



Faculty of Resource Science and Technology

**Forage Resources and Nutrient Content in Grazing Areas of Oil Palm
Plantation**

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Forage Resources and Nutrient Content in Grazing Areas of Oil Palm
Plantation

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Elaeis guineensis Jacq. is one of the most important commodity crops due to its high oil content and increasing global demand for oil in the food, fuel, and cosmetic industries. The extensiveness of oil palm plantation in Malaysia and its luxuriant cover crops have been viewed as a potential avenue for promoting livestock-tree crop integration. The huge land areas of plantations have integrated livestock and crop production. The specific objectives of this study were to (i) determine the floristic diversity and carbon stock of weed species in an integrated oil palm plantation area, (ii) examine the forage recovery of selected forage species following livestock grazing, (iii) examine the forage preferred by livestock between cut and uncut forages, and (iv) determine the selected elements and toxic elements contained in the selected forage and weeds species. The study was conducted at an integrated oil palm plantation in Serian, Sarawak. Initial sampling showed that 10961 total individuals were recorded, belonging to 53 species of weeds. The second sampling carried out six months after the initial sampling recorded 9959 individuals consisting of 62 species and higher diversity than the initial sampling. The estimated carbon stock was 0.43 tonne ha⁻¹ for the initial sampling and 0.41 tonne ha⁻¹ for the second sampling. Recovery of *Axonopus compressus* showed the significant difference of mean height between grazed, cut, and ungrazed, in which the ungrazed was higher than grazed and cut. For cut *A. compressus* the recovery height was better in shaded than opened areas. The height recovery for grazed, cut, and ungrazed *Elaeis guineensis* seedlings differed significantly. The recovery of *E. guineensis* was higher in ungrazed than grazed. The difference was significant for grazed and cut and between cut and ungrazed. The cut *E. guineensis* showed a higher height recovery in opened than the shaded area. There was a significant difference in the recovery of new shoots for grazed and cut *Antrophyum reticulatum*. The mean percentage of forage

preferred by livestock showed that the uncut was higher than cut *A. compressus*. Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg), Sulphur (S), and Sodium (Na) were detected in *A. compressus*, *E. guineensis*, *A. reticulatum*, *Asystasia gangetica*, and *Scleromitrium verticillatum* in different concentrations. No heavy metals were detected in the consumed plants. Toxicity analyses of unconsumed plants; *Melastoma malabathricum*, *Miconia crenata*, *Diplazium esculentum*, *Taenitis blechnoides*, and *Torenia crustacea* did not contain hazardous elements such as Lead (Pb), Cadmium (Cd), Mercury (Hg), and Arsenic (Ar) except for Aluminium (Al). This study revealed that no cutting of forages is required provided that the rotation system incorporate forage recovery in the rotation schedule. Livestock did not adversely affect forage growth and development because grazed weeds are tolerant of grazing stress.

Keywords: Integrated oil palm plantation, weeds diversity, forage recovery, forage preferences, elements in forage

Sumber Makanan Ternakan dan Kandungan Nutrien di dalam Kawasan Ragut Ladang Kelapa Sawit

ABSTRAK

Elaeis guineensis Jacq. merupakan salah satu daripada komoditi tanaman terpenting disebabkan oleh kandungan minyak yang tinggi dan juga peningkatan permintaan global untuk penggunaan minyak sawit dalam industri makanan, bahan api dan kosmetik. Keluasan ladang kelapa sawit di Malaysia dan kekayaan tanaman penutup dilihat sebagai berpotensi untuk mempromosi integrasi di antara ternakan-tanaman pokok. Ladang yang mempunyai kawasan tanah yang luas sudah pun mengamalkan integrasi ternakan dengan penghasilan tanaman. Objektif-objektif spesifik kajian ini ialah untuk (i) menentukan diversiti floristik dan stok karbon spesies rumpai dalam kawasan ladang kelapa sawit bersepadu (ii) meneliti pemulihan foraj bagi spesies foraj yang terpilih setelah diragut oleh ternakan (iii) meneliti foraj yang disukai oleh ternakan sama ada foraj yang telah dipotong dan tidak dipotong, dan (iv) menentukan kandungan unsur dan unsur toksik yang terpilih dalam spesies tanaman ragut dan rumpai yang terpilih. Kajian telah dilakukan di ladang kelapa sawit bersepadu di Serian, Sarawak. Pensampelan awal menunjukkan sejumlah 10961 individu telah direkodkan terdiri dari 53 spesies. Pensampelan kedua dijalankan selepas enam bulan dari pensampelan awal merekodkan sejumlah 9959 individu terdiri daripada 62 spesies dan diversiti adalah lebih tinggi daripada pensampelan awal. Stok karbon dianggarkan 0.43 metrik tan ha⁻¹ untuk pensampelan awal dan 0.41 metrik tan ha⁻¹ untuk pensampelan kedua. Pemulihan *Axonopus compressus* menunjukkan perbezaan ketara bagi min tinggi diantara yang diragut, dipotong, dan tidak diragut di mana yang tidak diragut adalah lebih tinggi daripada yang diragut dan dipotong. Untuk *A. compressus* yang dipotong pemulihan ketinggian adalah lebih cepat di kawasan redup daripada terbuka. Pemulihan ketinggian

bagi anak pokok E. guineensis yang diragut, dipotong dan tidak diragut adalah berbeza dengan ketara. Pemulihan E. guineensis yang tidak diragut adalah lebih cepat dibandingkan dengan yang diragut dan perbezaan adalah ketara bagi yang diragut dan dipotong dan juga diantara yang dipotong dan tidak diragut. E. guineensis yang dipotong menunjukkan pemulihan ketinggian yang cepat dalam kawasan terbuka dibandingkan dengan kawasan redup. Terdapat perbezaan yang ketara di dalam pemulihan pucuk baru bagi Antrophyum reticulatum yang telah diragut dan dipotong. Min peratusan foraj yang disukai oleh ternakan menunjukkan A. compressus yang tidak dipotong adalah menjadi pilihan dari yang dipotong. Komposisi unsur Nitrogen (N), Fosforus (P), Kalium (K), Magnesium (Mg), Sulfur (S), dan Natrium (Na) bagi spesies yang dimakan oleh ternakan termasuk A. compressus, E. guineensis, A. reticulatum, Asystasia gangetica, dan Scleromitron verticillatum telah dikesan di dalam semua spesies tetapi dalam kandungan yang berbeza dan tiada logam berat telah dikesan. Analisis toksik yang dilakukan ke atas spesies terpilih yang tidak dimakan oleh ternakan termasuk Melastoma malabathricum, Miconia crenata, Diplazium esculentum, Taenitis blechnoides, dan Torenia crustacea menunjukkan bahawa Plumbum (Pb), Kadmium (Cd), Raksa (Hg), dan Arsenik (Ar) tidak dikesan di dalam semua spesies kecuali bagi Aluminium (Al). Kajian ini mendedahkan bahawa pemotongan foraj adalah tidak perlu dilakukan dengan syarat sistem giliran mengambilkira pemulihan foraj dalam merangka jadual giliran. Ternakan tidak memberi kesan buruk ke atas pertumbuhan dan perkembangan foraj kerana rumpai yang diragut adalah toleran terhadap tekanan akibat dari ragutan.

Kata kunci: Ladang kelapa sawit bersepadu, diversiti rumpai, pemulihan foraj, foraj pilihan, unsur dalam foraj

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LIST OF ABBREVIATIONS

1-D	Simpson's Index of Diversity
3P	People, Planet, Profit
AAS	Atomic Absorption Spectrometry
Asymp. Sig.	Asymptotic significance
cm	centimetre
CO ₂	Carbon dioxide
CPO	Crude palm oil
D	Density
DM	Dry matter
DVS	The Department of Veterinary Services
ESPEK	Sistem Maklumat Pekebun Kecil
EU	European Union
F	Frequency
FELDA	Federal Land Administration Authority
g	gram
GHGs	Greenhouse Gases
GNI	Gross national income
ha	Hectare
ha ⁻¹	per hectare
H'	Shannon-Wiener Diversity Index
IAEA	International Atomic Energy Agency
IPM	Integrated pest management

IPNI	International Plant Names Index
IV	Important Value
J'	Pielou's Evenness Index
kg	kilogram
m	metre
Mmtons	Million metric tons
MPOB	Malaysia Palm Oil Board
MSPO	Malaysian Palm Oil Sustainable
MYR	Malaysian Ringgit
NRC	National Research Council
PAR	Photosynthetically Active Radiation
PgC	Petagram of Carbon
PINTAR	The Malay acronym for Ruminant Tree Crop Integration Project
R	Coefficient correlation
R'	Margalef's Richness Index
RD	Relative Density
RF	Relative Frequency
RISDA	Rubber Industry Smallholders Development Authority
RSPO	Roundtable on Sustainable Palm Oil
SDR	Summed Dominance Ratio
SI	Sorensen's Similarity Index
Sig.	Significance
TAC	Targeted Area Concentration
TDN	Total Digestible Nutrient

t tonne

ton tonne

USDA United States Department of Agriculture

CHAPTER 1

INTRODUCTION

1.1 Research Background

The oil palm plantation area in Malaysia had shown dramatic growth from about 55 000 ha in 1960 to 193 000 ha in 1970, and the development was remarkably rapid, with the area of planted oil palm reaching 1.02 million ha in 1980. It then continually expanded to 2.03 million ha in 1990, then added to 5.74 million ha in 2016 (MPOB, 2017; Nambiappan et al., 2018) and recently reached 5.87 million ha in 2020 (MPOB, 2021). In recent years, mostly Sabah and Sarawak contributed to expanding oil palm planted areas because of the decreasing availability of suitable land in Peninsular Malaysia. As of 2016, about 47% of the planted area was in Peninsular Malaysia, 27% in Sabah and 26% in Sarawak (Nambiappan et al., 2018). Meanwhile, both Malaysia and Indonesia produced approximately 85% of the total palm oil production. The demand is rapidly spreading globally because China and India are the main import countries next to the EU (USDA, 2012; Ferdous et al., 2015).

Oil palm plays a vital role in providing food to more than 3 billion people in more than 200 countries, and it will be a great challenge to supply an additional 2 billion people by 2050 with limited arable land. As compared to the other oil crops, oil palm requires less land to produce the same amount of oils. For example, oil palm only needs 0.26 hectares (ha) to produce 1 tonne (t) of oil compared to 2.2, 2.0 and 1.5 ha for soybean, sunflower, and rapeseed, respectively (Wahid et al., 2011; Nambiappan et al., 2018). The palm oil industry has brought significant economic benefits to Malaysia, and the current production of 19 million metric tons (Mmtons) of crude palm oil (CPO) adds 8% to the country's gross