Challenges in Managing Oil Palm Nursery and Effects of Fertilization on Oil Palm to Increase Production and Profitability

By

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Research Project Submitted in Partial Fulfilment of the Requirements

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DECLARATION

I hereby declare that the research project is based on my original work except for quotations and citations that have been duly acknowledged. I also declare it has not been previously or concurrently submitted for any other degree at Universiti Tun Abdul Razak (UNIRAZAK) or other institution.

Signature :

Name :

Date :

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I'm appreciative to Allah S.W.T, the most charitable and the most forgiving, for the gift to achieve this undertaking.

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Tissue culture-derived planting materials have been proven to outperform the productivity, in which most clones have reportedly surpassed the standard performance by at least 20% on average in terms of fresh fruit bunch (FFB) yield on a per hectare basis. This advantage seems to benefit the industry players as higher productivity will lead to higher income. However, the cost of producing clonal materials is considered as one of the major bottle-necks in the large scale usage of clonal planting materials in the oil palm industry. There is limited data on the most suitable fertilizer type used, method and rates of fertilizer application for these clonal seedlings. A similar compost type, technique and paces of use for DXP seedlings is being utilized by Sawit Kinabalu Sdn Bhd for clonal seedlings. This study aims to evaluate the impacts of different type, method and rates of compostused on the development and leaf supplement content of clonal palm seedlings. Two isolated factorial totally randomized planned areas were selected to study at Gomantong Estate, Kinabatangan. Trial one showed no critical contrasts between all compost application techniques and rates on the vegetative development of the seedlings. A result shows that customary compost application was satisfactory to prescribe to the clonal palm seedlings to accomplish standard vegetative development before field planting. Results of the study showed no critical difference between manure proportion and rates on the vegetative development and leaf supplement content of the clonal palm seedlings. The leaf nutrient content had shown at the optimum level from the standard nutrients required by oil palm seedlings. Therefore, symptom of disorder known as white stripe that normally affecting DXP seedling was discovered happen to clonal palm seedling when higher dosage of N being applied. The study of both experiments found that there was no deterioration in the soil properties over 12 months at the nursery stage. There was no response of higher dosage of fertilizer applied in both experiments. The selection of methods of application and types of fertilizer depends on the size of the nursery and number of workers availability.

CHAPTER 1
INTRODUCTION

Palm oil industry in Malaysia has developed and dynamic industry. Oil palm is one of the principal drivers of Malaysia's farming area, contributed 30.1 percent to 32.3 percent per annum of agribusiness' GDP for the time of 2006-2010 (Statistic, 2006-2010). Altogether, the job of this industry is not just towards building the monetary based, yet additionally to accomplishment the financial goal. The historical backdrop of oil palm as of now ranges across over 100 years in Malaysia, subsequently offering benefit to this nation as one of the effective producers of oils and fats on the planet (PEMANDU, 2010).

1.1 Oil Palm and Clonal Industry

Oil palm (*Elaeis guineensis*) is a tropical tree (crop) which primarily produce vegetative oil. The oil palm demand has been increasing over the past decades. Palm oil demand is expected to grow at a similar rate to meet the demand for the growing population. However, the production of palm oil depends on the availability of suitable planted area, soil, location and environment, stable high temperature and rainfall. This growth of palm trees are process is influenced by moisture and temperature conditions, fertilization and other secondary ecological factors (Corley and Tinker, 2003).With the limited arable land, the production of oil palm has been declined in Malaysia (MPOB, 2018). The strategy to increase oil palm production within the limited area is productivity increase and reduction of production cost.

Clonal oil palm extends the potential for increasing productivity because clonal oil palm is highly productive and has uniform tree stands comprising identical copies (clones) of a limited number of palms. Cloning is a process in which identical of a selected palm (ortet) are reproduced by developing plantlets from the leaf tissue of tenera oil palms. The identical characteristics e.g., higher yield of palm products per hectare, disease resistance, drought tolerance, and small height increment).

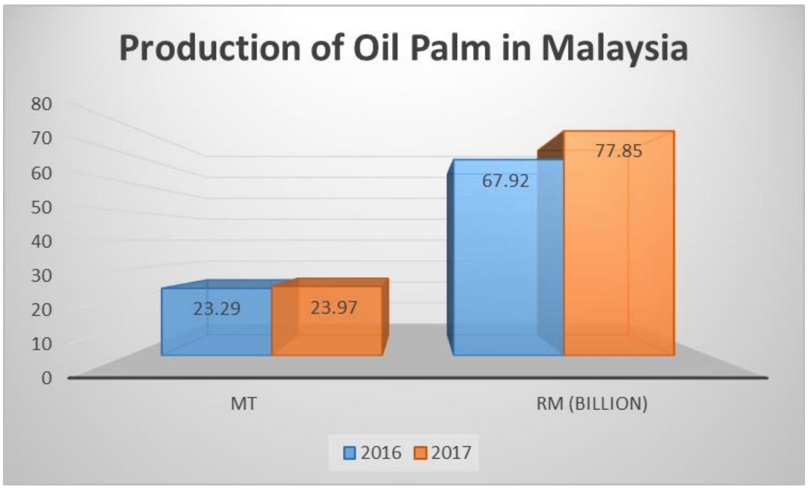
The whole process of oil palm starts from initial tissue culture to the matured stage and field-tested clones takes about 10 years. Out of total, only 40 percent of ortets are developed into viable clones. Therefore, production of clone requires a large land area of elite palms for example 10,000 per year in order to select the ortets. Generally, a small number of plantlets (100 to 10,000) can be produced from a single ortet, and each ortet can only be harvested for leaf explants once in 3 to 5 years.

Clonal oil palm introduced in the 1970s. Over the decades, clonal oil palm has been successfully planted in several thousand hectares in Southeast Asia. In Malaysia, nearly 100,000 mature clones in the field have been successful. The incidence of abnormality rate in the plots was very small (less than 1 percent). Clone yield was 30 percent higher compared with DxP material grown in commercial test plots. However, it requires more fertilizer inputs to sustain higher yields in clonal oil palm, but it is worth that clonal oil palms use fertilizer more efficiently compared to DxP seedlings (Woo et al., 1994).

Therefore, in spite of the greater cost of clones compared with DxP material and their greater fertilizer requirements, clones offer a large economic advantage over DxP material. Soil readiness is huge task for oil palm plantation during the dry months. In 2009, creation of clonal oil palm in Malaysia was 2.53 million ramets and should be expanded (Khuzairy et al., 2010). Malaysia Palm Oil Board – MPOB (2017) statistics show that, the Malaysian oil palm industry showed excellent performance in 2017. Crude palm oil (CPO) production and fresh fruit bunch (FFB) yield witnessed significant increases following recovery from the impact of the El-Nino phenomenon in the previous year.

The Department of Statistics, Malaysia, show that higher palm oil costs and further developed. Oil palm established region in 2017 arrived at 5.81 million hectares, an expansion of 1.3% as against 5.74 million hectares in the earlier year. Sarawak overwhelmed Sabah as the biggest oil palm established state, with 1.56 million hectares or 26.8% of the absolute Malaysian oil palm established region, trailed by Sabah with 1.55 million hectares or 26.6% and Peninsular Malaysia with 2.70 million hectares or 46.6%.

__Table 1:__ Production of Oil Palm in Malaysia (2016-2017)



All out fares of oil palm items rose 2.9% to 23.97 million tons in 2017 from 23.29 million tons sent out in 2016. Essentially, complete fare income expanded forcefully by 14.6% to RM77.85 billion when contrasted with the RM67.92 billion out of 2016 because of higher fare volume and cost.

1.2 Nursery Management Overview

The first and most important task is to establish material, regardless of whether plants, seed or clonal ortets, buy from a respected provider. The ideal nursery site require suitable land, close to a reliable water source, over the flood level and has a dirt source reasonable for pack filling near to the plot. As indicated by Sawit Kinabalu nursery's strategy, the nursery framework is intended to give a controlled and helpful climate for oil palm seedlings to develop, particularly during early stage. Two types of nurseries: the single stage nursery and the two-stage nursery. These two practices should be possible in either polythene sacks or in the open field. The pre-nursery stage serves to distinguishing any unacceptable and unfortunate seedlings for oil palm replanting purposes. In this way, the pre-nursery is a course of getting ready and choosing oil palm seedlings so that eventually, simply the best seedlings or ramets will go through the following nursery stage. Mulching in the nursery stage has been observed to be useful. Water is fundamental for huge number of physiological cycles that happens inside the seedlings, and the upkeep of an unlimited water supply to seedlings requires steady carefulness to forestall over-watering and waterlogged.

An unassuming and adjusted manure supply is additionally vital. An infections that is exceptionally normal in the nursery is leaf spots and further evening flying bugs, crickets, grasshoppers and leaf cutting insects are among bugs that assault the seedlings. Accordingly, showering of fungicide and insect poison is a typical practice in the nursery.

Tissue culture-derived planting materials have been proven to outperform the standard dura x pisifera (DxP) materials, in which most clones have reportedly surpassed the standard DxP performance by at least 20% on average in terms of fresh fruit bunch (FFB) yield on a per hectare basis. This advantage seems to benefit the industry players as higher productivity will lead to higher income. However, the cost of producing clonal materials is considered as one of the major bottlenecks in the large-scale usage of clonal planting materials in the oil palm industry. Past studies suggests that the clonal planting material is a viable venture and worth investment as it provides better yield, both in terms of FFB and oil yield, which translates into better returns for the industry players despite the premium price of clonal materials as compared to that of the seed derived standard DxP.

The yield potential for oil palm's long term useful life is generally characterized during the initial year, from seed planting in the nursery until the planting at the field. A significant precondition for the advancement of any tree crop is the arrangement of good quality uniform establishing material chose for energy and effectively planted at the fitting establishing thickness. While botches in upkeep can be rectified, carelessness in nursery choice detrimentally affects yields all through the useful existence of the stand and can't be revised without any problem. A lot more noteworthy consistency is normal once clonal material is presented, yet as long as seedlings are raised from seed, a decent nursery and merciless winnowing are the foundations for the improvement of exceptional returns and productive fertilizer utilization.

1.3 Problem Statement

Many factors contribute to this high productivity of oil palm, improved planting materials, agronomy and management. Amongst them, fertilization was the most important contributor accounting for 29% of the yield increment. Fertilizers not only have the greatest impact on productivity but also commonly constitute the highest operational cost in well run plantations in Malaysia. It plays a pivotal role in the sustainability and profitability of oil palm.

Getting the fertilizer rates right is only the first step and one of the key factors in the fertilizer management system. We need to ensure that the fertilizers are appropriately applied according to recommended practices for maximum uptake and utilization by the palms i.e. maximizes fertilizer use efficiency.

Fertilizer application is among the main errand in oil palm development. It is exorbitant and establishes about 25% of the functional expense during the nursery time frame (Sawit Kinabalu, 2017). To guarantee solid palm development and to set up the palm to support significant returns during the useful years it is fundamental and critical to guarantee that compost application is done accurately and that all palms get satisfactory and adjusted sustenance.

1.4 Current Problems Faced by the Oil Palm Industry

Pests and diseases as of now represent a critical danger to oil palm development. The harvest yield can decay seriously when tainted by vermin and sicknesses that rival the palm for supplements and harm the trees. Significant nuisances known in oil palm estate are defoliators, which incorporate bagworms (Metisa plana and Pteroma pendula), bother and slug caterpillars (Darna spp. What's more, Setora nitens), moth, rhinoceros creepy crawly, and so forth In Johor Bharu, Malaysia, defoliation by bagworm and Limacodids cause misfortunes in the harvests yield more than 4 tons of new natural product bundles (FFB) per section of land with half defoliation, at 4 to a half year after the assault. In one more review directed in Sabah, Malaysia, S. nitens was accounted for to lessen the creation of FFB (27 tons for each section of land) during 30 months with 60% defoliation. In Indonesia, the yield misfortune was up to 70% in the main year after defoliation and can increment up to 90% in the next year. In an Indian overview from 1995 to 2002, Acria sp. was accounted for to cause a 29% yield decrease in the primary year, 31% in the subsequent year, and 21% in the following resulting year.

To smother these assaults, the utilization of bio-pesticides and organic control strategies are supported by supporting the hunters and parasitism just as pheromone catching. Another issues in the oil palm industry is declining oil extraction rate (OER) and the tremendous creation of build-up and waste. OER alludes to the rate weight of palm oil created from the known load of FFB in the creation of palm oil in palm plants. In 2017, normal OER in Malaysia declined to 19.7% contrasted with the earlier year, with 20.2%. The bad quality of FFB, just as environmental change, may be supporters of this issue. Aside from that, the oil palm industry and palm oil factories produce about 90% of bio-squander, as oil just records for 10% of the biomass. Inappropriate treatment of this build up and bio-waste might prompt ecological and wellbeing worries, as it can add to eutrophication, contamination, and some other kind of aggravations for both amphibian and earthbound life.

The standards of the supplement spending plan have served us well as confirmed by the high efficiency of oil palm notwithstanding it being developed to a great extent on endured, corrupted soils in the jungles. This lack should be addressed rapidly to comprehend the different marvels found in the fields, like pre-mature frond drying up, connection among irritation and infections and palm sustenance the root framework and its system for supplement take-up, and the jobs of plant nourishment in environmental change among others and foster new bearings for concentrating on plant sustenance and better, common sense manure use innovation. Fresher agronomic information are presently accessible and these examinations are directed with later age of establishing materials and current suggested the board rehearses on more different soil types and conditions, which are presumably more pertinent to the oil palm industry today.

Subsequently, it seems intelligent to lead another meta-investigation of these more up to date information. The palm oil factories ought to be viewed as enormous stores or supplies of supplements/composts and carbon/natural matter. The current strategies to use these assets are as yet dreary, relentless, awkward and restricted to explicit regions. Innovation, methods and hardware are currently accessible and there are not really any justifications for why these investigations can't be embraced effectively. What is required is innovativeness and resourcefulness to take care of the issues.

In this way, the fate of successful composts, fertilizer use proficiency and fertilizer management, and the subsequent usefulness of oil palm dwell in constant age of new material sciences, reception of new advances and planning new techniques to execute them accurately and effectively, and lessening the vulnerabilities identified with compost the executives.

1.5 Research Question

1. Whether the cost of inputs is higher for oil palm nursery plants
2. How the clone nursery growth differs between the production systems?
3. How the cost of fertilizer impact on the productivity and growth of oil palm?

1.6 Objective of the Study

The main objectives of the study are:

i. To examine the relationship between the cost of inputs (labour, fertilizer) and oil palm nursery growth and yield.
ii. To examine the effects fertilizer application methods on the growth of ramets at nursery stage
iii. To determine the best fertilizer rate for clonal ramets to achieve the standard growth at nursery stage.

1.7 Significant of the Study

Fertilizer management is a significant part in the efficiency and benefit of the oil palm. The high manure costs and additionally low palm oil costs, inquiries concerning how compost rates can be managed and chances oversaw will be as often as possible inquired. Lamentably, there are no broad convenient solutions and people need to survey for themselves the dangers they will take (Murrell, 2009) and falling back to the core values of manure the board of oil palm.

In view of the investigations, a couple of proposals can be recommended to grower or people who are associated with the new establishing material of clonal palm to work on vegetative development and accomplish ideal supplement take-up for better field planting. More prominent measures of manure supplement inputs are needed to support more significant returns in clonal oil palm, yet clonal oil palms additionally use compost supplements more effectively than DxP seedlings, (Woo et al., 1994).

This review will survey the distinctive compost prerequisites among DXP and Clonal palm at nursery stage. The reason for this review is to decide the preparing technique and best pace of manure application for clonal ramets where right now there are no norm or rules of proposal treating practice for clonal ramets. In other issue, the indication of confusion known as white stripe influence DXP seedling at six to a year old however for the ramets is obscure. A reasonable clarification for this indication is supplement unevenness (Gillbanks, 2003).

This advantage of this review is agronomists to suggest the proper manure applications for the clonal ramets all things considered and to audit the new compost rate necessities for the DXP for fantastic development, cost viability, winnowing rate and age for field planting. A decent administration particularly in manure application for ideal supplement take-up will decide the yield capability of the oil palm at first Year reaping. The limit of the nursery region can be maximally used if the winnowing rate is diminished. The work necessities subsequently by implication diminished just as to the expense of creation.

This review is huge on the grounds that it can give the compost proposals to the business particularly for the clonal palm at the nursery stage. Proper technique for manure application and exact proportion of NPK will decide the ideal yield per hectare during the main year of gathering. Ideal compost will supply adequate supplements in adjusted extent to guarantee sound vegetative development and ideal monetary yields and to limit squander identified with over-preparing. By joining proper technique and proportion of compost application, the likely yield of clonal palms which is over 15% better than regular DXP material referenced by Soh (1995) can be chronicled.

CHAPTER 2
LITERATURE REVIEW

Introduction

This chapter will discuss about the oil palm nursery plantation and productivity and growth of oil palm in Sabah Malaysia. The literature reviews provided some theoretical and empirical studies regarding factors affecting costs of plantation to adapt cost effective production management of oil palm. The reviews provide some current situation of clonal oil palm system for improving productivity and benefits from oil palm production.

2.1 Oil Palm Production in Malaysia

Palm oil creation is fundamental for the economy of Malaysia, which is the world's second-biggest maker of the product after Indonesia. The Malaysian Palm Oil Board (MPOB) is an administration organization liable for the advancement and improvement of the palm oil area in the country. The nation's palm oil industry produces around 90 million tons of lignocelluloses biomass, including empty fruit bunches (EFB), oil palm trunks, and oil palm fronds, just as palm oil mill effluent (POME). In 2010, in light of worries about friendly and natural effect of palm oil, the Malaysian Government vowed to restrict palm oil estate development by holding half of the country's property as woodland cover.

Table 2: *Palm Oil Plantation Area in Malaysia (1975-2012)*

Palm oil plantation area in Malaysia by year (1975-2012)		
Year	Plantation area (million hectares)	Percentage over total land area in Malaysia
1975	0.64	1.9%
1980	1.02	3.1%
1985	1.48	4.5%
1990	2.03	6.1%
1995	2.54	7.7%
2000	3.37	10.2%
2005	4.05	12.2%
2012	5.10	15.4%

In the middle 1960s, palm oil development expanded altogether under the public authority enhancement program to decrease Malaysia's reliance on rubber and tin. The FELDA land settlement plans were presented encompassing the vast majority of the palm oil estate fields to destroy destitution among the neighbourhood individuals. In a similar period, Malaysia likewise turned into the world's biggest palm oil exporter. During the 1980s, the public authority nationalized three significant palm oil organizations, which were Guthrie, Golden Hope and Sime Darby.

Table 3: *Palm Oil Plantation Area by State (2016)*

Palm oil plantation area in Malaysia by state (2016)			
State	**Plantation area (hectares)**	**Percentage of total plantation area**	**Percentage of state area**
Sabah	1,551,714	27.0%	21.1%
Sarawak	1,506,769	26.3%	12.1%
Johor	745,630	13.0%	38.8%
Pahang	732,052	12.8%	20.3%
Perak	397,908	6.9%	18.9%
Negeri Sembilan	178,958	3.1%	26.8%
Terengganu	171,943	3.0%	13.2%
Kelantan	155,458	2.7%	10.3%
Selangor	138,831	2.4%	17.1%
Kedah	87,786	1.5%	33.7%
Melaka	56,149	1.0%	13.5%
Penang	14,135	0.2%	9.2%
Perlis	652	0.0%	0.8%

2.1.1 Oil Palm Ecology and Growing Condition

Oil palm is an agribusiness crop that needs regular assets for developing. At first it was planted as fancy harvests before business planting began in 1917. Be that as it may, the huge scope development didn't take off until the 1960s, following the public authority's yield expansion push technique to diminish the country's reliance on elastic (CH. Teoh, 2002). As a mechanical harvest, appropriate land and environment condition for manor are significant components to advance development and creation. The palm oil plant grows within 10 degrees in latitude from the equator; however ideal growing conditions are within five degrees.

Therefore, the vast majority of palm oil delivering nations are situated around the equator that hold the most elevated thickness of palm trees around Southeast Asia locale, including Malaysia that is normally enriched to establish oil palm. Development of oil palm is consider reasonable in the profound very much depleted medium topsoil soil, wealthy in humus with an all-around disseminated precipitation of 2,500 to 4,000 mm for each annum and a temperature scope of 19-33° C. It is a water-cherishing yield and it requires sufficient water system. In any case, this harvest reacts well to trickle water system and yields are accounted for to increment by something like 20%. Oil palm is planted in three-sided framework at dispersing of 9x9x9m obliging 143 plants in a hectare. Planting should be possible in any seasons, yet the best time frame ought to associate with June to December. Oil palm requires satisfactory water system, as it is a quickly developing harvest with high efficiency and biomass creation. For yielding palms of over three years old, at least 150 liters each day is required while for the more seasoned estates the necessity goes up to 20 liters each day. So, oil palm estate is considers appropriate to be planted in the marsh evergreen jungle especially peat trade region that help the most elevated biodiversity of any earthbound biological systems and shrouded practically all regions in Southeast Asia especially Malaysia and Indonesia.

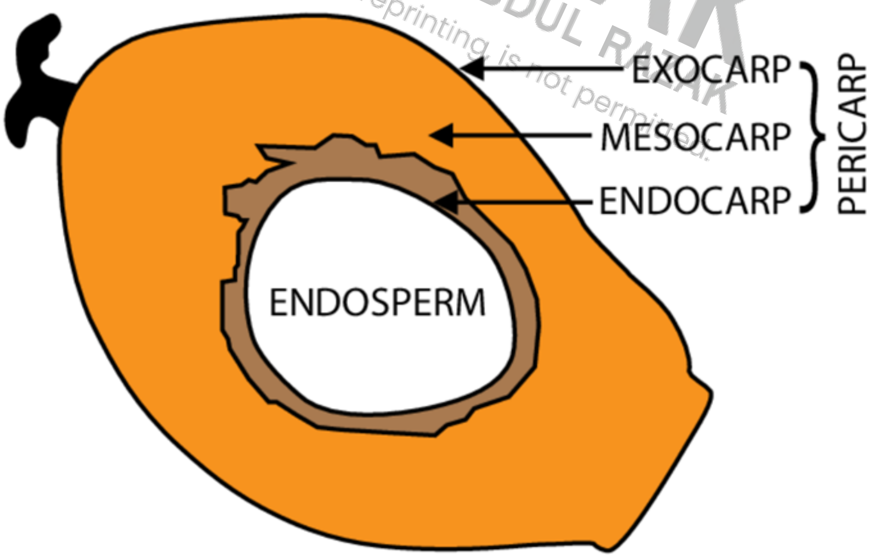


Figure 1: *Cross section of Oil Palm Fruitlet*

There are three oil palm assortments, Dura, Pisifiers and Tenera, use for mechanical creation. The oil palm fresh fruit bunches (FFB) are extraordinary harvest item which can deliver two kinds of oil. Crude palm oil (CPO) is gotten from the mesocarp while palm portion oil can be acquired from the piece inside the nuts (S.Vijaya, et al 2010).

A B C

A: *Dura* B: *Tenera* C: *Pisifera*

Figure 2: *Type of Oil Palm varieties*

Once gathered, the FFB should be treated in an oil factories within 24 hours to safeguard quality of oil. In typical conditions preparing factory plants will be worked inside the space of estate. Supply of top notch seed, seedling and youthful palms from reproducers and nursery activity are among significant factor for each estate to be achievement in long term. Typically a sprouted seed will be refined in the pre-nursery for a long time prior to climbing to nursery for extra nine to 10 months. After this underlying stage, the plant will be moved to ranch region for ordinary developing. The principal harvestable organic product early lunch will be delivered following 30 to three years in the ranch region and typically just weight between a few kg. The pinnacle efficiency of natural product informal breakfasts will happen in the eighth to fifteenth long periods of estate. The tree can reach up to 70 to 100 feet in tallness and normally will be taken out from creation once arrive at 25 feet which matches with as far as possible weight. The unbranched oil palm tree can satisfy 200 years, yet monetarily practical existence of length is around 22 to 25 years prior to chopping down for replanting.

2.1.2 Economic costs and returns from Oil Palm

The review of the oil palm plantations in all tropical regions show that oil palm is the most productive crop, and it is used in a variety of food and consumer products (Byerlee et al., 2016). Oil palm generates substantial economic returns and contributes to improve living standards (Euler et al., 2017). Oil palm plantations are managed differently, which determine their productivity and profitability (Corley and Tinker, 2016).

The main management activities include harvesting, pruning, weeding and fertilizing activities. These activities require major costs for producing commercially used oil palms. There are two main management strategies: weeding and fertilization. However, limited evidence are available about the weeding and fertilization practices that affect productivity and economic profitability. It is commonly understood that fertilization increases the growth rate and productivity of oil palm. However, fertilization is associated with negative environmental effects, such as greenhouse gas emissions, nutrient leaching losses (Hassler et al., 2017; Kurniawan et al., 2018). Lack of understanding on how different fertilization management strategies are related with oil palm productivity.

In order to increase yield, fertilization rates will also increase and thus fertilizer costs linearly increase. Therefore, income generated by the investment in fertilizer after deducting the expenses is highest before maximal yield levels are reached (Corley and Tinker, 2016). In other crops, when exceeded the economically optimum fertilization level, nutrient losses increase and results in negative environmental impacts (e.g., soil acidification, groundwater pollution). Chronic application of nitrogen fertilizer like urea reduces base cation availability (Lungu and Dynoodt, 2008; Corre et al., 2014; Cusack et al., 2016); it also reduces microbial biomass (Corre et al., 2010; Baldos et al., 2015) and leads to large changes in soil fungal communities (Brinkmann et al., 2019).

The application of less fertilizer may also increase profitability in the short term, because soils and palm trunks in mature oil palm monocultures already accumulated high amounts of nutrients (Nazeeb et al., 1993; Hanum et al., 2016). After this transition, profitability could be high due to fertilizer cost savings even if yields were lower under reduced fertilization.

FELDA is the world's greatest oil palm grower with established region near 900,000 hectares in Malaysia and Indonesia. FELDA considers as a critical driver for the advancement of palm oil industry in the country. It was set up by the public authority in 1956 with the socio-economy obligation of creating estate land for the landless and country helpless Malays (Yaacob, 1991). During the underlying foundation, FELDA engaged with the advancement of horticulture based settlements, planted with estate crops, at first with elastic and consequently with oil palm by opening new ranch regions, mostly by logged over woodland land (CH.Teoh, 2002).

The concentrate step by step changed to business advancement the executives of manors on a business premise since there was restricted of timberland land to be created. The primary planting of oil palms under the FELDA conspire was in 1961 at the Taib Andak Complex in Johor, Peninsular Malaysia and involved 8,100 hectares of land. In 1965 the absolute established region under the FELDA expanded to in excess of 11,000 hectares, or 11.4 percent, of complete oil palm regions (Pletcher, 1991). The contribution of FELDA in oil palm estate was one of the drives under the new economy procedure known as New Economy Policy (NEP), reported in 1971.

2.1.3 Supply Chain in Oil Palm Industry

The palm oil industry is one of the profoundly coordinated areas in the farming framework; comprises of upstream and downstream area which are effectively complete one another to turn out to be more evolved and enhanced area. Be that as it may, the improvement of this industry is still vigorously slanted towards upstream exercises and the downstream is still yet to be completely investigated. Throughout the most recent 50 years, R&D exercises and innovation have assisted raising with yielding and accordingly expanding the creation of oil palm. For the most part the palm oil inventory network can be partitioned into four major sections of upstream creation, halfway exercises (exchange and transport), downstream handling and buyer creation (Sime Darby, 2009). These sections can be limited to central parts that have direct engaged with the oil palm creation like estates or producers, mill operators, purifiers, processors, makers and retailers (CH. Teoh, 1999).

The upstream area of the oil palm industry comprises of a few gatherings of makers that play significant part to guarantee the supporting inventory of this significant vegetable oil to the entire world. Palm oil area has exceptional mix of proprietorship and is fundamentally isolated into two major elements of private possession and smallholder. Smallholders can be additionally assembled into coordinated smallholder under the administration of government offices and autonomous smallholders which represents 25 percent and 14 percent of absolute developed region separately (MPOB, 2012). While the remainder of 61 percent of complete developed region is overwhelmed by huge ranch organizations either exclusively possessed by the private or government-connected organization, as displayed in Table 4.

Table 4: *Oil Palm Planted Area by Category*

Category	Hectare	Per centage
Private Estates	3,037,468	60.7
FELDA	703,027	14.1
FELCRA	162,259	3.2
RISDA	79,743	1.6
Other Government/States Agencies	319,786	6.4
Independents Smallholders	697,826	14

SOURCE:MPOB WEBSITE

As indicated by the definition utilized by the Roundtable on Sustainable Palm Oil (RSPO), free smallholders are characterized as ranchers who are delivering palm oil dependent on family-undertaking proprietorship and generally own under 50 hectares of land. This gathering of ranchers has opportunity in settling on choice on their territory, independent, self-financed and not authoritatively bound with any plants or affiliations. They deal with the land without direct help from the public authority or privately owned business and sell their harvests straightforwardly to plants or brokers. Notwithstanding, to guarantee the efficiency of palm oil, government through particular office will give the help and supports. Then again, solidified smallholders which are described as ranchers who legally limited by credit arrangement and certain arranging just as being administered in planting and the board procedure by either government plans or processes. In Malaysia, this kind of smallholder enlisted into the exceptional government conspire and oversaw by the provincial advancement like FELDA, RISDA and FELCRA.

The greatest palm oil development regions are claimed by the private through ranch organizations' possession. The private area has been the fundamental driver for development in the turn of events and creation of palm oil over the most recent twenty years (B Ramasamy, 2005). This substance holds 61% of absolute developed oil palm regions since 1980 with all out spaces of 3.07 million hectares in 2011. The spans of palm oil organizations shift impressively, contingent upon the size of their ranch domains which range from a couple hundred hectares to more than 100,000 hectares. The vast majority of the organizations are recorded in the fundamental leading group of Kuala Lumpur Stock Exchange (KLSE) in Malaysia just as on the unfamiliar security sheets.

The downstream business covers all exercises for preparing oil palm into semi-completed materials as refined oil prior to trading to different nations. Delivering refined oil gives a tight edge which in the end is giving low profit from value. Notwithstanding, for organizations that gets into the more worth added portions of the chain, which is handled food creation, wellbeing food sources, oleo synthetics, and marked items, edges may go up altogether. Hence, the business is at present moving the concentration from the general refined items to the more particular high worth added items to climb the worth chain. In the oleo compound industry, palm oil and palm piece oil are utilized to create different synthetic feed stocks, for example, unsaturated fats and greasy esters, which are needed in the assembling of different non-food items. Likewise, palm oil can likewise be straightforwardly used to create bio fuel.

2.1.4 Palm Oil Benefits and Advantages

Palm oil has arisen as the significant wellspring of vegetables oils in the worldwide market because of its intensity and benefits when contrasted with other oilseed crops. Many investigations uncover a few factors that add to the effective of oil palm in the worldwide oils and fats market. Cost of palm oil is more serious than different vegetables oils. Therefore the utilization of palm oil recorder high development pace of 7.9 percent yearly contrasted with soy oil which recorded development pace of 5.6 percent during the beyond 40 years (Basiron, Balu and Chandramohan, 2004). The usefulness per unit space of palm oil is higher than some other yield (Ming and Chandaramohan, 2002). Creation of palm oil is more economical than different vegetables oils since it burns-through extensive less energy underway because of long useful life expectancy of 25 years, utilizes less land as far as expansive section of land development strategy and produces more oil per hectares analyzes to different oils.

In term of yield, oil palm creates the most elevated weight of oil per hectare each year contrast with other vegetable oils, as introduced in Table 5. In examination with soybean oil which produces 446 liters/hectare, palm oil can create 5,950 liters/hectare that is 12 times more.

Table 5: *Yield per Hectare for Major Vegetable Oils*

Source	Yield (liters/hectare)	Comparison of yields
Palm	5,950	1.00
Coconut	2,689	0.45
Jatropha	1,818	0.31
Rapeseed	1,190	0.20
Soybean	446	0.07

Another contributing element prompts increment interest of palm oil in the worldwide market is because of increment wellbeing mindfulness among shoppers. This trans-fat free oil contains two kinds of Vitamin E as cancer prevention agent: tocotrienols and tocopherols (Figure 3). Tocopherols can be sourced from other vegetable oils, for example, soy oil, canola and sunflower while tocotrienols are just accessible in high moves in palm oil.

Tocotrienols is more remarkable enemy of oxidant and stronger than tocopherols which ready to bring down the blood cholesterol levels, relapse the atherosclerotic plaques in stroke patients, hinder the section of white bloods cells into blood vessel divider and ready to restrain blood cluster arrangement in the circulatory system. By thusly, palm oil shields an individual from some persistent infections just as defer the maturing system of the body.

In this cases, palm oil is the most likely option chosen by food producers due to its natural semi-solid feature.

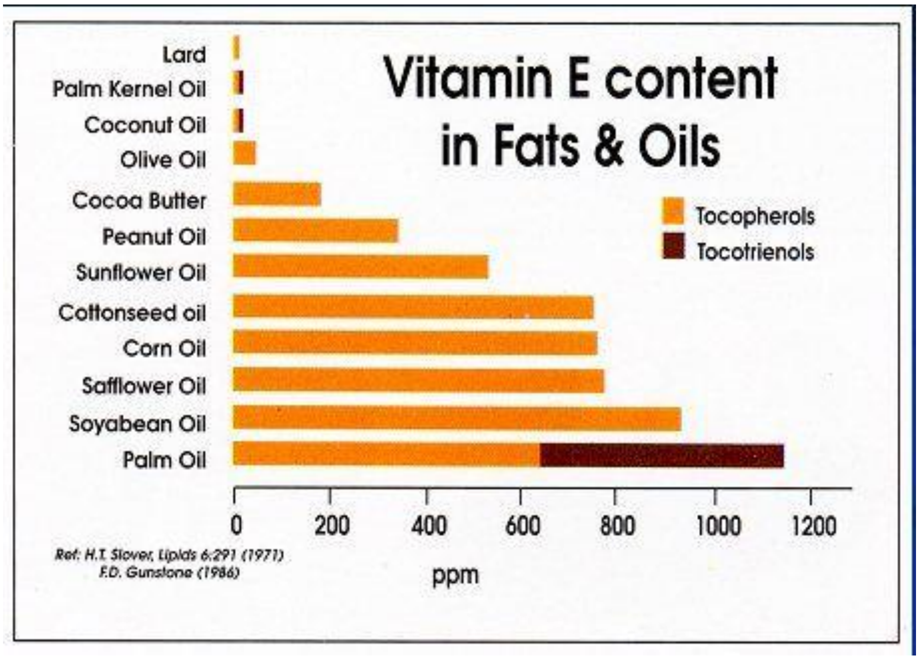


Figure 3: *Vitamin E Content in Major Vegetable Oils*

Unlike other oils, palm oil is a reasonable oil as it contains equivalent measures of both unsaturated (basically oleic) and immersed (chiefly palmitic) unsaturated fats, with the previous comprised generally by the favored mono-unsaturates. The vitally immersed unsaturated fat in palm oil is palmitic corrosive that is unbiased and doesn't raise blood cholesterol levels. Other soaked unsaturated fats, specifically myristic, are known for their cholesterol raising impacts.

Palm oil is the most adaptable oil as it very well may be utilized in different food and non-food applications with or without just insignificant change. It gets exceptionally popularity since it can supplant creature and other vegetable oils utilized in the handling enterprises. An expected of 74% of worldwide palm oil utilization is for food items and 24 percent is intended for modern purposes (USDA 2010). Palm oil extractions are broadly utilized as a fixing in the food items like margarine, treats and milk. Oleo compound from palm oil is utilized in the creation of non-food industry to deliver family items like cleansers and cleanser. The new use of palm oil as bio fuel for auto demonstrates its significant job in the advancement of elective fuel source (Belamina, 2010). These will set out one more new freedom to be investigated by the creating nations.

2.2 Management of Nursery, Input use and Productivity

The palm oil yield is reduced by weeds, pests, and diseases (van Ittersum and Rabbinge, 1997). Abnormal palms can only be replaced during the nursery phase and the first 12 months after planting. Pest and disease damage early in the plantation lifetime often have a large effect on total yield, especially when they lead to palm death. The main challenges of producing quality planting materials and reducing costs call for innovative improvements. The most important challenges are:

Soil requirement: In the conventional polybag pre-nursery method for oil palm, a large area of soil of suitable quality are needed. The poor soil causes wasteful use of inputs like fertiliser and water besides directly impeding growth of roots (Ayan, 2001; Slavica et al., 2005; Aklibasinda et al., 2011).

Labour requirement: The conventional polybag method is labour intensive. Labour is required for activities like polybag filling, sowing, weeding, fertilising and transplanting. The estimated rate of polybag filling is 500 to 1000 bags per man-day.

Weeds protect: Weeds protect the soil against erosion and provide a habitat for natural pest enemies, while interacting with the water and nutrient cycles. If weeds are allowed to grow uncontrolled, physical access to the plantation is reduced resulting in incomplete and inefficient harvesting.

Diseases: Two diseases cause significant yield losses in oil palm plantations: basal stem rot in Southeast Asia and Africa, and bud rot in Latin America. Basal stem rot, caused by the pathogenic fungi *Ganoderma boninense*, can devastate old plantations (Flood et al., 2000; Flood and Hasan, 2004; Idris et al., 2004). The onset of infection happens earlier at each replanting if no sanitation measures are taken, and can occur as soon as 1–2 years after planting when oil palm is planted after oil palm or coconut (Ariffin et al., 2000). The implementation of a one-year fallow can significantly reduce infection rates. However, there is no experimental evidence that shows conclusively that it reduces disease incidence (Idris et al., 2004; Hoong, 2007). Breeding for resistant planting material is an important strategy to prevent future yield losses (Durand-Gasselin et al., 2005; Ho and Tan, 2015).

Labour Inputs:

Lack of labour, especially for harvesting, is a key issue in Malaysia, and to a lesser extent in Indonesia, leading to longer harvesting rounds, which result in reduced oil extraction rates, loss of loose fruits and unharvest bunches (Murphy, 2014). A significant expense part in the oil palm bequest is the labour input. This significant homestead input had in the past experienced a genuine stock issue, because of the country metropolitan relocation wonder. This makes neighbourhood bequest work hard to find because of the sharp rivalry from different areas particularly those situated in the metropolitan regions.

Malaysia's Sime Darby is the biggest recorded palm oil organization universally, in light of manor region and new natural product pack creation. The organization was made through a Malaysian government started consolidation in December 2006. The world's second-biggest oil palm estate organization, Felda Global Ventures Holdings (FGV), is additionally situated in Malaysia. Felda Global Ventures Holdings is the world's third biggest palm oil organization by planted acreage, controlling more than 850,000 ha of land in the nation, including roughly 500,000 ha that it rents and oversees for smallholders. In late December 2020, the United States Customs and Border Protection (CBP) gave a "retain discharge request" forbidding the importation of palm oil into the United States created by Sime Darby following a months-in length examination concerning constrained work on Sime Darby–claimed ranches. The boycott can be lifted if healing move is made.

Attributable to supply pressure, wage rates were offered upwards. Large numbers of ranch's player must be represented an examination to mirror this present reality where the oil palm homes work. In the expense calculation, material and work costs have been lumped up together. To fuse the genuine expansion in labor would be dangerous. The arrangement is that we expected a no matter how you look at it expansion in cost of the accompanying oil palm remain by 5%, which goes from RM 1700 to RM 3500 in yearly. This change is decided to enough record for the expansion in the pay rate on oil palm domains.

Fertilizer: The application of fertilizer (N, P and K fertiliser) in Indonesia, Malaysia and Thailand are far less than optimal, ranging from 40 to 90% of recommended rates (Rankine and Fairhurst, 1999b). Almost double the amount of P and K are applied on plantations in Malaysia than in Indonesia, and three times more K than in Thailand, yet the average K application is still insufficient to replace the nutrients loss.

2.2.1 Fertilizer Terminology

Straight fertilizer is the term used to describe fertilizers, containing only one of the big three elements nitrogen, phosphorus or potassium. Straight fertilizers can be divided into straight nitrogenous, phosphatic and potassic fertilizers. Many of the straight fertilizer also contain sulphur as do some of the multi-nutrient fertilizers. For example sulphate of ammonia contains 24% sulphur: in fact this is higher than its nitrogen content. Yet it is classed as a straight nitrogenous fertilizer.

Compound fertilizers contain two or more of the three main elements nitrogen, phosphorus and potassium manufactured by a chemical reaction. In compound fertilizers, each particle of fertilizer is uniform in its chemical analysis. So there is no possibility that the component will segregate from each other during transport. They are usually high analysis products.

Slow release fertilizers are fertilizers that have been produced is such way that they are not readily water soluble. Treatment usually involves coating the fertilizer granules with a slowly soluble material, such as sulphur or wax. Liquid fertilizers may be clear solutions or in the form of slurries or suspension.

Fertilizer solutions are fertilizers dissolved in water. These are suitable for application through spray equipment and trickle irrigation system. Nitrogen solutions are the most common, but multi-nutrient solutions are also used. Slurries or suspension are similar to solutions except that part of the fertilizer may be held in suspension and not dissolved. They usually require a suspending agent, such as attapulgite clay, to ensure that the solid material does not settle down.

2.2.2 Fertilizer Management

The fast development and high efficiency of oil palm have been exhibited in preliminaries and all around oversaw manors. Plant rearing preliminaries and physiological calculation showed that the likely yield of the oil palm is around 17 mt oil/ha (Corley, 1985) while more than 12 mt oil/ha have been accounted for in limited scope reproducing preliminaries (Mohd. Commotion et al., 2005) and 6.8 mt oil/ha in enormous business plantings (Goh et al., 2002) utilizing current DxP materials. By and large, the clonal planting materials have been displayed to have extra 10-15 % oil contrasted and DxP materials (Soh et al., 2003).

Of late, the oil palm development has been extended to more assorted soil types with expanding spaces of profoundly debased soils, troublesome scenes and steep landscape, and negligible environment. The utilization of negligible or unacceptable land for oil palm has forced extra difficulties to the creation framework, which requires the adjustment of the climate to give the best developing conditions for example limited anxieties for high efficiency. In any case, it for the most part puts pointless strains on the framework through higher creation costs, work prerequisites and ability. In this way, one of the most key pre-necessities in oil palm usefulness should doubtlessly be cautious determination of the site to guarantee that the yield is planted ashore appropriate for it (Kee and Goh, 2006). This will pre-empt a significant part of the current challenges related with poor yields, low benefit and supportability (Kee and Goh, 2006).

In fact, we reverberation the call by Teo (2001) and Pushparajah (2002) that further development of oil palm regions into negligible or unsatisfactory land should be emphatically debilitate as better choices are generally accessible to upgrade benefit and besides, preparation can't beat all creation requirements. Besides, the intensity of the Malaysian oil palm industry as far as creation costs has likewise been dissolved contrasted and other oil palm makers. Goh et al. (2002) have shown that the best cure or maybe the best arrangement is to build efficiency per unit region. Many elements add to this high efficiency of oil palm, entomb alia, further developed planting materials, agronomy and the executives. Davidson (1993), in following the advancement of palm oil yield in Pamol, Kluang, which was raised from 1.3 t/ha/yr in 1951 to 5.43 t/ha/yr in 1991, barring negative elements, recorded seven significant practices that were answerable for this yield improvement.

Among them, preparation was the main supporter representing 29% of the yield increase. This was upheld by various manure reaction preliminaries led in Malaysia, which showed enormous FFB reactions to adjusted compost. Consequently, manures greatestly affect usefulness as well as regularly comprise the most noteworthy functional expense in very much run ranches in Malaysia. It assumes a urgent part in the maintainability and productivity of oil palm especially lately when costs of wares were dubious and financial aspects of cultivating have turned into the prevailing issue. The fast development and high efficiency of oil palm as explained above accompany an expense: the requirement for high, adjusted nourishment that is explicit to each site or climate for the duration of the existence pattern of the palms aside from the brief time frame prior to replanting when manure application may be removed.

The last practice is primarily for financial reasons. The great reactions of oil palm to manure inputs were fundamentally ascribed to the low fruitfulness of profoundly endured tropical soils or potentially dampness stress (Goh, 2005).

The reactions can go from under 10% to more than 200%. Xavier et al. (2008) gave a brief record of the reasonable FFB yield reactions to manure inputs on generally rich waterfront soils dependent on the accessibility of the above highlights in their examinations. Rather than this, it was most grievous that as of late there were various cases on the adequacy of different new agro the executives' practices and composts for oil palm ranches. A significant number of them were uncertain because of the absence of the above highlights in the "tests", among different shortcomings. By and by, a few defenders of such cases have executed them to the insult of the business and such unstable and informal practices should be stayed away from if the oil palm industry in Malaysia is to stay serious and reasonable.

Without N, expanding K rates discouraged oil palm yield yet had no impact on development. Then again, without K information, expanding N rates had little impact on FFB yields albeit vegetative development was essentially improved. Additionally, there are solid signs that where palms were better become because of appropriate compost the board, the yearly yield variances might be decreased significantly.

2.2.3 Fertilizer Application in the Nursery

During the earliest growth stage, the elongating radical and plumule derive most of their nourishment from nutrient reserves stored in the seed. The food-absorbing houstorium develops rapidly at the expense of the albumen, which it gradually digests. This continues over a period of about four months, by which time the houstorium fills the nut cavity. Inorganic nut nutrients must then be derived from the soil by the rapidly developing radical and organic nutrition initially depends on the photosynthetic activities of the plumule, until leaves are formed. Compared with knowledge of the nutritional requirements for mature oil palm, there is relatively little precise information on similar needs during the nursery phase. Given the wide range of soil types contained in polybags, nutrient requirements will obviously vary considerably. Even though only the best soil in an area should be used for nursery establishment, the amounts of available nutrients will vary between soil types.

For example, quite substantial differences have been found between the fertilizer requirements of nursery palms grown on clay and loam soils due to inherent variations in nutrients reserves, e. g. there is frequently a higher magnesium requirement by seedlings grown in loam soils.

It is usual practice, therefore, to provide the young palms with a fertilizer programme which incorporates all the major nutrients at a basic usage rate, with supplementary applications of individual nutrients should deficiency symptoms be observed (Turner, 2003). As a result, fertilizer policies are invariably generalized based on the principles of increasing nutrient needs with seeding age, a need for balanced nutrition, a need to produce the most vigorous seedlings for field planting, and the recognition that most soils are both nutritionally deficient and reserves in poly bags become exhausted as seedlings develop. At the same time, there is no point in applying more than is required. This is not only wasteful economically but may also predispose the seedlings to attacks by pests and diseases.

Trials have shown that adding four times the standard amount of fertilizer to seven-month-old seedlings had no significant effect on development. Turner, (2003) also stated that the dangers inherent in over-application particularly nitrogen since this not only greatly increases the risk of pest and disease occurrence but also renders the seedlings less resistant to drought. Too liberal use of incomplete surface has resulted in severe phytotoxicity. Such experimentation which has been done has clearly shown the beneficial effects of applying a complete nutritional mix. It is possible for some nutrients to be added which, although harmless to the seedling, are also of negligible value to it.

Potassium availability significantly affects vegetative growth and dry weight, as well as increasing protein concentration, but reduces magnesium and calcium contents. However, it has been demonstrated that balanced nutrition is as important during the nursery phase as it is in older palm, this being necessary for optimum chlorophyll formation. Where deficiency symptoms of particular nutrients develop, these can usually be readily corrected on an individual nutrient basis. Adding extra fertilizer to backward seedlings in an attempt to accelerate their development is inadvisable since it prevents satisfactory nursery selection. Such seedlings are probably poor planting materials and should be culled since they will invariably show inferior growth and yield if planted in the field. Flexibility in action is an important factor in successful nursery practices.

It is necessary to provide nursery workers with measures for each amount of fertilizer at every stage to ensure accuracy in the amounts applied. Any fertilizer used should be of the type in where the required nutrient is readily available to the seedling since where a requirement exists it will be immediate and rapid fertilizer solubility is needed. Thus, for example, where there is a phosphate requirement, this should be supplied as a readily soluble phosphate, rather than the more slowly available nutrient from rock phosphate.

Alternatively, since the major early requirement is for nitrogen, which is particularly important in stimulating vegetative growth, urea can be used up to the five-leaf stage. This is applied either in water at a rate of 7 g urea in 5 L water/100 seeding during the one-to three-leaf stage, increasing to 14 g urea at the four-to-five-leaf stage, or applied directly to the soil. Where urea spray is used, either as a basic nitrogen supply or to rectify symptoms of nitrogen deficiency, this is usually not washed off after application since the nitrogen is absorbed through the foliage.

Application is preferable either in the early morning or late afternoon. However, even urea spray can cause leaf scorch since the product normally contains variable amounts of a condensation product, biuret, which is a contaminant formed during manufacture. Where the biuret content exceeds 0.6 to 07%, leaf scorch can be severe, even when the spray concentration is as low as 0.1 % (156). It is thus necessary to ensure that the urea used is of good quality. In case of doubt, wash off the spray as a safety precaution. N fertilizer appreciably increases the length of rachis, girth, annual frond production and leaf dry weight, while K only increases the leaf area. Increasing rates of N significantly increases foliar P but lowers Ca and Mg levels, both in the leaf and rachis.

The effect of high K significantly increases foliar P but reduces the leaflet K status; in the rachis, however, this increase in K rates is accompanied by an increase in K, Ca and Mg levels. Teoh and Chew (1988) found that the rachis K levels were closely related to total palm uptake, whilst the leaf K levels often showed no relationship with total uptake. Interactions between N, P, K Ca and Mg and between K and B are frequently encountered.

2.2.3.1 Effects of Nitrogen

Nitrogen application increase leaf area, and further develops leaf creation and the net absorption pace of oil palms (Corley and Mok, 1972). Vegetative development and leaf area record (LA) increment when N is applied to youthful palms. An expansion in shade size drives straightforwardly to work on net digestion and builds biomass creation (Breure, 2004). In more established palms, notwithstanding, where LA> 6.5, there may not be a reaction to N application, and yields may really diminish because of expanded between palm contest and shared overshadowing (Breure, 2004). At the point when N is inadequate, it is moved from the more seasoned to more youthful and all the more physiologically dynamic leaf tissue and this clarifies why lack manifestations initially show up on more established leaves.

Nitrogen insufficiency influences chloroplast advancement and work, and in N-inadequate leaves, proteins are hydrolysed (proteolysis) to deliver amino acids which are rearranged to more youthful leaves. In this manner, N inadequacy brings about helpless palm development, and influenced palms seem hindered.

Older fronds influenced by N insufficiency initially show up consistently light green, prior to turning pale or dazzling yellow (chlorosis), and may in this way be influenced by kick the bucket back (corruption) if extreme and delayed lack isn't revised. At the point when insufficiency is extremely articulated, rot grows first on the tips and edges of pinnae. The rachis and midrib of seriously lacking fronds are yellowish orange, and pinnae are tight and roll inwards.

2.2.3.2 Effect of Phosphorus

Soil P recapitalization is needed during the foundation time frame on most inland soils Sumatra and Borneo. A lot of P should be applied to the LCP and palms during the long term advancement to develop soil P stocks. Phosphate composts are vulnerable to misfortune disintegration and surface spillover, be that as it may, and soil protection measures (stages, porches, bunds) and mulching with void packs ought to be done to lessen the deficiency of P applied in manure. Deficient P application during the foundation stage prompts helpless palm improvement (hindering, pyramid-molded trunks), poor LCP advancement (soil misfortunes because of the impact of disintegration and surface overflow on uncovered soil) and a wasteful utilization of N and K composts.

There is typically a critical reaction to P manures in palms not recently provided with P, and customary yearly P applications are needed to support ideal yields. Encourage and Prabowo (1996) found that P composts expands normal frond weight, frond creation rate, and organic product bundle yields because of an increment in pack weight, however bundle numbers were not influenced by P application. Ideal P content in frond #17 was 0.15-0.19 % dry matter and convergence of under 0.13% was found to show serious P insufficiency. On Malaysian inland soils, the ideal leaf P focus is about 0.165% P (Zakaria et al., 1992) and a huge reaction to P manure can be anticipated if the P fixation in frond #17 is under 0.165% or the extractable P content (Bray II) in the dirts is <20 mg kg-1 soil. A reasonable connection between leaf P, soil P and yield has been displayed for beach front soils in Malaysia. Differentiations with most other supplement, P-lacking leaves don't show explicit side effects in oil palm, other than decreased frond length.

Another apparent manifestation of P lack in oil palm is hindered development with short dull green fronds. Trunk measurement and bundle size are likewise decreased, and palms show an articulated pyramid shape because of the reformist exhaustion of soil. There is one recounted proof where the untimely drying up of more established leaves was related with P inadequacy however no indisputable proof is accessible as of now. Potassium expands dry season and infection protections in oil palm (Turner, 1996) and pack six and bundle numbers are decreased in K-inadequate palms. On certain dirts (for example sandy soils, peat soils) K insufficiency is typically the biggest single healthful factor restricting yields.

2.2.3.3 Effect of Potassium

Multiple regression uncovered a critical positive connection between's oil palm leaf K status and the quantity of useful leaves just as yield parts (bundle number and pack weight) (Nair and Sreedharan, 1983). In a compost preliminary in North Sumatra, K expanded yield, bundle weight and pack numbers however there was no reaction to P (Kusnu et al., 1996). Bundle parts (oil:bunch, fruit:bunch, dry mesocarp:fruit pack, kernel:bunch and kernel:fresh organic product) are influenced unequivocally by connections among N and K. An enormous reaction to K compost can be anticipated where soil replaceable K<0.2 cmol kg-1 soil. Potassium is recorded up effectively against a fixation inclination by palm roots, and supply is consequently coupled to the metabolic movement of the palm. K+ is the most bountiful in the cytoplasm, and it isn't utilized or bound in natural edifices of plants.

Potassium is consequently profoundly portable inside the palm and its focus is more noteworthy in the more metabolically dynamic tissue. Potassium initiates various chemicals that catalyze biochemical responses engaged with the combination of starch, proteins and fats. It is additionally needed in the different strides of protein combination (for example the interpretation of hereditary data and the fuse of inorganic nitrogen into amino acids) and for the vehicle of acclimatizes. Potassium additionally upgrades the impact of phytohormones (for example insole acidic corrosive (IAA) and cytokinins) needed for the development of meristematic tissue.

Potassium assumes a significant part in the change of light into biochemical energy during photosynthesis and is in this way needed for the obsession of CO_2. Potassium likewise plays a focal part in the osmoregulation of plants (for example cell augmentation, stomata guideline) and different capacities identified with water pressure resilience. Hence, when the K stockpile is adequate, the decrease in photosynthesis movement under states of dry spell or saltiness is diminished. Besides, K is associated with the movement of photosynthetic from source (passes on) to sink (inflorescence, organic product packs, roots).

2.2.3.4 Effects of Trace Elements

In experiments on a Typic Paleudult in Sumatra which was lacking in Mg and K (interchangeable Mg 0.12 cmol kg-1, replaceable K 0.12 cmol kg-1), mature oil palms didn't react to Mg in the initial two years of use (Kusnu et al., 1996). During the third and fourth years, be that as it may, a yearly utilization of 0.27 kg Mg palm-1 as kieserite expanded the FFB yield fundamentally with an increment in pack numbers. Frond dry weight, leaf region, leaf creation and yields are more modest in palms with intense Mg lack. Over the top measures of Mg compost, especially when applied as dolomite, may instigate K insufficiency because of enmities between Ca, Mg, and K take-up. There have been no reports of a development reaction to Ca in field palms. Seedlings filled in sand culture without Ca are hindered with strangely short and tight leaves and conspicuous leaf veins.

At a high level phase of inadequacy, leaves are little, contorted and influenced by terminal corruption. There is next to no data on the impact of S on oil palm development and yield. Use of S was found to build biomass creation in palm seedlings (Forde, 1968), however insufficiency was considered to happen just infrequently in oil palm, in light of an overview in Malaysia (Ng et al., 1988). Leaf creation stops totally under intense B inadequacy.

An enormous pit is shaped in the crown with the apical bud in the middle. Yield decrease in B-inadequate palms might be brought about by botanical early termination since dust germination and dust tube development are blocked in B-insufficient palms.

Through its long, beautiful and memorable excursion, the Malaysian oil palm industry has and will keep on thriving while at the same time proceeding to accept a critical job in the country. The great interest for the oil just as new freedoms as bio diesel as an elective fuel will guarantee that the excursion forward will be similarly energizing. The Malaysian oil palm industry is without a doubt the pride of the country. Be that as it may, issue on ecological and practical of this industry is important for challenges looked in the future.

2.3 Competitiveness of Malaysian Palm Oil

Malaysia overwhelmed Nigeria as the world's driving exporter and maker of palm oil in 1966 and 1971, individually (Gopal 2001: 122; Hacaharan Singh Khera, 1976; Malaysia, 1975). From that point forward Malaysia keeps the situation as the greatest maker of palm oil on the planet and contributes practically 50% of the world creation of palm oil. The current status of palm oil as it is today is without question because of the huge commitment of Malaysian palm oil industry, as a pioneer in this industry since 1960s. Malaysia turns into a good example for some other delivering nations to prod their economy through agribusiness area. The region under development in Malaysia has arrived at the immersion point in this way ruin the extension action (Okamoto.S, 1997). The regular environments that is hot and wet along the year with temperature marks going from 25 to 35 degree Celsius and has uniformly appropriated precipitation of 2000mm each year, is a benefit to Malaysia in palm oil ranch setting. Since relatively few nations has the comparative example of environment however found just 10 degree scope away, oil palm turns into the 'brilliant yield' which definitely change the scene of Malaysia agribusiness and economy since 1960s (Ariff Simeh, 2001). In term of land usage, palm oil development covers practically 58% of the complete developed land in Malaysia when contrasted with different harvests like elastic, cocoa and food crops.

A big part of the agrarian occupations in the nation are given by this ware either at the upstream level or at the downstream level; thus oil palm is a significant financial yield for Malaysia (Basiron.Y, 2005). The commercialisation of the palm oil industry during the 1960s permitted Malaysia to acquire a "first mover' advantage in quite a while of aptitude and mechanical headway over different countries who just began marketed arranging a lot later. This industry has advanced well because of good understanding and administration by the public authority and solid help by the private undertakings.

Enjoying benefit as the pioneer in the improvement of palm oil area on the planet, Malaysia is effective driving the R&D in all parts of palm oil including spearheading the innovative forward leaps in the palm oil industry. The business has embraced inventive procedures and maintainable practices in guaranteeing that oil palm development stays in congruity with the climate. Malaysia will keep on moving forward with new advancements covering a wide range of the business from upstream to downstream and specifically, the new arising areas of oleo-synthetic and bio diesel to improve the business' exhibition.

A reason behind the stoppage in development was constraint ashore accessible for advancement. In any case, study directed by Sumathi, Chai and Mohamed in 2008 expressed that Malaysia is the biggest maker of palm oil on the planet, having supply practically half of the world's palm oil interest through sends out. Cowardly in 2010 additionally uncovered that as far as worldwide stockpile, Malaysia is as yet the main country which demonstrates that this nation has consistently been a main provider of palm oil in the worldwide market. Subsequently, to stay cutthroat in the worldwide market, usefulness should be expanded through advancement just as extend the worth added at each degree of significant worth chains.

In spite of the fact that Malaysia is presently positioned second after Indonesia, strangely, very nearly 25% of oil palm region in Indonesia is possessed by private ranch organizations from Malaysia. Extension of development in Malaysia is restricted because of low accessible land for estate; subsequently it is simpler to extend ranch in Indonesia instead of unavoidable losses in additional advancement in Malaysia. Of the worldwide oilseed established space of 239.82 million hectares in 2009, Malaysian oil palm represented simply 1.9%. However, this 1.9% had the option to supply 11.1% (18.25 million tons) of worldwide vegetable oils and fats yield and represented 25.6% (16.37 million tons) of Malaysia's fare exchange oils and fats in 2009 (Sime Darby).

Today, 4.7 million hectares of land in Malaysia is developed with oil palm, creating 17.57 million tons of palm oil and 0.66 million tons of palm part oil. Malaysia is one the biggest makers and exporters of palm oil on the planet, representing 11% of the world's oils and fats creation and 26% of fare exchange of oils and fats (MPOC 2010). China, the European Union, Pakistan, United States, India, Japan and Bangladesh are the significant shippers of Malaysian palm oil. In 2006, these nations by and large represented 65.3% or 9.41 million tons of the all-out trade volume.

2.3.1 Institutional Framework

The persistent accomplishments of this industry are upheld both by the private and public area. Albeit the palm oil industry is driven by the private area, the public authority has assumed a critical part in deciding the heading of the advancement of this area (CH. Teoh, 2010). History has shown that the public authority's choice to bridling the capability of palm oil to drive the improvement of the nation after the Independence, has effectively reduced destitution and set Malaysia as a top palm oil maker on the planet. The unique advancement of the business is to a great extent ascribed to the essential methodology by the public authority in creating agribusiness land. Accentuation isn't simply ascribed to simply only endeavours in improving creation, but on the other hand was joined by drives in infiltrating and extending of business sectors, innovative work exercises and a favourable administrative structure (Arief Simeh, 2001). This was upheld by the foundation of solid government institutional with cooperation and inclusion from private areas. In the early year, initially there were three principle organizations required to do the specified strategy destinations, specifically Palm Oil Registration and Licensing Authority (PORLA), Palm Oil Research Institute of Malaysia (PORIM) and Malaysian Palm Oil Council (MPOC).

PORLA was set up in 1976 to complete errand to set the quality guidelines for palm oil items to guarantee an inventory of great fare items. These were involved two significant examination programs, first and foremost was the nature of oil items at their essential purposes of handling and also was exchange, including ports of fare, to guarantee that main palm oil items with the fitting quality were conveyed. Licenses were necessary for individuals associated with transportation, deal, buy, intermediary, trade, import, stockpiling, and overview or testing of any palm oil item.

The quality control of palm oil items without a doubt helped the general nature of palm oil items and along these lines the standing (Lars C. Bruno, 2010). PORIM was set up in 1978 predominantly for creating advances which intended to expand the productivity of palm oil creation and expanded the uses of palm oil. The exploration done at PORIM could be separated into three primary spaces of science, science and innovation just as techno-monetary and offer specialized warning types of assistance. Notwithstanding, in the mid of improving the public authority capacity being developed of this industry and solid institutional help, PORIM and PORLA were converged to frame another organization, Malaysian Palm Oil Board (MPOB) in 2000. As a chief organization in checking the business, MPOB is mindful to advance and foster public goals, strategies and needs for the prosperity of the business development.

Simultaneously, MPOC is entrusted to foster an exhaustive technique to situate Malaysia as a global forerunner in the oils and fats market through limited time exercises. Seeing the requirement for item improvement to support the upstream advancement of palm oil, the business was hailed for sectoral support under the Industrial Master Plan of 1986 (IMP1). The IMP1 underlined the justification of refining and fractionation to build proficiency and intensity of Malaysian palm oil on the planet market (Sime Darby, 2009). Therefore, Malaysia turned into a center point of palm oil downstream preparing and hence leads in trading the refined oil. In IMP2, government zeroed in on the extension of development region to East Malaysia and urged private area to look for crude materials for downstream exercises abroad. Research and development exercises had been strengthened especially to build oil palm efficiency and further worth included item advancement.

Government is intense on extending the benefit of this industry consequently set palm oil as one of the critical regions to be engaged in the furthest down the line government's arrangement to help the economy and accomplish a big time salary status by 2020. Three regions will be given need consideration including increment the upstream efficiency, extension of downstream just as support the supportability of palm oil industry.

2.3.2 Production and Nutritional Value of Palm Oil

Elaeis guineensis is an oil palm species that began from the tropical rainforest of West Africa. The palm tree is monoecious, where the male and female parts can be found on a similar tree. It might grow up to in excess of thirty feet and begin to create natural product bundles from three years old in the wake of planting. Their normal useful range life is around 25 to 30 years, where each tree can bear 8 to 12 natural product packs each year. Because of their high return in oil, palm oil is arising as the most proficient vegetable oilseed crop on the planet, whereby a hectare of oil palm estate can deliver multiple times more oil contrasted with the other world-driving oilseed crops, including rapeseed, sunflower, and soybean.

The world's essential oilseed creation in 2017 are palm oil (68 million tons), soybean oil (54 million tons), rapeseed oil (25 million tons), and sunflower oil (19 million tons), where the 33% (34%) of the world's oil and fats creation is contributed by palm oil. Palm oil contains a fair sythesis of immersed and unsaturated fats with around 44% of monounsaturated oleic corrosive, 10% of polyunsaturated linoleic corrosive, 40% of soaked palmitic corrosive, and 5% of immersed stearic corrosive. It is liberated from cholesterol and trans unsaturated fats. On another note, palm oil is plentiful in cancer prevention agents as nutrient E (tocopherols and tocotrienols), where 60 to 100 mg of nutrient E can be found in rough or crude palm oil and about portion of it stays subsequent to refining. Palm oil has the most extravagant tocotrienols content versus different oilseeds like soybean, sunflower, corn and olive. These tocotrienols have been discovered compelling in bringing down terrible cholesterol levels just as ensuring the mind against sicknesses.

Palm oil is likewise plentiful in nutrient A (carotenoids), where 100 g of unrefined petroleum contains around 50 to 70 mg of carotenoids. Nutrient An assumes a fundamental part in controlling the development and elements of body tissues, invigorates the resistant framework, and advances great vision.

2.4 Summary

Palm oil is the world's most elevated yielding oil crop, with a yield 5–10 times more prominent per hectare than other driving vegetable oils. Joined with generally low costs, relative rack soundness, and revealed dietary advantages (Bethe, 2010), palm oil use regular benefits that position it as a probable long haul staple of the worldwide eating routine. Quickly extending populaces and changing utilization designs, just as expanding request from the bioenergy and oleochemicals ventures, have brought about supported exorbitant costs for rough palm oil. These market influences have driven colossal development of the palm oil industry in ongoing many years. Examiners foresee further palm oil request speed increase in the close to term–conceivably a 36% increment by 2012 more than 2010 baselines, and over 65% development by 2020 (Mielke, 2011).

Achievement, be that as it may, isn't ensured. Palm oil yields differ significantly across tasks, in view of the executives' practices, hereditary qualities and topography. Yields can go from short of what one to in excess of 7 metric tons unrefined palm oil per hectare. Moreover, a unique arrangement of outer difficulties face the business, including area and work deficiencies, natural corruption, social struggles, unpredictable climate designs, rising fuel and manure costs, administrative dangers in maker and purchaser markets, and customer and corporate purchaser tension for straightforwardness and manageability. The world is evolving rapidly, with seismic market and political movements happening in progressively brief periods of time. These ocean changes join with the innate idea of ware areas to drive down benefits, pretty much ruling out blunder. Powerful administration requires sharp dynamic and long haul vision.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

The research was using the secondary data that useful for gain insight into both the methodologies and statistical methods, better understand the necessity of a rigorous planning before initiating a comparative effectiveness investigation, and optimize the quality of the investigations. This research also included the experiment & analysis made at the oil palm nursery itself.

The economic analysis for the cost production of clonal ramets only for material only for experiment on effects of fertilizing methods and application rates on the growth of clonal ramets is presented in Table 6. The estimated cost analysis month after treatment per ramets at 12 months as indicated generated RM0.27 for foliar fertilizer, RM0.29 for NPK Blue (Control) and RM0.48 for slow release fertilizer. Data cost recorded that cost for foliar is about 6% lesser but for slow release fertilizer the cost is about 65% higher as compare to NPK blue. The cost per ramets is increased in order with the increase of the fertilizer rates. The total of fertilizer application round was in order of foliar with weekly application, NPK blue with monthly application whilst slow release only two rounds of application throughout the year. This is indicate that more workers needed for foliar application but lesser for slow release fertilizer application.

Table 6: *Estimated cost per clonal ramets (material only) for experiment on effects of fertilizing methods and application rates on the growth of clonal ramets.*

Expenditure Item	Round of application	*Cost Per Ramet (RM)	Cost per Ramet at different rate (RM)			
A. Material			0%	5%	10%	15%
1. Foliar	Weekly	0.27	0.27	0.28	0.30	0.32
2. NPK Blue	Once/Month	0.29	0.29	0.30	0.32	0.35
3.Slow Release Fertilizer	twice/year	0.48	0.48	0.50	0.53	0.58

* fertilizer price in 2017

Source; Sawit Kinabalu fertilizer price 2017

The economic analysis for the cost production of clonal ramets only for material only for experiment on effects of NPK ratio in different rate on the growth of clonal ramets is presented in Table 7. The cost analysis showed the comparison of cost per ramets orderly with an additional of straight fertilizer and rates. Data cost recorded that cost for additional rate for MOP is about 6% higher whilst SOA is about 3% higher than the conventional practices with an additional of RP.

Table 7: *Estimated cost per clonal ramets (material only) for experiment on effects of NPK ratio in different rate on the growth of clonal ramets*

Expenditure Item	Cost Per Ramet (NPK Blue only)	Cost/ramet + Additional rate of straight fertilizer		
A. Material		0%	10%	20%
1. NPK Blue + SOA	RM0.29	RM0.29	RM0.34	RM0.38
2. NPK Blue + RP	RM0.29	RM0.29	RM0.33	RM0.37
3. NPK Blue + MOP	RM0.29	RM0.29	RM0.35	RM0.41

* fertilizer price in 2017

Source; Sawit Kinabalu fertilizer price 2017

3.2 Location and Sample Frame

3.2.1 Experiment & Analysis

Two experiments were conducted in Ladang Gomantong, Kinabatangan, Sabah. The location of the studies was at latitude 5° 55'N and longitude 118° 02'E at the nursery site called Annex Nursery owned by Sawit Kinabalu Sdn Bhd. Germinated ramets of clonal palm were obtained from Sawit Kinabalu's tissue culture lab. The age of the ramets received was 4 months after hardening. There was no pre-nursery process for clonal palm seedlings. The source of soil for the experiments was from Gomantong Estate area which was used as the Sawit Kinabalu Nursery growth medium. The soil was classified as Kuah series. Shading of clonal palms was also provided at the site to avoid ramets from exposer to dry weather and heavy rain.

3.2.2 Survey & Questionnaire

A survey has been done to investigate the characteristics, behaviors, or opinions of a group of people. These research tools are used to ask questions about demographic information about characteristics such as management, cost, productivity, and other factors. The data was summaries using MS Excel & SPSS to get the cross tabulation, dummy table, and also the correlation tables.

3.3 Factor & Measurement of the Variable Factor

There were two experiments conducted in one time. However, both experiments split into two different sites.

3.3.1 Effects of fertilizing methods and application rates on the growth of clonal ramets

This study was conducted using a 3 X 4 factorial arranged in a randomized complete block design. There were two factors (fertilizer application methods and fertilizer rates). There were 3 fertilizer application methods each at 4 application rates. Each treatment combination with three replication. Therefore the total number of experimental plants were 36. The treatments are shown in Table 8. The types of fertilizers used were foliar fertilizer (F1), slow release fertilizer (F2) NPK-Blue (F3). The nutrient composition of each fertilizer is shown in Table 8.

Table 8: *Application rates for each fertilizer application methods*

NPK Ratio **Rates**	T1 (Control)	T2	T3
NPKBlue+SOA-N (F1)	0%	10%	20%
NPKBlue+CIPR-P (F2) (Control)	0%	10%	20%
NPKBlue+MOP-K (F3)	0%	10%	20%

T= rates (The percentage values is that above the conventional application rates)

Table 9 depicts the application rates for each fertilizer application methods. There were four rates used in this experiment the control (0%), and additional rates of 5% (T2), 10% (T3) and 15% (T4). The fertilizing methods used were Foliar (F1), and slow release fertilizer (F2).

Table 9: *Percentage nutrient composition of each fertilizer*

Nutrients	Foliar (%)	SRF (%)	NPKBlue (%)
N	12	17	12
P_2O_5	6	8	12
K_2O	8	9	17
MgO	0	3	2

The percentages of nutrients content of fertilizer methods used is shown in Table 8. The comparison of nutrient level of N content is high in slow release fertilizer, P2O5 in NPK-Blue, K2O in NPK-Blue and MgO high in slow release fertilizer. There was no MgO in Foliar fertilizer.

3.3.2 Effects of NPK ratio in different rate on the growth of clonal ramets

This study was conducted using a 3X3 factorial CRD experimental design. There were two factors (NPK ratio and NPK rates). There were 3 NPK ratios each at 3 different application rates. Each treatment combination was replicated 3 times. Therefore the total number of experimental plants were 27. The treatments are shown in Table 2.1. The types of fertilizers used for additional N, P and K were SOA (F1), CIRP (F2-Control) and MOP (F3) respectively. The nutrient composition for these fertilizers are shown in Table 10.

Table 10: *Application rate for each NPK ratio*

NPK Ratio **Rates**	T1 (Control)	T2	T3
NPKBlue+SOA-N (F1)	0%	10%	20%
NPKBlue+CIPR-P (F2) (Control)	0%	10%	20%
NPKBlue+MOP-K (F3)	0%	10%	20%

T=rates (The percentage values is for the additional nutrient applied)

The application rates for each additional fertilizer type added to conventional standard recommendation presented in Table 10. There were three rates used in this experiment the control (0%), and additional rates of 10% (T2) and 20% (T3). The straight fertilizer type used were SOA (F1), CiRP (F2-Control) and MOP (F3).

Table 11: *Nutrient composition and type of fertilizer in each NPK ratio.*

Fertilizer Type	SOA-N	CIRP-P_20_5	MOP-K_20
% Nutrient	21	30	60

The percentages of major nutrient in the straight fertilizer used is shown in Table 11. The N content in SOA is 21%, 30% P2O5 in CIRP and 60% of K2O in MOP.

3.3.3 Material

The major materials used for both experiments were clonal ramets, soil and fertilizers. The soil was taken from Gomantong Estate area and the soil belongs to Kuah series. There were three types of fertilizer used as a treatments, Nutrifert as foliar (12:6:8), Agroblen as slow release fertilizer (17:8:9:3) and NPKBlue as control (12:12:17:2). These type of fertilizers were common used in Sawit Kinabalu's nursery. A rain gauge station was installed nearby to record the daily rainfall at site.

3.3.4 Media and Clonal Ramets Management

The site and material preparations before planting the clonal ramets were a priority. Therefore, selection of site, piping for watering, shading, signboard, numbering, fertilizer packaging and tools for data collection were done before starting the experiments. The lining of the soil media filled polybags was done properly before receiving the consignment of the clonal ramets. A single-stage polybag nursery was practised to maintain standards to ensure the development of healthy, vigorous and uniform ramets and seedlings. This also helps to reduce the transplanting shock.

3.3.5 Nursery management

Large 38 cm x 50 cm lay-flat black perforated polybags of 500 gauges were used. The polybags were filled at least one week before planting the clonal ramets and well-watered to allow soil consolidation. The polybags were arranged at 90 cm triangular spacing. All the clonal ramets were placed under shading with shade netting of 70% shade for the whole of the 12 months of the experiment. Watering is perhaps the single most important requirement in a polybag nursery. Calibrated manual watering was carried out twice daily at about 1.5 litres per bag. An accurate rain gauge was placed in the nursery to ascertain whether watering was required. When overnight rainfall was more than 12 mm, watering was not necessary (Sawit Kinabalu Policy, 2014). This it to avoid overwatering and water logged of the clonal ramets. Weeding by hoeing in between polybags and hand picking within the polybags was carried out manually as and when necessary.

3.3.6 Fertilizer application

Fertilizer application commenced during planting of the ramets with the type and rate of fertilizer for each treatment. Fertilizers were weighed accordingly before being applied to the seedlings by broadcasting on the medium within the polybag except for the slow release and foliar fertilizers. Upon broadcasting, the granular fertilizer was kept a distance of at least 2-4 cm away from the base of the seedlings. For slow release fertilizer, the weighted fertilizer was mixed with the growth medium accordingly prior to filling the polybags. The foliar fertilizer was apply by spraying to wet the leaves and the application was done according to recommended practice.

3.4 Survey & Questionnaire

An overview and survey have been done to examine the qualities, practices, or assessments of a gathering of individuals. These exploration instruments are utilized to pose inquiries about segment data about attributes like management, cost, productivity, and other factors. The summary to define the data was made using the MS Excel and SPSS.

3.4.1 Parameters and Measurement

Clonal ramets in both experiments were subjected to vegetative growth measurements. Parameters measured were divided into data for statistical analysis on vegetative growth. There were some observations that recorded for further discussion. The parameters for vegetative growth consisted of seven growth parameters which were height (cm), number of frond (total), number of leaflets (total), girth (cm), rachis length (cm), leaf area index (cm2) and leaf dry weight (Gram) whereas for record purpose the criteria for observation were on abnormality incidence, pest and disease incidences, nutrient imbalance symptoms, nutrient deficiency symptoms, culling rate, soil sampling analysis and foliar sampling analysis. Frond 3 (Sawit Kinabalu Policy, 2014) of the core clonal ramets was sampled for nutrient analysis when 12 months old.

Two rounds of vegetative growth measurements were executed at age 8 and 12 months after planting. The vegetative growth measurement at age 8 months is considered the preliminary data collection while the final data collection was the vegetative growth measurement at the age of 12 months. The standard of vegetative growth by Sawit Kinabalu Policy in accordance to MPOB standard. Seedlings height was measured using a ruler from ground level to the tip of the youngest spear leaf. Number of frond production was determined by counting all the leaves where the tip was visible above the older leaf.

The rachis length was calculated by measuring the length of the youngest fully open leaf from lowest leaflets with or without leaf blades to tip of rachis and not the tip of the optical leaflets. Clonal ramet’s girth in the nursery was measured by measuring the thickness of the frond base using a caliper. The diameter of the clonal ramets with frond base included was then was calculated. Leaf region (LA) was determined after the plants were a year old and had created pamphlets on the third leaf from the top opened leaf. Three leaflet were taken from the focal point of each side of the frond and the width and length were estimated with a caliper and ruler. The method for the length and width of the leaflet acquired were placed into equation to assess the LA.

Calculation:

Leaf area (LA) = b (n x LW)

where;

n = number of leaflets

LW = mean of length x mid-width for sample of the leaflets

b = the correction factor of 0.57 (Hardon et al., 1969)

Chemical properties analysis were estimated by sending samples to central laboratory owned by Sawit Kinabalu. Study parameters on leaf analysis were Nitrogen (%), Phosphorus (%), Potassium (%), Magnesium (%) and Boron (ppm). Leaf analysis was done to determine the nutrients content after the experiments at age of 12 Months. The initial values of leaf analysis required at nursery stage were shown in Table 12.

***Table 12**: Initial Values of Major nutrient of leaf analysis.*

Characteristics	Value
N (%)	2.6
P (%)	0.16
K (%)	1.1
Mg (%)	0.33
B (ppm)	11
Ca (%)	0.51

Source: Fairhurst (1999)

3.5 Effects of different fertilizer application methods and NPK ratio on vegetative growth of clonal ramets.

3.5.1 Ramets Height (cm)

As from the studies, clonal ramets height increased over the period following the any application of fertilizer and rates, yet no significant ($p>0.05$) differences were observed. Result in both experiments revealed that clonal ramets height are not influenced by fertilizer application methods or by adding additional sources straight fertilizer of N, P or K.

It showed that clonal ramet's height are not significantly influenced by increasing dosage in both different methods and N, P and K ratio of the fertilizer. All treatments showed increment in clonal ramet's height throughout the planting duration. This revealed that by increasing of recommended fertilizer rate had no influence on clonal ramet's height as indicated by Turner et al., (2003). Turner et al.,(2003) stated that trials have shown that adding four times the standard amount of fertilizer to seven-month-old seedling had no significant effect on seedling growth. This suggested that the applied amendment had no influence on seedling height as stated by Danso (2008).

3.5.2 Foliage (Frond production)

The numbers of frond production were not significantly influenced by the different application method and different dosage of recommended rate of fertilizer. The growth pattern in clonal ramets treated with different method of application and NPK ratio was similar in the number of fronds per ramets irrespective of cost per ramets. Also ramets frond numbers produced were not affected by increasing of rate in both experiments. Garcia et al.(2012) also found no significant ($p>0.05$) different in frond numbers after the application of different chemical fertilizers and attributed it to low application rates. Additionally, the lack of significance in frond number may be due to the natural growth habit of producing one frond per month, which may not be influenced by nutrient inputs. Early work by Mutert et al.(1999) reported 5 to 8 functional healthy fronds after 8 months in the nursery.

3.5.3 Number of Leaflet (Total)

The number of leaflet is associated with frond production which is most important yield attributing character (Kushairi et al,. 2010). The incorporation of fertilizer application methods and NPK ratio at different application rates did not show the significant difference of the number of leaflet. Nonetheless, a similar observation was made in the current study. This according to Gomez et al.(2006) is indicative of high photosynthetic rate and therefore the greater possibility of synthesizing biomass.

3.5.4 Girth (cm)

The girth of clonal palm were not significantly affected the increasing dosage of fertilizer even in different fertilizer application method and different ratio of N, P and K. This lack of significant effects may be due to the fact that N, P2O5 and K2O was not limiting in the soil and nutrients other than P influenced seedlings growth.

3.5.5 Rachis Length (cm)

The fertilizer application methods in different rates and the NPK ratio in different rates had shown no significant effects on the rachis length. The rachis is proximally very board (the petiole)/ its width varying with genetic composition (Turner et al., (2003). The frond bases collectively unsheathed the trunk until they fall away. Nonetheless, a similar observation was made in the current study. This according to Gomez et al. (2006) is indicative of high photosynthetic rate and therefore the greater possibility of synthesizing biomass.

3.5.6 Leaf Area (cm2)

There is no significant effect observed showed that fertilizer method in different rate and NPK ratio in different rate were not the major limiting nutrients in the growth medium. The marginal increases in LA following fertilizer application could be due to the release of more nutrients into the medium as a result of the higher rates (Emmanuel., 2015).

Integral use NPK-Blue, the customary fertilizer gave the most noteworthy LA, because of more supplement delivered which additionally further developed the supplement use proficiency of the clonal ramets. Comparative work by Bello et al., (2014) utilizing P fertilizer altered with organic fertilizer was credited to the way that organic fertilizer strengthened with it upgraded the pace of supplements delivered in the rhizosphere for speedy assimilation for plant development.

Studies by Tan and Hardon (1976) revealed significant correlation with many characteristics of the mature palm based on LA and LAI's measured at the later main nursery stage and concluded that nursery selection based on LA and LAI could result in higher growth rates in the field and higher yields in the oil palm. Subronto et al.(1989) on the other hand reported that LA could be used as selection criteria in 9 months old seedlings as each was highly correlated with yield.

3.5.7 Leaf Dry Weight

There was not much statistical difference among the dry weight produced from all treatment and treatment after running data analysis. The differences in clonal ramet dry matter produced among the methods and various nutrient inputs could be attributed to the differences in their formulation. It was observed that it marginally higher dry matter produced in NPK Blue may be associated with high solubilization and utilization in the metabolic processes of the clonal ramets. The mechanism that need to be considered for dry matter perhaps on the antagonism. The paramount importance of nutrient interactions due to synergistic effect as proposed by Cooke (1982) that could lead to increase yield potential, should be develop. The selection of appropriate fertilizer according to Fraser and Percival (2003) is critical as growth effect could vary widely based on the different active organisms used in the formulation of the product.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Demographics

One the most difficult issue defying the oil palm industry is demonstrating its obligation to supportable creation of palm oil and oil palm products. With customers from created nations turning out to be progressively worried about the social and environment issues and promoting of products, manageability prerequisites are being joined into public laws and regulations.

For Oil Palm Nursery management the nursery size are based on capacity of the seedling at one time. Based on the result of questionnaire and survey, the nursery capacity is almost 44% for medium size nursery which cover 100,001 to 200,000 and 13% were large nursery which cover more than 200,000 seedlings at one time. It's consist of large company or establish Oil Palm Plantation. Meanwhile, only 7% were less than 50,000 seedling which is small holders' nursery.

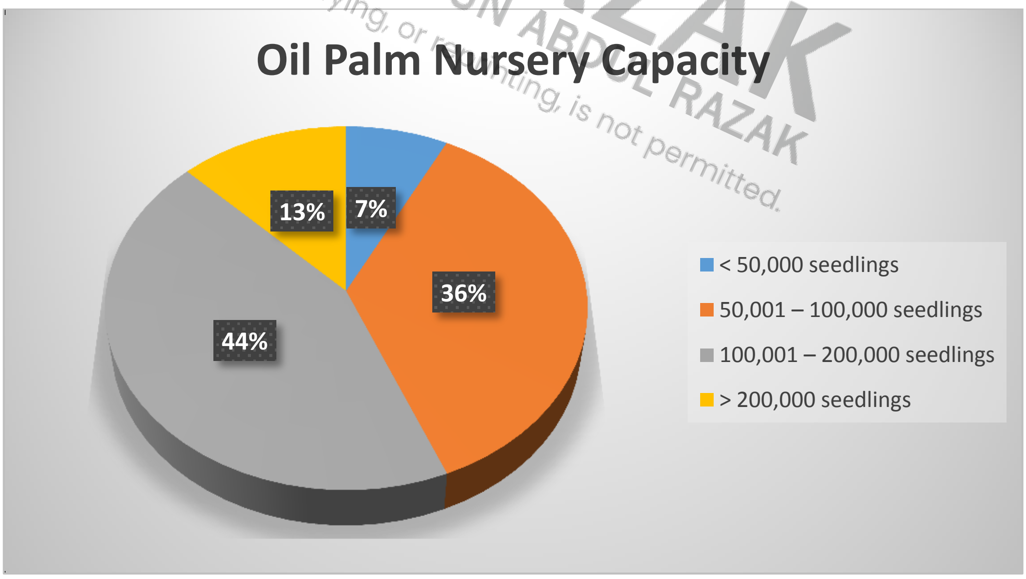


Figure 4: *Oil Palm Nursery Capacity*

4.2 Labour and Manpower

The commitment of the palm oil area to work age is as yet discussed. The latest report discovers conditions on the manors remain generally something very similar, including high dangers of child labour and constrained work conditions, just as labourers who are regularly presented to exceptionally unsafe pesticides, paid beneath the base wages, wrongfully kept in an impermanent work status to fill centre positions, and dissuaded from framing autonomous trade guilds, among different discoveries.

From the result of questionnaire and survey, most of the employees that was engage by Oil Palm nursery was foreigners by 60% of the total workers. As we can see from Figure 5, 47% from the large size nursery was employed the foreigners' as their workers.

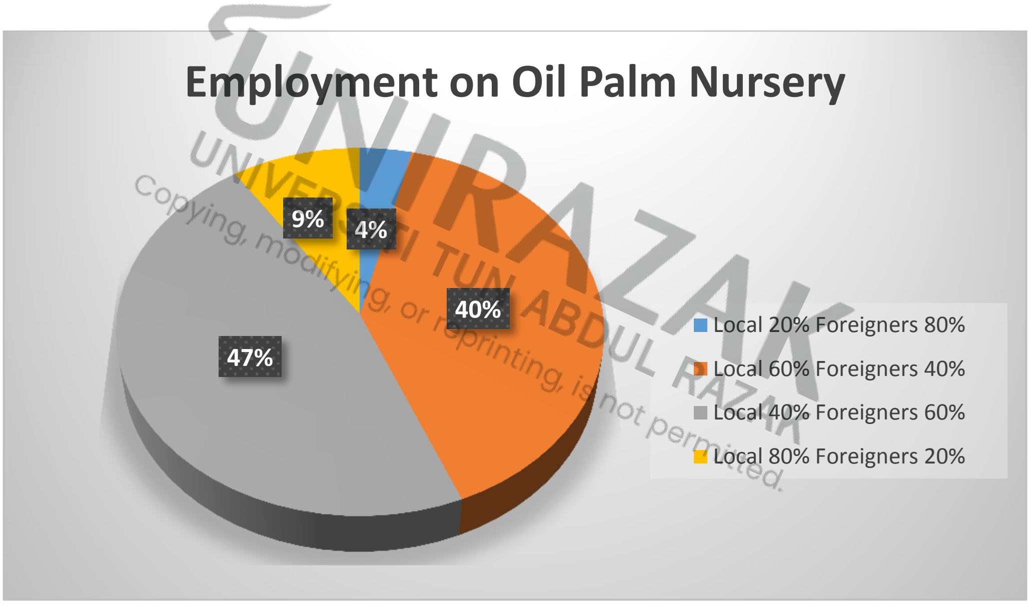


Figure 5: *Employment in Oil Palm Nursery*

Meanwhile in Figure 6, employees' satisfaction for their take home pay shows a good result even though most of them were paid based on piece rate. Its shows that the workers' productivity was good and they can gain more through piece rated wages calculation.

Figure 6: *Satisfaction on wages paid*

4.3 Management

The utilization of organic fertilizer has benefit of being cheap, further developing soil structure, surface and air circulation expanding the dirt water maintenance capacities and invigorating solid root advancement. Natural manure has many sources like minerals, creature source, sewage muck and plant. Somehow rather, most of the Oil Palm Nursery are not use of this type of fertilizer. As on Figure 7 shows that there are 79% of the nursery using the inorganic/chemical fertilizer as their manuring application.

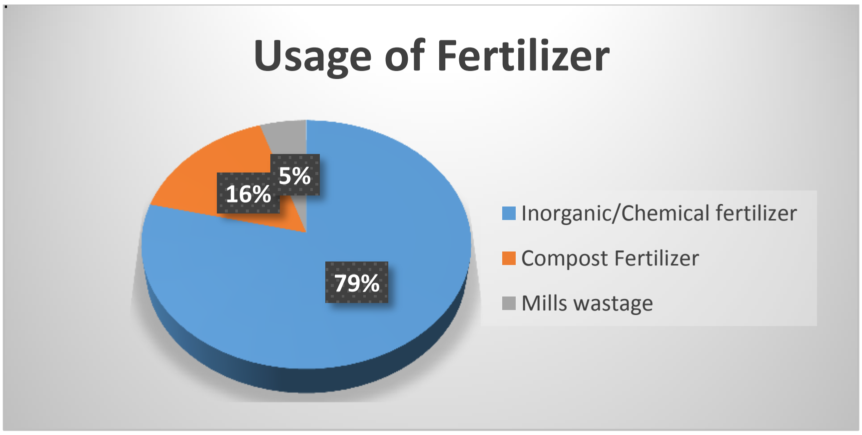


Figure 7: *Usage of Fertilizer*

4.3.1 Integrated Pest Management

There is no major pest and disease detected during the period of the experiments. Only one clonal ramets T3F1 (NPK-Blue with 20% of additional rate of SOA) in experiment two attacked by leaf eater at age of 6 months. It is important to implement effective monitoring and control measures so that seedling damage caused by insects, other pests and disease is minimized. Pest infestations and outbreaks must be detected early and treated promptly and effectively. Careful inspection of seedlings (including the underside of fronds and the unopened spear) is a responsibility of all nursery personnel.

4.3.2 Culling Program

The importance of culling program is to minimize the number of poor quality seedlings planted in the field and ensure that all seedlings which are planted in the field become productive palms. Culling result shown that clonal ramets in both experiments is lesser at average of 3% compared to 10%-20% of conventional DXP seedlings at age of 12 months. There is no different criteria of culling in clonal palm seedling and DXP seedlings.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

5.1.1 Experiment & Analysis

Based on the two experiment and analysis result that was made and conducted at the nursery site called Annex Nursery, Ladang Gomantong Kinabatangan Sabah, finding and the outcome of the both experiments to improve the growth and the leaf nutrient content of the clonal ramets, the following conclusions were drawn.

The experiment on the effect of fertilizer method in different rate could be concluded by comparing the treatments and the economic value, result showed that F3 (control) and T2 (increased 5% from recommended dosage) respectively marginally showed the highest mean of leaf area and low cost per ramets as compare to the others. The highest mean leaf dry weight were showed in F3 (control) on application methods and T1 (Control) on the different rates. The development of each parameters is both interrelated with, and determined by, the environment of the area in which the clonal ramets is growing. Growth measurements give a good guide development when comparing growth of similar material in different environments. The study was conducted in Sandakan region which is receiving more than 2000mm per year. It is also suggested to have further study on this planting material to the other regions.

The objective for experiment on the effect of NPK ratio in different rate revealed that, the cause of white stripe was similarly symptoms can be induced artificially in boron-deficiency. From this study, a likely explanation was that symptoms are those of nutrient imbalance and also occurred in clonal ramets instead of D X P seedlings. Thus symptoms may range from a slight chlorosis or mottling in ramets or seedlings with very mild nutritional imbalance to severe chlorosis where imbalance is pronounced.

Figure 8: *Visit during experiment & analysis was conducted*

There is need to evaluate the optimal rates and behavior of fertilizer especially slow release available and marketed to the oil palm industry. All slow release fertilizers may not necessarily give the desired result in responding to growth. Nevertheless it is obvious that not all the slow release fertilizer behave equally in responding to seedlings growth due to their way of releasing nutrients, the type and thickness in coasting and behavior to the external factor likes temperature, moisture. It is important to check the soil media before planting the clonal ramets. Sending soil sample to laboratory is highly recommended.

5.1.2 Survey & Questionnaire

An overview and survey has been done to examine the qualities, practices, or assessments of a gathering of individuals. These exploration instruments are utilized to pose inquiries about segment data about attributes like management, cost, productivity, and other factors. The summary to define the data was made using the MS Excel and SPSS.

From the MPOB statistic data in 2017, it was stated that industry will facing 27% of declining of foreign workers in Malaysia. Other aspects that need to be considered are the minimum wages, MSPO compliances, the increasing of workers levy and these will leads to increase the overhead cost. Foliar fertilizer is the cheapest fertilizer amongst the other fertilizers but need frequent applications. Distribution of the fertilizer in a broad band around the seeding is important, with care also being taken to keep materials away from the stem base. Effort to use slow release fertilizer are accompanied by high cost, strengthen security and supervision during application is very crucial nevertheless needs very less dosage and workers compared to the other fertilization methods.

Based on data collected from survey and questionnaire, there were 47% of the total workers are foreigner from the large size nursery was employed and almost 60% of the total workers are foreigners. This shows that the foreign workers are valuable and must be take care of their hospitality and at first their take home pay.

5.2 Recommendations

The early fertilizer suggestion framework for oil palm was generally founded on soil investigation results and supplement balance approach. The hidden reason is that the dirt can constantly supply an extent of supplements to the palms with irrelevant exhaustion of soil supplements. In this way, it makes the supposition that the dirt supplements taken up by the palms can be recharged by soil enduring cycles and organic exercises. In any case, the dirt supplement supply fluctuates significantly relying upon its richness status. fertility status. Based on the result of the vegetative growth and the cost production, the conventional fertilizer recommendation is applicable for clonal ramets at nursery stage.

However, there is an option by the nursery operator to decide the methods of application and types depends on the size of the nursery, number of workers availability and environment factors. Fertilizer quality compound fertilizers should be used in the nursery. On most soil 12-12-17-2 gives satisfactory results. Errors are less likely and easier to trace if only one or perhaps two compound fertilizer type are used for the duration of whole nursery period. Foliar sprays or high – N fertilizers are sometimes preferred for the first 2-3 months on seedlings.

It is important to check the soil media before planting the clonal seedling. Sending soil sample to laboratory is highly recommended.

i. Correction of any imbalance may take some time, with severely chlorotic leaves never regaining normality.
ii. Correction of nutrient deficiency more severe to N deficiency in the nursery stage, foliar fertilizer or N source is recommended one off application to the clonal palm with pale or yellowing seedlings.

The palm oil industry is labour intensive and utilizes between 3.7 million and 8 million workers. As per local media and NGO reports, a large number of people have been exposed to constrained work in the production of palm oil. In Malaysia, the second biggest palm oil creating nation all around the world, there are 505,972 ranch labourers. Guaranteeing these labourers are dealt with reasonably and their privileges are maintained is a vital need for the RSPO and our individuals.

Because of this, we saw the need to bring issues to light among employers in the palm sector on what sorts of good practices make a decent work environment and furthermore their labourers salary fulfilment. Such great practices can urge labourers to remain on in an organization, while likewise assisting employers with keeping away from the danger of constrained work and illegal exploitation.

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APPROVAL PAGE

TITLE OF PROJECT PAPER : **CHALLENGES IN MANAGING OIL PALM NURSERY AND EFFECTS OF FERTILIZATION ON OIL PALM TO INCREASE PRODUCTION AND PROFITABILITY**

NAME OF AUTHOR : **SHAHRUL AZMIN BIN MD TAUHID**

The undersigned is pleased to certify that the above candidate has fulfilled the condition of the project paper prepared in partial fulfilment for the award of the degree of Master of Business Administration.

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