



**PLANT COMPOSITION AND ARRANGEMENT OF  
AGROFORESTRY SYSTEMS IN OIL PALM  
SMALLHOLDINGS AT KLUANG, JOHOR**

**BY**

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**A thesis submitted in fulfilment of the requirement for  
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## ABSTRACT

Malaysia is known as the largest exporter and second largest producer of world palm oil market. Despite such contributions, a huge amount of forest land has been supplanted by oil palm cultivation. This activity is considered as a major driver of deforestation, which contributes to three-quarters of tropical deforestation globally. The critique of this field reveals agroforestry systems as an option to overcome the issues brought up by a monoculture system of oil palm cultivation. This inquiry is directed to study plant composition and arrangement for agroforestry systems in oil palm smallholdings. To this end, three objectives formulated which are: (i) to investigate agroforestry systems as sustainable agriculture practices in oil palm smallholdings, (ii) to explore plant composition and arrangement of agroforestry systems for a sustainable oil palm smallholdings, and (iii) to recommend sustainable plant composition and arrangement of agroforestry systems that can be implemented in oil palm smallholdings. Data were gathered using a qualitative approach involving 10 oil palm smallholdings at Kluang, Johor. Three methods of data collection were adopted, which consists of non-participant observation, semi-structured interview, and document analysis. The collected data were analyzed using thematic analysis that were triangulated to provide systematic, efficient, and accurate data analysis. The findings suggested that there are 50 plant species and 3 types of arrangement suitable to be implemented in oil palm smallholdings. The plant species are in the ranged of perennial crops, annual crops, leguminous cover crops, and grasses. Meanwhile, the arrangement involves triangular, double avenue, and boundary planting systems. Further analysis traced that these plant species and arrangement can be categorized into two main categories which are: (i) sustainable plant composition and arrangement, and (ii) unsustainable into sustainable plant composition and arrangement. The study concluded that the transformation of the monoculture system with low sustainability towards more sustainable farming practices of agroforestry systems can be achieved through five considerations. It is subjected to the oil palm crops as the main component, maturity of oil palm crops, market values and demand, belowground and aboveground interaction, and horizontal and vertical diversification of plant composition and arrangement.

## ملخص البحث

تعرف ماليزيا بأنها أكبر دولة مصدرة لزيت النخيل وثاني أكبر دولة منتجة له في السوق العالمي، وقد جعلت هذه الإسهامات قدراً كبيراً من أراضي الغابات الماليزية يتحول إلى زراعة زيت النخيل، ويعد هذا النشاط عاملاً رئيساً في القضاء على هذه الغابات، مما يسهم في نحو ثلاثة أرباع الغابات المداري على مستوى العالم. وإن الانتقاد الموجه إلى هذا النشاط يكشف أن نظم الزراعة المختلطة بالغابات تعتبر خياراً للتغلب على المسائل التي أثرت من لدن النظام الأحادي المتبع في زراعة زيت النخيل. إن هذا الاستفسار موجهٌ لدراسة تكوين النبات وترتيب نظم الزراعة المختلطة بالغابات في الحيازات الصغيرة لزيت النخيل. زلتحقيق هذه الغاية تمت صياغة ثلاثة أهداف، وهي: أولاً: التحقق من نظم الزراعة المختلطة بالغابات، مثل: ممارسة الزراعة المستدامة لأصحاب الحيازات الصغيرة من مزارع زيت النخيل، ثانياً: استكشاف تكوين النبات وترتيب نظم الزراعة المختلطة بالغابات من أجل استدامة الحيازات الصغيرة لزيت النخيل، ثالثاً: التوصية بتكوين الزراعة الميتمدة وترتيب نظم الزراعة المختلطة بالغابات التي يمكن تنفيذها في الحيازات الصغيرة لزيت النخيل. وقد تمّ جمع البيانات باستخدام المنهج النوعي، حيث اشتمل على عشرة من الحيازات الصغيرة لزيت النخيل في: كلوانج بولاية جوهور، وتمّ اعتماد ثلاثة أساليب لجمع البيانات اشتملت على الملاحظة لغير المشاركين، والمقابلات شبه المقيدة، والتحليل الوثائقي. وقد تمّ تحليل البيانات التي تمّ جمعها باستخدام التحليل الموضوعي؛ حيث تمّ تثليثها للتأكد من تحليل البيانات بشكل منهجي وفعال ودقيق. وتشير النتائج إلى أنّ هناك خمسين نوعاً من النباتات وثلاثة أنواع من الترتيبات المناسبة يمكن تطبيقها على أصحاب الحيازات الصغيرة لزيت النخيل. إن تلك الأنواع النباتية تتمثل في: المحاصيل المعمرة، والمحاصيل السنوية، وغطاء المحاصيل البقولية، والأعشاب. وفي الوقت نفسه فإنّ الترتيب الثلاثي ينطوي على: السبل المزدوجة، وأنظمة زراعة الحواف. وبإجراء مزيد من التحليل يتبيّن لنا أنّ هذه الأنواع النباتية وتلك الترتيبات الإجرائية يمكن تقسيمها على فئتين رئيسيتين، وهما: (أ) تكوينات النظم النباتية المستدامة، و (ب) تكوينات النظم النباتية غير المستدامة. وقد خلصت الدراسة إلى أنّ التحوّل في نظام الزراعة الأحادية مع الاستدامة المنخفضة من أجل تحقيق ممارسة زراعة أكثر استدامة لنظم الزراعة المختلطة بالغابات يمكن أن يتحقق من خلال خمسة اعتبارات، تتمثل في: أن تكون خاضعة لمحاصيل زيت النخيل باعتباره العنصر الرئيس، واشتراط نضج محاصيل زيت النخيل، والقيمة السوقية والطلب، والتفاعل بين سطح التربة وقمة الأشجار، وأخيراً التنوع الأفقي والرأسي في زراعة النباتات وتركيبها.

## APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Built Environment.

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## DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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It is hope that my research could benefit to the public and the person involved in agroforestry systems especially in oil palm cultivation context. *Insyallah*. Lastly, I pray to Allah that all of us can achieve the balance in every development which can meet the sustainability of the environment, social, and economic. *Amin ...*

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## LIST OF ABBREVIATIONS

BPK	Bantuan Penyelenggaraan Kebun
COP	Codes of Practice
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
FRIM	Forest Research Institute Malaysia
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
MPIC	Ministry of Plantation Industries and Commodities
MPOB	Malaysian Palm Oil Board
NAP3	Third National Agricultural Policy
PKNS	Selangor State Development Corporation
QDA	Qualitative Data Analysis
RISDA	Rubber Industry Smallholder Development Authority
RSPO	Roundtable Sustainable Palm Oil
SALCRA	Sarawak Land Consolidation and Rehabilitation Authority
TBSPK	Tanam Baru Sawit Pekebun Kecil
TSSPK	Tanam Semula Sawit Pekebun Kecil
TUNAS	Tunjuk Ajar dan Nasihat Sawit

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.0 INTRODUCTION**

Sustainable development is becoming a dominant criterion in guiding current development in the planning stage. The concept of sustainable development is closely related to the humanity as a human has the ability to create and improve the development to become sustainable during the planning stage (United Nations Documents, n.d.). In order to protect the incorrption of the global environmental and developmental system at the local, national, and international levels (Malaysian Productivity Corporation, 2010), this concept has slowly been adapted by many developing countries such as Malaysia, Indonesia, Brazil, Papua New Guinea, and Zimbabwe (American Mathematical Society, 2014).

Among one of the most vital sectors that needs to be developed in a sustainable way is the agricultural sector. It is reported that food sufficiency, environmental stewardship, and socioeconomic viability and equity are the major paradigms of sustainable agriculture development (Smit and Smithers, 1993; Hansen, 1996; Smith and McDonald, 1998; Devendra, 2011). Sustainable agriculture is a multi-dimensional concept considering the environmental or ecological, social, and economic dimensions (Smit and Smithers, 1993; Smith and McDonald, 1998; Sydorovych and Wossink, 2008; Devendra, 2011; Suryanto and Susila Putra, 2012).

Environmental aspects focus on the plant development, including plant growth and its management, which are affected by the agronomic study of soil, water, and crops (Smit and Smithers, 1993). From an economic perspective, the importance of

sustainable agriculture is seen in its sufficient economic returns as an enterprise at the farm level, and a vital economic sector at the regional and national levels. The sector contributes a large amount in the national gross domestic product (GDP) (Smith and McDonald, 1998; Dahlan Ismail, 2009). Finally, the social dimension suggests that agriculture as the primary supplier for food, fibre, and shelter, which simultaneously provide basic societal needs for human population and boost the quality of life of the surrounding community (Smit and Smithers, 1993; Kassie and Zikhali, 2009). The interaction of these dimensions is known as the principles of sustainability.

On the other hand, agroforestry systems are the approach in sustainable agriculture practices that consider the principles of sustainability. It is defined as a dynamic and harmonious solution of natural resources management with the efforts to integrate trees and animals in farming system (Suryanto and Susila Putra, 2012). The purpose is to increase environmental, social, and economic benefits for both agriculture and forestry sectors. In addition, agroforestry systems are also known as a practice of growing crops, trees, and animals in the same unit of agricultural land by holding the principles of sustainability (Nair, 2011). These imply that the systems have been accepted as an approach in sustainable agriculture practices. It becomes dynamic systems in which the joint application of agricultural crops, plant, and animal species is able to improve the effectiveness of natural resource usage, increase job opportunities and income, as well as an increase pragmatic production system (Devendra, 2011).

In details, this study examines the implementation of agroforestry systems as sustainable agriculture practices in oil palm cultivation, especially among smallholdings. The study concerns about how the plant composition and arrangement of agroforestry systems provide positive and neutral benefits to oil palm growers and

the surroundings. As such, agroforestry interaction between oil palm crops and other plant species are studied as sustainable agriculture practices by concentrating on its environmental and rural quality, sustainable composition and arrangement, as well as factors that contributed to the agricultural sustainability of the systems in oil palm smallholdings. Thus, the study explores and discusses the plant composition and arrangement that has a potential to be integrated in oil palm smallholdings based on its suitability and sustainability.

Accordingly, this chapter presents the introduction of the study, which consists of ten sections. Section 1.0 introduces the research while Section 1.1 explains the research background, as well as the gap of the research. Problem statements are presented in Section 1.2. Sections 1.3, 1.4, and 1.5 review the questions, aim, and objectives of the research, respectively. Next, Sections 1.6 and 1.7 clarify the significance and scopes of the research, respectively. Section 1.8 outlines the research methodology and followed by Section 1.9 which explains the organization of the research. Finally, the summary is presented in Section 1.10.

## **1.1 RESEARCH BACKGROUND**

Agroforestry systems are an attempt to overcome the negative effects of the oil palm monoculture development in the agriculture sector. The systems are seen as a sustainable form of land use options which have the capability to improve the productivity and well-being of rural community (Faridah Ahmad, 2001; Ahmad Fauzi and Huda Farhana, 2006; Nurul Ain et al., 2011). Most importantly, the systems enable oil palm farmers to maximize the utilization of agricultural land in a sustainable way. Therefore, for this research, agroforestry systems refer to various

types of farming practices concerning the composition and arrangement of the components that involve in these systems. The systems must be systematically planned and designed in order to be adopted as a mechanism in planning good agricultural practices (GAP) (Faridah Ahmad, 2001; Ahmad Fauzi and Huda Farhana, 2006; Dahlan Ismail, 2009; Devendra, 2011).

Generally, the evolution of agroforestry systems has been started in Europe, America, Africa, and Asia through shifting cultivation, intercropping, and mixed farming practices (Conklin, 1957; Nair, 1993; Zeleza, 1993). The systems were first implemented in Malaysia through *taungya* method or intercropping in 1950 (Ahmad Fauzi and Huda Farhana, 2006). It involved a combination of agricultural and forestry components of agricultural crops, plant, and livestock species. As the knowledge has been developed, these farming practices were improved by considering the environmental, social, and economic aspects thus known as agroforestry systems. Nowadays, the systems recognized as a new name of old agricultural practices that improved and acknowledged as sustainable agriculture practices (Nair, 1993).

In details, Table 1.0 describes the chronological studies of agroforestry systems as sustainable agriculture practices around the world. The table suggests that the composition and arrangement of agroforestry components are linked to each other in generating sustainable agriculture practices. The concern of the study shows that the systems involve proper organization of land use management, planting design and planning, and technical skills of the farmers. As a result, agricultural land which is systematically planned and designed with proper management, selection of composition and arrangement of agroforestry components, and information on agroforestry systems gives consistent positive and neutral impacts towards the environment, social, and economic aspects.

Table 1.0  
Chronological studies on agroforestry systems around the world

Year	Author	Concern of study
1996	Haselwandter and Bowen	Selection of tree species used in agroforestry, especially silvopastoral systems which influence the performance of soil fertility through the existence of fungus.
1998	Olson	Interrelation between landscape, farm structure, and crop production of agroforestry systems in order to provide balance needs of food, wood, and cash crop production.
1999	Balandier and Dupraz	Influence of component arrangement in tree height growth, diameter growth, tree death, and injury.
2001	Faridah Ahmad	Agroforestry systems as one of the sustainable agriculture practices that consider its sustainability, correct designs, and techniques of the combination between main crops and other crops.
2005	Thakur et al.	Selection and management of suitable agroforestry systems on agricultural fields and sloppy land in order to diversify and increase land productivity.
2006	Ahmad Fauzi and Huda Farhana	Recommendation on the most sufficient composition and arrangement based on economic feasibility.
2007	Thakur, Dutt, and Singh	Evaluation and development of suitable composition and arrangement of medicinal and aromatic herbs with timber tree species for diversification of land use option.
2010	Parwada et al.	Levels and factors that affect the adoption of agroforestry systems between trained and untrained farmers.
2011	Nurul Ain et al.	The sustainability on the composition and arrangement of the agroforestry components is examined through the development of diameter at breast height of the main crops.
2012	Suryanto and Susila Putra	Management of agroforestry systems in order to increase the application of the systems.

Since the study is concentrating on the implementation of agroforestry systems within oil palm cultivation in the Malaysian context, Table 1.1 further summarizes the benefits of the systems based on the environment, social, and economic aspects. Based on the concern of the study, it shows that oil palm crops in Malaysia tend to be integrated with livestock of cattle instead of goat, buffalo, and chicken. The integration that known as a silvopastoral sub-system is largely integrated within oil palm crops due to the decreased availability of arable land, as well as rapid demand for animal protein production include meat and dairy product (Dahlan Ismail, 2009; Devendra, 2011).

In contrast, studies that analyzed the integration between oil palm crops and other plant species or known as agrisilviculture sub-system are only slightly developed and undervalued its potential, especially towards the environment. As mentioned by Devendra (2011), the initial focus of sustainable agriculture is on environmental aspects. However, it has expanded into broader socioeconomic and political aspects rather than environmental aspects. As the knowledge on sustainability has been spreading in all sectors, it is important to draw attention on the environment, social, and economic benefits of agroforestry systems especially with the integration of oil palm crops and other plant species. Remarkably, the benefits on the environmental aspects are simultaneously giving positive and neutral impact on socioeconomic aspects.

Accordingly, the table further summarizes that studies on the composition of agroforestry components in oil palm cultivation are given attention by many researchers in the early 2000 to present due to its benefits of the environment, social, and economic aspects. However, the earlier studies are mostly focused on the socioeconomic benefits such as increase yield production, additional income for the farmers, and decline cost of weeding and herbicides instead of environmental benefits. Then, in the early 2010, studies on environmental benefits has been spreading among the researcher, especially governmental sector include Malaysian Palm Oil Board (MPOB), Sabah Forestry Department, and Forest Research Institute Malaysia (FRIM). Consideration on three aspects of environment, social, and economic benefits was further developed in the current studies.