communities face difficulties with handling the authorities and it affects their economy from the forest gardens. For instance, there is a clash of the governmental acts such as the Aboriginal Peoples Act 1954 (No. 134) and the Forestry Act 1984 whereby in the latter, no one is allowed to harvest fruits and vegetables in the forest, but the former exempts the indigenous community from these rules. This confuses the Forestry authorities and causes arguments between them and the indigenous communities whenever the villagers try to harvest from their forest gardens. Forestry department also does not allow indigenous communities to take trees uncontrollably. They are only allowed to obtain the trees for their own consumption (in example, rattan for decorative purposes) as resources are scarce. This limits the harvesting of forest products for the indigenous communities.

The Forestry Act 1984 also prevents the villagers from conducting touristic activities for their forest gardens as the villagers need to obtain a permit from the Forestry department. This is because several forest gardens are located under a forest reserve, so outsiders are not allowed in the forest without a permit. The application must be made by the indigenous communities which is a hassle for them if they want to conduct a tourism attraction for forest gardens. However, there is a benefit in restricting outsiders' movement in the forest gardens by implementing the permit application process as this ensures that outsiders cannot take advantage of the villagers to encroach the forest gardens and prevent them from taking the forest gardens land. Not only that, but the villagers also must apply land for their forest gardens with the Forestry department whereby the process takes a long time. This led to the villagers to create their forest gardens and then informing the location to the Forestry department for application. Moreover, there are also bureaucracy issues regarding gazettement of land for the forest gardens (providing grant of the forest garden land to the villagers) which have never reached the authorities as the villagers were always approached by a middleman to apply for gazettement. This led to NGOs helping

to defend the forest gardens by fighting for the rights of indigenous communities via protesting and relaying the complaints of indigenous communities to higher authorities. However, some NGOs do not respond to some of the villagers' demands. This causes the indigenous communities to be wary and distrust outsiders.

### 3. Other challenges to forest gardens

The general challenges faced by indigenous communities is that their culture and way of life clashes with the outside culture and with the Forestry Act 1984. They also face issues of sustainable consumption and management whereby their resources will degrade if their harvesting practices are not sustainable. For instance, the depletion of their bamboo supply due to constant competition to supply bamboo to outsiders for them to make lemang. If the bamboo is not preserved, then it will be extinct. To prevent extinction, JAKOA has advised the indigenous communities to preserve the bamboo for continuous supply as well as preserve Kacip Fatimah and Tongkat Ali for future generation as it is used for medicinal purposes.

Furthermore, the villagers always faced disturbances from wild animals such as monkeys and wild boar whereby the animals will interfere with the fruits by eating or damaging it which coincides with findings from Ng, Nath and Jose (2018). Some villagers tolerate the disturbances by letting the animals be as they believe if they leave the animals alone then the animals will leave them alone. However, one village had to cull some of the monkeys (long tailed macaques) which were abandoned at their village from the zoo for their own safety and wellbeing. Other than that, the villagers were also affected by the Movement Control Order (MCO) during the pandemic as it led to none, or minimal harvest being sold despite the abundance of harvest during the fruiting season. This led to a decrease in the villagers' economy. For *Kg Orang Asli Pulau Ketam*, the villagers faced pollution on their mangrove mushroom as outsiders dispose rubbish and other polluting items into the sea. This has led to fewer harvest of the mangrove mushrooms and crabs for their self-consumption.

#### ***Limitation of the study***

Most of the villagers were not available from Monday until Saturday due to their work and were only available on Sundays as it was their day off. Moreover, some of the villagers were wary of outsiders as they have been taken advantage of before and would not cooperate in the research study. Some villagers also do not have a forest garden due to not continuing the tradition or they were a new family that had just migrated to the village and have not been assigned with a forest garden by the Tuk Batin or Chairman. There were also some villagers who were not well or inebriated during the fieldwork period. This led to the difficulty in collecting a larger sample size and is the reason a pilot study was not conducted as well. This is why convenience sampling was used as it is less expensive, easy to implement and efficient. Albeit it can lead to an overrepresentation of the findings, the convenience sampling used for this study was based on the FG characteristic indicated in this research paper. Therefore, it can be a good representation of the FG system that operates in Peninsular Malaysia if the FG in other regions match the characteristic of FG indicated in this research paper. Moreover, the target participants of this study are the indigenous community



which have similar socioeconomic status, technological introduction and customary lifestyle within the villages. Thus, the findings from the sample size should not significantly differ from non-participants of this study.

There were also challenges in communicating with the indigenous community for the research study as most of the villagers do not speak English and some do not speak Bahasa Melayu. Thus, a translator was acquired to assist in the collection of the research data as they were able to translate the survey questions to the participants in their native language. Then, the responses of the participants were translated to Bahasa Melayu to the researcher. This ensures that the participants clearly understand the required information and prevents any misunderstandings. Other than that, the fruiting season during the period of research did not provide a good harvest to the villagers leading to less income from the sale of forest garden harvests for this research. This can lead to an underrepresentation of the income obtained from forest gardens compared to good harvesting seasons. Albeit it demonstrates the unstable nature of the forest gardens economy.

### ***Recommendations of Future Research***

Future research can be focused on detailed aspects of the GIAHS criteria such as focusing on the forest garden income from a bountiful harvest during the fruiting season since this research study was conducted during a period of less harvest during the fruiting season. A study comparison can also be made on the income for those relying on middleman to market their harvests and those that are directly marketing their harvests. These potential researches can help indigenous communities and governmental agencies in understanding the support needed for the economic growth of forest gardens. It can also be a guide to governmental agencies in providing the necessary tools and fundings for the indigenous communities to market their forest gardens.

More research is also required on the sampling of soil richness as well as the species richness of the forest gardens for a better view on the agrobiodiversity of forest gardens and the variables that affect them. This might lead to the effective preservation of both forest gardens and forest as well as influencing policymakers in implementing new policies for the benefit of forest gardens. Research can also be done on the mitigation measures of wildlife disturbances on the forest gardens to ensure lesser destruction of crops. This can help reduce the conflict between human and animal while preserving the forest gardens.

Moreover, research on the local and traditional knowledge of the indigenous communities can be explored further to promote the integration of the knowledge into formal schools by policymakers. Research on social and cultural values is also vital to find out the solution of preserving the practices as well as the factors causing the loss of their culture. The potential findings can help indigenous communities to not only integrate into modern society but also preserve their traditional knowledge and values.

The challenges of maintaining forest gardens can also be researched further to find the solution and necessary collaboration with governmental agencies to preserve sustainability of the forest gardens. Further research can also focus on

the application of GIAHS recognition for forest gardens in Malaysia and the impact it has on Malaysia's policies and laws. These researches might cause the revision of existing policies and laws for the preservation of forest gardens' sustainability. It might also lead to Malaysia obtaining a GIAHS recognition for the forest gardens. Furthermore, a larger sample size can be obtained by venturing to more villagers in Selangor and to other indigenous villages in other states for future research. The potential findings might cause the collaboration of state governments in preserving forest gardens as it is impacted by the state government's decision. It might also cause a universal policy and law solely for forest garden management and preservation.

### **Chapter 5: Conclusion and Policy Implications**

Forest gardens are sustainable due to the indigenous management as it provides food and livelihood security, supports agrobiodiversity, utilises local and traditional knowledge, impacts the social and cultural values of the indigenous community and has a unique landscape because of the assimilation with natural forest. The forest gardens are vital to the indigenous communities as it represents their identity and heritage which they want to fully preserve for the younger generation. Moreover, the forest gardens have opportunities to grow as an agrotourism business which can lead to a steady income for the indigenous communities and improve livelihood of the villages. Furthermore, the harvests and benefits of the forest gardens need to be made aware and acknowledged by those outside the indigenous communities via media for the communities to independently market their harvests, cutting off the middleman that gave them unfair prices for their harvests. From the awareness, the indigenous communities can also market the agrotourism business and their culture similar to the tourism practices of the Mah Meri tribe in Pulau Carey. This can lead to a higher source of income from their forest gardens which can attract younger generations to preserve their heritage, in return preserving the forest gardens.

However, this is a challenge when the forest garden land is not formally owned by the indigenous communities in the form of grant. This is because the Aboriginal Peoples Act 1954 (No. 134) only protects their way of life to live near the forests but does not provide them with ownership of the forested lands. Instead, it is owned by the state government which can be reclaimed at any moment for development. The indigenous communities only way of preventing this issue is to apply for grant on their forest garden lands with the state government. Moreover, a partnership between the indigenous communities and the governance agencies such as Forestry department and JAKOA are vital for agrotourism. This is because a permit is required for potential tourists to explore the forest gardens as it is protected by the Forestry Act 1984 which does not allow outsiders to venture easily. This is to ensure the preservation of the forest reserve which not only relates to the forest gardens but also act as habitat for wildlife. Thus, the agrotourism business will also be impacted by the Wildlife Conservation Act 2010 (Act No. 716). Hence, a mutual agreement and process for the agrotourism business between the stakeholders will greatly benefit not only the indigenous communities but also the forest gardens and its surroundings as more people are aware on its existence which leads to preservation. Lastly, a global recognition of the forest gardens and the indigenous practices such as the

GIAHS recognition can lead to a collaboration between the indigenous communities and the Malaysian government to preserve the forest gardens.

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## **Appendix 1: Questionnaire for household survey**

- A. Socio-demographic of respondents
1. What is your gender? Male/Female
  2. What is your age? 18-30 years, 30-50 years, >50 years.
  3. What is your family size? <3, 3-5, 5-7, >7
  4. What is your highest qualification? None, Primary School, Middle School, High School, Diploma, Undergraduate, Masters, PhD
  5. What are the sources of your family income? Main source: Business, Government employee, Private Sector, NGO/Volunteer, Agriculture, Other sources: Business, Government employee, Private Sector, NGO/Volunteer, Agriculture
  6. What is your mean monthly household income (RM) from all sources? Up to 1500; 1500-3000; 3000-4500; >4500
  7. How long are you involved with a Forest Garden System (FGS)?
  8. Do you have your own forest gardens or communal ones?
  9. What is the area of forest gardens?
  10. How do you manage forest gardens? Key issues include 1) types of crops – trees, fruits, vegetables, etc., 2) Natural and planted crops, 3) how do they choose crops, 4) regular activities done, 5) Fertiliser, pesticides, 6) gender role, 7) support from JAKOA or other agencies

## 11. What are the products do you harvest/collect from forest garden?

Products	Quantity/month or year	Sell (%) of quantity)	Family consumption (%)	Market value (RM)
Fruits				
Forest Product				
Vegetable				
Others				

Please provide your opinion on following statements

[5= strongly agree, 4 agree, 3= Not sure, 2= Disagree, 1= Strongly disagree]

Statement	Level of agreement				
	1	2	3	4	5
<b>1. FOOD AND LIVELIHOOD SECURITY</b>					
Activities such as replanting, harvesting, etc within the forest garden system and their interrelations influence positively the food and livelihood security of the local community					
The agricultural activities provide food and livelihood security					
The activities that have been carried out by the villagers in forest gardens are adaptive with the environment					
The forest gardens are endowed with the necessary support to recover from external threats (e. g. natural disasters, climate change).					
There is tourism activities in the forest gardens thus improve local economy					
Forest gardens has created opportunities for business towards stabilizing rural economy					
<b>2. AGRO-BIODIVERSITY</b>					
The forest gardens support a variety of local animals, plants, and micro-organisms					
Components of forest provide goods and services important for local peoples' livelihoods.					
The forest gardens consist of local varieties, diversity and genetic resources that ensure the resistance of the crop					
The forest gardens have ensured crop rotations, intercropping, crop-livestock systems, etc., which increase the resilience of the system and ensure productive viability					
<b>3. LOCAL AND TRADITIONAL KNOWLEDGE SYSTEMS</b>					
The forest gardens have practices that incorporate traditional knowledge for agricultural system to function sustainably with respect to water and soil resources.					

There are invaluable traditional knowledge and adaptive technology that are being practiced					
Forest gardens conserve traditional agricultural practices and innovations					
The system has evolved in such a way that it maintains its qualities as a reservoir of invaluable traditional knowledge and practices.					
<b>4. CULTURES, VALUE SYSTEMS AND SOCIAL ORGANIZATIONS</b>					
The individuals, families, groups or local communities play a key role in the forest gardens conservation					
Social organizations play a critical role in balancing environmental and socio-economic objectives of forest gardens					
Forest gardens help to form social relations through collective farming, sharing of knowledge, and social cohesiveness.					
Forest gardens help to form multi-stakeholders' partnership for co-management of natural resource management					
The festive events, rituals, and beliefs are part of cultural identity and a sense of belonging that are embedded in and belong to the forest gardens					
The traditional crop varieties grown in forest gardens satisfy the locals food preferences and the preparation of traditional dishes					
The traditional medicine culture is part of cultural identity and a sense of belonging that are embedded in and belong to the forest gardens					
The local social organizations have developed strategies, and practices that lead to the recognition and promotion of the diverse cultural expressions of the territory					
<b>5. LANDSCAPES AND SEASCAPES FEATURES</b>					
Forest gardens can contribute to the preservation of a mosaic of landscapes in this region					
The forest gardens present landscapes that have been developed over time through the interaction between humans and the environment.					
The infrastructure and settlements within forest gardens reflect the interconnection between the human and environmental sphere					
The local social organizations have developed strategies, rules, and practices that allow and ensure the maintenance of the territory potentialities and landscape quality.					

Please provide your opinion on the “Challenges” of forest gardens  
 [1= strongly agree, 2= agree, 3= Not sure, 4= Disagree, 5= Strongly disagree]

Statement	Level of agreement				
	1	2	3	4	5
One of the challenges of forest gardens is to deal with adverse environmental impacts such as climate change					
The traditional practices in forest gardens are affected by changes in governmental policies and laws					
The inheritance of traditional knowledge in forest gardens is jeopardized by aging farming populations and depopulation of younger generation					
Forest gardens are experiencing a decrease in production, poor maintenance and the imminent disappearance of traditional techniques due to fewer people to take over the family farms and continue the traditional practices					
Forest gardens are faced with encroachment of human and economic development into farmlands					
Dependency on imports of agricultural produces may discourage local farming and thus farmers abandon traditional agricultural practices					
Other challenges faced by forest gardens are lack of education, trainings, monitoring, and partnerships on forest gardens					

Other challenges facing forest gardens?

## Appendix 2: Non-parametric data analysis on Livelihood and Food Security

### i) Gender with the resilience of forest gardens

Variable	Participants' responses on Livelihood and Food Security (n)	Results
	The forest gardens are endowed with the necessary support to recover from external threats (e. g. natural disasters, climate change).	

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Man Whitney U test	Significance
Male	35	7	0	1	0	707.5	0.019
Female	25	15	2	1	0		

## ii) Level of education business opportunities of forest gardens

Variable	Participants' responses on Livelihood and Food Security (n)					Results	
	Forest gardens has created opportunities for business towards stabilizing rural economy					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	4	15	1	4	1	18.022	0.001
Primary School	12	24	0	0	0		
High School	13	10	0	0	0		
Diploma	1	0	0	0	0		
Bachelor Degree	0	0	0	1	0		

## iii) Income (RM) with the resilience of forest gardens

Variable	Participants' responses on Livelihood and Food Security (n)					Results	
	The forest gardens are endowed with the necessary support to recover from external threats (e. g. natural disasters, climate change).					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
Until 1500	43	15	1	2	0	14.147	0.007
1500-3000	17	3	0	0	0		
3000-45000	0	2	0	0	0		
>4500	0	2	0	0	0		
N/A	0	0	1	0	0		

**Appendix 3: Non-parametric data analysis on Agrobiodiversity**

## i) Ownership with general diversity of crops/ livestock varieties of forest gardens

Variable	Participants' responses on Agrobiodiversity (n)	Results
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	The forest gardens have ensured crop rotations, intercropping, crop-livestock systems, etc., which increase the resilience of the system and ensure productive viability					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
Own	48	14	0	3	0	11.084	0.004
Share	7	8	0	2	2		
Both	2	0	0	0	0		

ii) No. of crops with general diversity of crops/ livestock varieties of forest gardens

Variable	<b>Participants' responses on Agrobiodiversity (n)</b>					Results	
	The forest gardens have ensured crop rotations, intercropping, crop-livestock systems, etc., which increase the resilience of the system and ensure productive viability					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
1	0	0	0	1	0	23.671	0.034
2	1	1	0	0	0		
3	3	2	0	1	2		
4	5	2	0	0	0		
5	5	5	0	0	0		
6	10	6	0	1	0		
7	8	1	0	0	0		
8	11	0	0	0	0		
9	3	1	0	1	0		
10	6	2	0	0	0		
11	2	0	0	0	0		
12	2	1	0	0	0		
13	0	1	0	1	0		
14	1	0	0	0	0		

iii) Area of forest gardens with general diversity of crops/ livestock varieties of forest gardens

Variable	<b>Participants' responses on Agrobiodiversity (n)</b>					Results	
	The forest gardens have ensured crop rotations, intercropping, crop-livestock systems, etc., which						



	increase the resilience of the system and ensure productive viability					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
0.12	1	0	0	0	0	36.101	0.007
0.5	1	0	0	0	0		
0.9	1	0	0	1	0		
1	11	3	0	0	0		
1.5	3	3	0	0	0		
1.9	1	0	0	0	0		
2	9	3	0	0	0		
2.5	5	0	0	0	0		
3	6	4	0	0	0		
3.5	2	1	0	0	0		
4	5	0	0	0	0		
5	3	0	0	0	0		
6	2	2	0	0	0		
7	2	1	0	0	0		
8	0	1	0	0	0		
10	2	1	0	0	0		
11	0	0	0	0	1		
14	1	0	0	0	0		
20	1	0	0	0	0		
21	0	0	0	1	0		
30	1	0	0	0	0		
31	0	1	0	0	0		
34	0	0	0	1	0		
40	0	2	0	0	0		
56664	0	0	0	2	1		

## iv) Income sources with biodiversity of forest gardens

Variable	Participants' responses on Agrobiodiversity (n)	Results
	Biodiversity: Flora and fauna	

	The forest gardens support a variety of local animals, plants, and micro-organisms						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
None	0	0	1	0		18.065	0.021
Agriculture (FG)	4	0	0	0	0		
Agriculture (FG) & Private	13	9	0	0	0		
Agriculture (FG) and Others	27	8	0	0	0		
Agriculture (FG) and Government	7	1	0	0	0		
Private	4	4	0	0	1		
Own	3	1	0	0	0		
Government	0	2	0	0	0		
Own & Private	0	1	0	0	0		

#### Appendix 4: Non-parametric data analysis on Local and Traditional Knowledge Systems

##### i) Income (RM) with water and soil management

Variable	<b>Participants' responses on Local &amp; Traditional Knowledge Systems (n)</b>					Results	
	The forest gardens have practices and systems of traditional knowledge that allows the agricultural system to function sustainably with respect to water and soil resources.						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
Until 1500	50	10	0	1	0	10.294	0.036
1500-3000	12	7	0	1	0		
3000-45000	2	0	0	0	0		
>4500	2	0	0	0	0		
N/A	0	0	0	1	0		

##### ii) Income (RM) with resilience and sustainability of forest gardens

Variable	<b>Participants' responses on Local &amp; Traditional Knowledge Systems (n)</b>					Results	
	The system has evolved in such a way that it maintains its qualities as a reservoir of invaluable traditional knowledge and practices.						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
Until 1500	46	15	0	0	0	15.658	0.004
1500-3000	16	4	0	0	0		
3000-45000	0	2	0	0	0		
>4500	0	2	0	0	0		
N/A	0	0	1	0	0		

### Appendix 5: Non-parametric data analysis on Culture, Value Systems and Social Organizations

#### i) Age with social organizations supporting the system

Variable	<b>Participants' responses on Culture, Value Systems and Social Organization (n)</b>					Results	
	Social organizations play a critical role in balancing environmental and socio-economic objectives						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
18-30 years old	0	0	0	6	3	8.759	0.013
30-50 years old	8	7	1	23	14		
>50 years old	0	3	1	5	15		

#### ii) Gender contribution with social organizations supporting the system

Variable	<b>Participants' responses on Culture, Value Systems and Social Organization (n)</b>					Results	
	Social organizations play a critical role in balancing environmental and socio-economic objectives						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
Men	2	4	0	25	22	11.975	0.003
Women	1	1	0	1	6		
Same	5	5	2	8	4		

#### iii) Support from government with social organizations supporting the system

Variable	<b>Participants' responses on Culture, Value Systems and Social Organization (n)</b>					Results	
	Social organizations play a critical role in balancing environmental and socio-economic objectives					Man Whitney U test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
Yes	5	2	1	11	4	487.5	0.014
No	3	8	1	23	28		

## iv) No. of crops with traditional culinary culture

Variable	<b>Participants' responses on Culture, Value Systems and Social Organization (n)</b>					Results	
	The traditional crop varieties grown in forest gardens satisfy the locals food preferences and the preparation of traditional dishes					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
1	1	0	0	0	0	27.64	0.01
2	0	2	0	0	0		
3	5	3	0	0	0		
4	6	1	0	0	0		
5	9	1	0	0	0		
6	12	5	0	0	0		
7	8	1	0	0	0		
8	8	3	0	0	0		
9	5	0	0	0	0		
10	8	0	0	0	0		
11	2	0	0	0	0		
12	3	0	0	0	0		
13	0	1	0	1	0		
14	0	1	0	0	0		

## v) Income sources with social organizations supporting the system

Variable	<b>Participants' responses on Culture, Value Systems and Social Organization (n)</b>					Results	
	Social organizations play a critical role in balancing environmental and socio-economic objectives						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
None	0	0	1	0	0	17.184	0.028
Agriculture (FG)	0	0	0	3	1		
Agriculture (FG) & Private	2	4	0	7	9		
Agriculture (FG) and Others	4	6	1	15	9		
Agriculture (FG) and Government	0	0	0	1	7		
Private	1	0	0	6	2		
Own	0	0	0	2	2		
Government	0	0	0	0	2		
Own & Private	1	0	0	0	0		

## vi) Income sources with festive events, rituals and beliefs

Variable	<b>Participants' responses on Culture, Value Systems and Social Organization (n)</b>					Results	
	The festive events, rituals, and beliefs are part of cultural identity and a sense of belonging that are embedded in and belong to the forest gardens						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
None	0	0	0	1	0	16.561	0.035
Agriculture (FG)	3	1	0	0	0		
Agriculture (FG) & Private	11	4	0	6	1		
Agriculture (FG) and Others	23	9	1	2	0		
Agriculture (FG) and Government	7	0	0	0	1		

Private	3	4	0	2	0		
Own	0	2	0	0	2		
Government	1	0	0	0	1		
Own & Private	1	0	0	0	0		

## Appendix 6: Non-parametric data analysis on Landscape features

### i) Level of education with the main planning of the territory

Variable	Participants' responses on Landscape Features (n)					Results	
	The local social organizations have developed strategies, rules, and practices that allow and ensure the maintenance of the territory potentialities and landscape quality.					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	1	2	2	11	9	9.909	0.042
Primary School	2	1	1	19	13		
High School	1	0	1	4	17		
Diploma	0	0	0	0	1		
Bachelor Degree	0	0	0	0	1		

### ii) Income sources with landscape diversity

Variable	Participants' responses on Landscape and Seascape Features (n)					Results	
	Forest gardens can contribute to the preservation of a mosaic of landscapes in this region					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	0	1	0	0	0	16.545	0.035
Agriculture (FG)	4	0	0	0	0		
Agriculture (FG) & Private	19	3	0	0	0		
Agriculture (FG) and Others	27	8	0	0	0		
Agriculture (FG) and Government	8	0	0	0	0		
Private	4	5	0	0	0		
Own	4	0					

Government	2	0	0	0	0		
Own & Private	1	0	0	0	0		

## iii) Income sources with the main planning of the territory

Variable	Participants' responses on Landscape and Seascape Features (n)					Results	
	The local social organizations have developed strategies, rules, and practices that allow and ensure the maintenance of the territory potentialities and landscape quality.					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	0	0	1	0	0	17.955	0.022
Agriculture (FG)	0	0	0	2	2		
Agriculture (FG) & Private	3	3	1	7	8		
Agriculture (FG) and Others	1	0	1	17	16		
Agriculture (FG) and Government	0	0	0	0	8		
Private	0	0	0	6	3		
Own	0	0	0	2	2		
Government	0	0	0	0	2		
Own & Private	0	0	1	0	0		

**Appendix 7: Non-parametric data analysis on Challenges of Forest Gardens**

## i) Age with encroachment of forest gardens

Variable	Participants' responses on Challenges					Results	
	Forest gardens are faced with encroachment of human and economic development into farmlands					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
18-30 years old	2	0	0	6	1	15.727	<.001
30-50 years old	11	8	0	25	8		
>50 years old	15	5	0	3	1		

## ii) Age with dependency of imports of agricultural produces

Variable	Participants' responses on Challenges					Results	
	Dependency on imports of agricultural produces may discourage local farming and thus farmers abandon traditional agricultural practices					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
18-30 years old	1	1	0	5	2	7.092	0.029
30-50 years old	7	19	3	13	11		
>50 years old	0	6	1	6	11		

## iii) Level of education with climate change

Variable	Participants' responses on Challenges					Results	
	One of the challenges of forest gardens is to deal with adverse environmental impacts such as climate change					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	0	1	1	18	5	10.37	0.035
Primary School	1	2	1	20	12		
High School	1	1	0	7	14		
Diploma	0	0	0	0	1		
Bachelor Degree	0	1	0	0	0		

## iv) Level of education with encroachment of forest gardens

Variable	Participants' responses on Challenges					Results	
	Forest gardens are faced with encroachment of human and economic development into farmlands					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	5	6	0	11	1	10.154	0.038
Primary School	9	5	0	18	0		
High School	13	2	0	5	0		
Diploma	1	0	0	0	0		
Bachelor Degree	0	0	0	0	1		



## v) Usage of chemical fertilizers/ pesticides with inheritance of traditional knowledge

Variable	<b>Participants' responses on Challenges</b>					Results	
	The inheritance of traditional knowledge in forest gardens is jeopardized by aging farming populations and depopulation of younger generation						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
Chemical fertilizers only	6	1	1	0	0	11.6	0.009
Pesticides only	1	3	0	0	0		
Both	3	14	0	0	1		
None	35	18	1	1	1		

## vi) Usage of chemical fertilizers/ pesticides with maintenance of forest gardens

Variable	<b>Participants' responses on Challenges</b>					Results	
	Forest gardens are experiencing a decrease in production, poor maintenance and the imminent disappearance of traditional techniques due to fewer people to take over the family farms and continue the traditional practices						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
Chemical fertilizers only	6	1	1	0	0	9.321	0.025
Pesticides only	2	2	0	0	0		
Both	4	12	0	2	0		
None	35	18	1	1	1		

## vii) Contribution of gender with changes in governmental policies and laws

Variable	<b>Participants' responses on Challenges</b>					Results	
	The traditional practices in forest gardens are affected by changes in governmental policies and laws						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
Men	9	17	2	16	9	6.695	0.035
Women	1	2	0	5	1		
Same	10	7	0	6	1		

## viii) Support from government with maintenance of forest garden

Variable	Participants' responses on Challenges					Results	
	Forest gardens are experiencing a decrease in production, poor maintenance and the imminent disappearance of traditional techniques due to fewer people to take over the family farms and continue the traditional practices						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Man Whitney U test	Significance
Yes	8	13	1	1	0	535.5	0.037
No	39	20	1	2	1		

## ix) Support from government with dependency of imports in agricultural produces

Variable	Participants' responses on Challenges					Results	
	Dependency on imports of agricultural produces may discourage local farming and thus farmers abandon traditional agricultural practices						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Man Whitney U test	Significance
Yes	2	11	1	7	22	508.5	0.029
No	6	15	3	17	22		

## x) No. of crops with encroachment of forest gardens

Variable	Participants' responses on Challenges					Results	
	Forest gardens are faced with encroachment of human and economic development into farmlands						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
1	0	0	0	0	1	22.93	0.043
2	0	0	0	1	1		
3	0	1	0	4	3		
4	4	1	0	2	0		
5	3	2	0	5	0		
6	5	4	0	6	1		
7	3	2	0	4	0		
8	6	1	0	3	1		
9	3	0	0	1	1		
10	1	0	0	5	2		
11	1	1	0	0	0		
12	0	1	0	2	0		
13	1	0	0	1	0		
14	1	0	0	0	0		

## xi) Area of forest gardens with encroachment of forest gardens

Variable	Participants' responses on Challenges					Results	
	Forest gardens are faced with encroachment of human and economic development into farmlands					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
0.12	1	0	0	0	0	32.518	0.019
0.5	1	0	0	0	0		
0.9	2	0	0	0	0		
1	7	1	0	6	0		
1.5	1	1	0	4	0		
1.9	1	0	0	0	0		
2	2	2	0	5	3		
2.5	2	1	0	2	0		
3	1	2	0	6	1		
3.5	1	1	0	1	0		
4	1	2	0	2	0		
5	0	0	0	2	1		
6	2	1	0	0	1		
7	1	1	0	1	0		
8	1	0	0	0	0		
10	3	0	0	0	0		
11	0	0	0	0	1		
14	0	0	0	1	0		
20	1	0	0	0	0		
21	0	0	0	1	0		
30	0	0	0	1	0		
31	0	1	0	0	0		
34	0	1	0	0	0		
40	0	0	0	2	0		
56664	0	0	0	0	3		

## xii) Income sources with inheritance of traditional knowledge

Variable	Participants' responses on Challenges					Results	
	The inheritance of traditional knowledge in forest gardens is jeopardized by aging farming populations and depopulation of younger generation					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	0	0	1	0	0	15.708	0.047

Agriculture (FG)	2	2	0	0	0		
Agriculture (FG) & Private	13	8	0	0	1		
Agriculture (FG) and Others	13	20	1	0	1		
Agriculture (FG) and Government	7	0	0	1	0		
Private	3	6	0	0	0		
Own	4	0	0	0	0		
Government	2	0	0	0	0		
Own & Private	1	0	0	0	0		

## xiii) Income sources with maintenance of forest gardens

Variable	Participants' responses on Challenges					Results	
	Forest gardens are experiencing a decrease in production, poor maintenance and the imminent disappearance of traditional techniques due to fewer people to take over the family farms and continue the traditional practices					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	0	0	1	0	0	18.682	0.017
Agriculture (FG)	2	2	0	0	0		
Agriculture (FG) & Private	13	7	0	2	0		
Agriculture (FG) and Others	14	19	1	0	1		
Agriculture (FG) and Government	8	0	0	0	0		
Private	3	5	0	1	0		
Own	4	0	0	0	0		
Government	2	0	0	0	0		
Own & Private	1	0	0	0	0		

## xiv) Income sources with encroachment of forest gardens

Variable	Participants' responses on Challenges					Results	
	Forest gardens are faced with encroachment of human and economic development into farmlands						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
None	0	1	0	0	0	19.68	0.012
Agriculture (FG)	1	1	0	1	1		
Agriculture (FG) & Private	6	4	0	10	2		
Agriculture (FG) and Others	11	5	0	16	2		
Agriculture (FG) and Government	7	1	0	0	0		
Private	1	1	0	5	2		
Own	0	0	0	2	2		
Government	1	0	0	0	1		
Own & Private	1	0	0	0	0		

## xv) Income sources with dependency on imports of agricultural produces

Variable	Participants' responses on Challenges					Results	
	Dependency on imports of agricultural produces may discourage local farming and thus farmers abandon traditional agricultural practices						
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	Kruskal Wallis test	Significance
None	0	1	0	0	0	17.326	0.027
Agriculture (FG)	1	1	0	1	1		
Agriculture (FG) & Private	1	5	1	8	7		
Agriculture (FG) and Others	4	14	0	10	7		

Agriculture (FG) and Government	0	0	1	2	5		
Private	1	5	2	1	0		
Own	1	0	0	1	2		
Government	0	0	0	1	1		
Own & Private	0	0	0	0	1		

## xvi) Income sources with other challenges

Variable	Participants' responses on Challenges					Results	
	Other challenges faced by forest gardens are lack of education, trainings, monitoring, and partnerships on forest gardens					Kruskal Wallis test	Significance
	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree		
None	0	0	0	1	0	17.685	0.024
Agriculture (FG)	0	2	0	1	1		
Agriculture (FG) & Private	13	8	0	1	0		
Agriculture (FG) and Others	12	19	2	1	1		
Agriculture (FG) and Government	5	3	0	0	0		
Private	4	5	0	0	0		
Own	2	2	0	0	0		
Government	0	1	1	0	0		
Own & Private	1	0	0	0	0		