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ABSTRACTS

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IMPLEMENTATION OF MULTI-SYSTEM SILVICULTURE (MSS) TO IMPROVE PERFORMANCE OF PRODUCTION FOREST MANAGEMENT: A CASE STUDY OF PT. SARPATIM, CENTRAL KALIMANTAN

(IMPLEMENTASI MULTI SISTEM SILVIKULTUR (MSS) UNTUK MENINGKATKAN PERFORMA PENGELOLAAN HUTAN PRODUKSI: STUDI KASUS DI PT. SARPATIM, KALIMANTAN TENGAH)

Performa pengelolaan hutan produksi di Indonesia saat ini memprihatinkan. Luas konsesi, produksi kayu dan penyerapan tenaga kerja mengalami penurunan dari waktu ke waktu. Peduli untuk kebutuhan ini, telah dilakukan penelitian selama enam tahun (2008-2013) dan menghasilkan rekomendasi untuk menggunakan Multisistem Silvikultur (MSS). Dua perangkat MSS telah berhasil disediakan, yaitu kriteria dan indikator sebagai pedoman dalam memilih sistem silvikultur dan supersilvik, sebuah perangkat model untuk membantu menyusun rencana kelola terbaik. Tulisan ini bertujuan untuk mengevaluasi dan memperkuat rekomendasi melalui simulasi penggunaan dua perangkat MSS tersebut di PT. Sarmiento Parakantja Timber (Sarpatim), Kalimantan Tengah, Indonesia. Beragam data digunakan, meliputi peta tematik tentang kawasan serta data tegakan, bahan, peralatan, tenaga kerja, pembiayaan, dan pendapatan. Data tersebut diolah dengan menggunakan berbagai formulasi rumus yang saling terhubung satu sama lain dalam sistem model untuk menghasilkan data luaran berkenaan dengan produksi, finansial, serapan tenaga kerja dan kontribusi pajak. Studi ini menghasilkan empat pilihan untuk peningkatan performa usaha kelola PT. Sarpatim, dimana salah satunya adalah pilihan terbaik. Jika dibandingkan dengan usaha kelola menggunakan sistem silvikultur yang terbatas, diproyeksikan bahwa dengan menggunakan MSS diperoleh peningkatan penggunaan lahan, produksi kayu dan penyerapan tenaga kerja sebesar 151-753%. Penerapan MSS akan berdampak baik dalam membangun usaha yang lebih sehat, ditandai dengan peningkatan NPV hingga 193%. MSS juga berdampak baik dalam meningkatkan penerimaan pajak hingga 308%. Studi kasus ini mendorong penggunaan teori baru bahwa pengusahaan hutan produksi berkenaan dengan tata kelola lahan dan tanaman, yang menempatkan lahan sebagai faktor modal dan silvikultur sebagai faktor penggerak produksi. Pengambil kebijakan dapat menggunakan hasil penelitian ini sebagai acuan dalam implementasi MSS secara luas untuk meningkatkan kinerja pengelolaan hutan produksi sebagai bagian dari praktik pengelolaan hutan secara lestari.

Kata kunci: Multisistem silvikultur, hutan produksi, supersilvik, pemodelan, simulasi

UDC/ODC 630* 176.2(594.42)

Rospita O. P. Situmorang

SOCIAL CAPITAL IN MANAGING MANGROVE ECOTOURISM AREA BY THE MUARA BAIMBAI COMMUNITY

(MODAL SOSIAL DALAM PENGELOLAAN KAWASAN EKOWISATA MANGROVE OLEH KOMUNITAS MUARA BAIMBAI)

Keberhasilan pengelolaan lingkungan melalui pelibatan masyarakat dipengaruhi oleh situasi sosial. Penelitian ini bertujuan untuk menganalisis modal sosial yang dimiliki oleh Komunitas Muara Baimbai di Desa Sei Nagalawan dalam mengelola kawasan mangrove secara ekowisata. Penelitian ini berlokasi di kawasan mangrove Muara Baimbai, Desa Sei Nagalawan, Kecamatan Perbaungan, Kabupaten Serdang Bedagai, Sumatera Utara pada bulan Juni hingga Desember 2014. Data dikumpulkan melalui observasi lapangan, pembuatan kuesioner terstruktur, dan wawancara mendalam. Komunitas Muara Baimbai memiliki modal sosial yang tinggi dalam mengelola kawasan ekowisata mangrove. Indikator dari modal sosial yang kuat ditunjukkan dengan berjalannya institusi kelompok sesuai dengan yang diharapkan. Keberhasilan kelompok merehabilitasi kawasan mangrove di Desa Sei Nagalawan dan memanfaatkan sumberdaya tersebut secara berkelanjutan merupakan hasil dari tingkat partisipasi yang tinggi dan peran kader-kader aktif sebagai symbolic power yang mendorong dan memotivasi para anggota dalam perjuangan mereka. Motivasi yang kuat, alokasi kerja dan pembangian keuntungan yang adil, ikatan internal yang kuat, dan jaringan yang luas sangat penting dalam menguatkan modal sosial. Selanjutnya, peningkatan kesejahteraan yang didapat oleh masyarakat melalui peningkatan pendapatan, lapangan pekerjaan, dan pengetahuan adalah manfaat yang diperoleh dalam pengelolaan hutan berkelanjutan yang dapat memelihara keberadaan komunitas dan sumber daya.

Kata kunci: Komunitas, modal sosial, ekowisata, mangrove

UDC/ODC 630*232.315

Naning Yuniarti and Nurhasybi

THE PHYSIOLOGICAL AND NUTRITIONAL CONTENT CHANGES OF JELUTUNG (*Dyera polyphylla* (Miq.) Steenis) SEED THROUGH DRYING AND STORAGE

(PERUBAHAN FISIOLOGI DAN KANDUNGAN NUTRISI BENIH JELUTUNG (Dyera polyphylla (*Miq.*) *Steenis*) PADA PROSES PENGERINGAN DAN PENYIMPANAN)

Secara alami benih jelutung seiring dengan bertambahnya waktu akan mengalami kemunduran mutu benih yang dapat menyebabkan perubahan baik fisik, fisiologis maupun nutrisi yang mengakibatkan menurunnya viabilitas benih. Tujuan penelitian ini adalah untuk menguji pengaruh lama pengeringan dan ruang penyimpanan terhadap viabilitas dan komposisi nutrisi benih jelutung (Dyera polyphylla (*Miq.*) *Steenis*). Penelitian pengeringan dirancang dengan menggunakan Rancangan Acak Lengkap dengan waktu pengeringan selama 0, 24, 48, 72, 96, dan 120 jam; , sedangkan pengujian viabilitas dan kandungan nutrisi benih terhadap lama pengeringan dan ruang penyimpanan menggunakan RAL pola faktorial dengan dua faktor, yaitu faktor lama pengeringan benih (0, 24, 48, 72, 96, dan 120 jam), dan faktor ruang simpan (ruang suhu kamar, AC, kulkas). Kedua tahapan penelitian menggunakan peubah kadar air benih, daya berkecambah dan kandungan nutrisi benih. Hasil yang diperoleh yaitu lama pengeringan dan ruang penyimpanan mengakibatkan perubahan viabilitas dan kandungan biokimia pada benih jelutung, interaksi lama pengeringan dan ruang penyimpanan berpengaruh nyata terhadap nilai kadar air, daya berkecambah, dan kandungan nutrisi (lemak, karbohidrat, protein) benih jelutung, semakin lama pengeringan, akan menyebabkan menurunnya nilai kadar air dan daya berkecambah, meningkatnya kadar lemak dan protein, serta menurunnya kadar karbohidrat pada benih jelutung, benih jelutung yang disimpan di ruang AC dapat menghasilkan viabilitas benih yang lebih baik dibandingkan dengan penyimpanan di ruang kamar dan kulkas.

Kata kunci: Benih jelutung, viabilitas, nutrisi, pengeringan, penyimpanan

UDC/ODC 630*26:67(594.48)

Bambang T. Premono and Sri Lestari

FINANCIAL ANALYSIS ON AGROFORESTRY SYSTEM OF COFFEE WITH MARRANGO TREE (*Azadirachta excelsa* Jack.) IN REJANG LEBONG REGENCY, BENGKULU PROVINCE, INDONESIA

(ANALISIS FINANSIAL SISTEM AGROFORESTRI KAYU BAWANG DAN TANAMAN KOPI DI KABUPATEN REJANG LEBONG, BENGKULU, INDONESIA)

Kayu bawang (Azadirachta excelsa Jack.) telah diperkenalkan sebagai pohon penaung untuk tanaman kopi. Selain itu pohon ini juga menghasilkan kayu yang cukup bernilai terutama untuk kayu pertukangan dan kayu energi. Tulisan ini bertujuan untuk melakukan analisis finansial sistem agroforestri kayu bawang dan tanaman kopi. Termasuk diantaranya melihat pengelolaan lahan yang diterapkan, mengetahui biaya dan pendapatan, kelayakan finansial dan melakukan analisis sensitivitas terhadap sistem agroforestri yang diterapkan. Penelitian ini dilaksanakan di dataran tinggi Kabupaten Rejang Lebong, Bengkulu, dengan metode observasi lapangan dan wawancara. Data dikumpulkan melalui observasi, survei rumah tangga dan wawancara mendalam dengan beberapa aktor kunci untuk memperdalam informasi dan memverifikasi data yang telah diperoleh. Data dianalisis dengan menggunakan analisis deskriptif kuantitatif dan finansial. Hasil penelitian menunjukkan bahwa pengelolaan agroforestri kopi dengan marrango tree di Kabupaten Rejang Lebong masih belum intensif. Petani mengelola lahan dengan cara tradisional. Meskipun demikian, sistem agroforestri tanaman kopi dan kayu bawang layak secara finansial pada tingkat faktor diskonto 8 % (NPV = Rp76,250,582; BCR 2.28 dan IRR 22%). Sistem agroforestri ini juga memiliki ketahanan yang baik terhadap perubahan harga kopi, produksi kopi dan harga kayu bawang. Sistem agroforestri masih layak meski produksi kopi menurun 50%, harga kopi turun hingga 40%, dan produksi kayu turun sebesar 50%. Perubahan produksi dan harga kopi adalah faktor yang paling berpengaruh terhadap kelayakan agroforestri tanaman kopi dan kayu bawang. Dengan demikian sistem agroforestry relatif tahan terhadap perubahan harga pasar baik kopi dan kayu bawang. Sistem agroforestri ini menguntungkan bagi petani. Oleh karena itu, pemerintah daerah harus mendorong masyarakat untuk menerapkan system ini.

Kata kunci: Agroforestri, kopi, analisis finansial, kayu bawang

UDC/ODC 630*145.7

Kuntadi, Yelin Adelina and Kun E. Maharani

NUTRITIONAL COMPOSITIONS OF SIX EDIBLE INSECTS IN JAVA

(KANDUNGAN NUTRISI ENAM JENIS SERANGGA LAYAK KONSUMSI DI JAWA)

Kekurangan pangan dan nutrisi masih menjadi persoalan yang dihadapi banyak keluarga di Indonesia. Salah satu persoalan penting dalam permasalahan tersebut yaitu tingkat konsumsi protein yang masih di bawah standar kebutuhan minimum. Serangga dapat menjadi alternatif terbaik penyedia protein hewani mengingat ketersediaannya di alam cukup melimpah. Tulisan ini mempelajari komposisi proksimat, potensi nutrisi, dan nilai gizi enam jenis serangga layak konsumsi, baik yang berasal dari kegiatan budi daya maupun yang berasal dari alam. Serangga hasil budi daya terdiri dari jangkrik (Gryllus sp.), ulat jerman (Zophobas morio F.), ulat hongkong (Tenebrio molitor L.), dan pupa ulat sutera (Bombyx mori L.), adapun serangga hasil tangkapan dari alam terdiri dari belalang kayu (Valanga nigricornis Burm.) dan belalang jerami (Nomadacris succincta L.). Hasil penelitian menunjukkan kandungan nutrisi masing-masing jenis serangga sangat bervariasi. Setiap 100g berat kering specimen serangga mengandung protein 32,59-76,69%, lemak 6,9-29,47%, karbohidrat 0,92-30,76%, abu 2,80-5,79%, energi 407,34-517,50 kkal, serta mineral Ca dan Fe sekitar 24,82-31,22 mg dan 3,15-4,1 mg. Beberapa jenis serangga seperti belalang, pupa ulat sutera, dan jangkrik memiliki kandungan protein yang tinggi sehingga sangat potensial untuk dimanfaatkan sebagai alternatif sumber protein dalam upaya memerangi masalah malnutrisi dan meningkatkan konsumsi makanan bergizi. Berbagai upaya perlu dilakukan untuk mendorong pemanfaatan serangga sebagai alternatif sumber protein hewani. Pemasyarakatan konsumsi serangga perlu dilakukan bagi masyarakat pedesaan dan yang tinggal di sekitar hutan mengingat kawasan hutan merupakan habitat beragam jenis serangga.

Kata kunci : Serangga layak konsumsi, proksimat, nilai nutrisi, makanan

UDC/ODC 630*922.2 (594.71)

Budiman Ahmad and Dian Diniyati

CONSUMPTION BEHAVIOUR OF FARMER HOUSEHOLDS IN RURAL SUMBAWA, INDONESIA

(POLA KONSUMSI RUMAH TANGGA PETANI DI PEDESAAN SUMBAWA, INDONESIA)

Tingkat kesejahteraan petani di pedesaan Sumbawa tetap rendah meskipun potensi sumberdaya alam di sekitar mereka tinggi. Penelitian ini mengungkap faktor-faktor yang mempengaruhi pola konsumsi dan tingkat kesejahteraan petani pedesaan Sumbawa, Indonesia. Ukuran rumah tangga, lamanya pendidikan, dan pendapatan dari usaha tani digunakan sebagai indikator dari kinerja lahan pertanian. Penelitian ini dilakukan pada bulan Pebruari sampai April 2015 pada dua areal hutan yang terpisah dimana secara administrasi berada dalam Desa Labuhan Badas yaitu: hutan kemasyarakatan (HKm) di dalam area hutan produksi negara dan hutan milik (HR). Di tiap lokasi, sebanyak 34 responden dipilih secara sengaja. Analisis multilinear regresi digunakan untuk menganalisis faktor-faktor yang mempengaruhi pola konsumsi, sementara itu nilai tukar pendapatan rumah tangga petani (NTPRP) digunakan untuk mengukur tingkat kesejahteraan. Regresi mengungkap bahwa pola konsumsi petani di dua areal hutan berkorelasi positif dengan ketiga indikator. Sementara itu, ukuran rumah tangga mempengaruhi pola konsumsi petani di HKm, tetapi tidak di HR. Selanjutnya, pola konsumsi dipengaruhi oleh pendapatan usaha tani di kedua areal hutan. Melalui pendekatan NTPRP diketahui bahwa tingkat pendapatan seluruh petani masih rendah (NTPRP = 0,74-0,99). Oleh karena itu pemerintah sebaiknya mensubsidi bibit padi tadah hujan dan bibit tembakau yang varietasnya sesuai dengan iklim setempat, sementara itu petaniya sebaiknya dilatih untuk mengolah daging buah jambu mete menjadi anggur dan kripik, didorong menanam pohon kaliandra untuk pakan lebah madu dan bahan pembuatan pelet kayu atau arang.

Kata kunci: Petani, kinerja lahan pertanian, hutan milik, hutan negara, kesejahteraan

IMPLEMENTATION OF MULTI-SYSTEM SILVICULTURE (MSS) TO IMPROVE PERFORMANCE OF PRODUCTION FOREST MANAGEMENT: A CASE STUDY OF PT. SARPATIM, CENTRAL KALIMANTAN

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IMPLEMENTATION OF MULTI-SYSTEM SILVICULTURE (MSS) TO IMPROVE PERFORMANCE OF PRODUCTION FOREST MANAGEMENT: A CASE STUDY OF PT. SARPATIM, CENTRAL KALIMANTAN. To date, performance of the management of Indonesian production forests are discouraging. The concession areas, timber production and employment have been decreasing over time. To concern on these matter and to improve management, a research was conducted for six years (2008-2013) and resulted in recommendations to implement the Multi-System of Silviculture (MSS) systems. Two products were generated in MSS; criteria and indicator to guide the selection of appropriate silvicultural system and supersilvik, a model to develop the best business plans. This paper evaluates and strengthens the recommendations through the simulation of MSS products in PT. Sarmiento Parakantja Timber (Sarpatim), Central Kalimantan, Indonesia. Various data variables were used, such as thematic maps of forest areas, data of stand, materials, equipments, labors, finances and incomes. Data were processed in a variety of formulations which were connected to each other in model systems to produce a variety of outcomes, such as production, finance, employment and tax contributions. Results offer four options to improve PT. Sarpatim performance, one of which is the best choice. Compared to the former business model under limited silvicultural systems, MSS projected an increase in the use of land, timber production and employment by 151-753%. Implementing MSS will provide a better and healthier finance for company with an increase of NPV up to 193%; as well as for government tax revenues with an increase up to 308%. This MSS case study strongly suggests using the new theory that the management of production forests is a land and plant-based enterprises, which should put the land as the major capital and silvicultural aspects as the driving engine for production. The policy makers should be able to use these results as a reference in implementing MSS widely as part of Sustainable Forest Management (SFM) practices.

Keywords: Multi-system silviculture, production forest, supersilvik, model, simulation

IMPLEMENTASI MULTI SISTEM SILVIKULTUR (MSS) UNTUK MENINGKATKAN PERFORMA PENGELOLAAN HUTAN PRODUKSI: STUDI KASUS DI PT. SARPATIM, KALIMANTAN TENGAH. Performa pengelolaan hutan produksi di Indonesia saat ini memprihatinkan. Luas konsesi, produksi kayu dan penyerapan tenaga kerja mengalami penurunan dari waktu ke waktu. Peduli untuk kebutuhan ini, telah dilakukan penelitian selama enam tahun (2008-2013) dan menghasilkan rekomendasi untuk menggunakan Multisistem Silvikultur (MSS). Dua perangkat MSS telah berhasil disediakan, yaitu kriteria dan indikator sebagai pedoman dalam memilih

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sistem silvikultur dan supersilvik, sebuah perangkat model untuk membantu menyusun rencana kelola terbaik. Tulisan ini bertujuan untuk mengevaluasi dan memperkuat rekomendasi melalui simulasi penggunaan dua perangkat MSS tersebut di PT. Sarmiento Parakantja Timber (Sarpatim), Kalimantan Tengah, Indonesia. Beragam data digunakan, meliputi peta tematik tentang kawasan serta data tegakan, bahan, peralatan, tenaga kerja, pembiayaan, dan pendapatan. Data tersebut diolah dengan menggunakan berbagai formulasi rumus yang saling terhubung satu sama lain dalam sistem model untuk menghasilkan data luaran berkenaan dengan produksi, finansial, serapan tenaga kerja dan kontribusi pajak. Studi ini menghasilkan empat pilihan untuk peningkatan performa usaha kelola PT. Sarpatim, dimana salah satunya adalah pilihan terbaik. Jika dibandingkan dengan usaha kelola menggunakan sistem silvikultur yang terbatas, diproyeksikan bahwa dengan menggunakan MSS diperoleh peningkatan penggunaan lahan, produksi kayu dan penyerapan tenaga kerja sebesar 151-753%. Penerapan MSS akan berdampak baik dalam membangun usaha yang lebih sehat, ditandai dengan peningkatan NPV hingga 193%. MSS juga berdampak baik dalam meningkatkan penerimaan pajak hingga 308%. Studi kasus ini mendorong penggunaan teori baru bahwa pengusahaan hutan produksi berkenaan dengan tata kelola lahan dan tanaman, yang menempatkan lahan sebagai faktor modal dan silvikultur sebagai faktor penggerak produksi. Pengambil kebijakan dapat menggunakan hasil penelitian ini sebagai acuan dalam implementasi MSS secara luas untuk meningkatkan kinerja pengelolaan hutan produksi sebagai bagian dari praktik pengelolaan hutan secara lestari.

Kata kunci: Multisistem silvikultur, hutan produksi, supersilvik, pemodelan, simulasi

I. INTRODUCTION

Performances of the management of production forests in Indonesia are currently discouraging (Suryanto & Wahyuni, 2016). Only 30.3% of production forests are actively managed under forest concessions (SoFS, 2016a) and produces timber less than forty-five million cubic meter per year in 2016 (MoEF, 2017; SoFS, 2017). Hence, interest is currently decreasing for investment in logging concession. In 1993, the number of natural forest production concessionaires, namely IUPHHK-HA, was 575 covering 61.7 million ha area concession (MoF, 2012), but only 251 IUPHHK-HA were left covering 19 million ha in 2016 (MoEF, 2017). Furthermore, Indonesia has begun granting licenses for industrial forest plantation business, namely IUPHHK-HT, as an effort to build new timber resources by converting some natural forests to forest plantation. It was started in 1990 with 30 thousand hectares licensed area of IUPHHK-HT outside Java (MoF, 2012), and then the number increased to 286 IUPHHK-HT in 2016 (including Java). However, the investment just only covers 10.8 million ha (MoEF, 2017), and this is less than the sum of the natural production of forest loss. Subsequently, only 188 IUPHHK-HA and 189 IUPHHK-HT have actively used their licenses in the field and they only cover 25 million ha of concession areas (SoFs, 2016a). The worsening performance was due to two problems: i.e. limited use of relevant silvicultural systems, and fragmented concession area (Suryanto & Wahyuni, 2016). It has also resulted in that approximately 43.8 million ha of the 68.8 million ha production forests available in Indonesia are not managed properly (MoEF, 2017; SoFS, 2016a).

Considering that problem, a continuous study was conducted during the period of 2008-2013 in 10 forest concessions in Kalimantan and Sumatera. Through the study, the concept ideas of Multi-System Silviculture (MSS) which was initiated by the National Workshop on Implementation of Multi Silvicultural System, Bogor, August 23, 2008 were developed. MSS which is actually driving to the MFM Concept (Multiple-use Forest Management) bring to improve the performance of production forest management (Kusmana, 2011a) by using more than one silvicultural system in a single forest concession, particularly in natural production forest concession. Through policy briefs, Suryanto, Nurrochmat, Prijono, Budiaman and Suyana (2010) and supported by other experts

(Kusmana, 2011b), MSS concept has come to influence a change in government policy (MoF, 2014). However, MFM implementation has been lacking behind expectations (Fernández, Pérez, & Wunder, 2008). MSS has not been implemented in the field level yet. Therefore, scientific evidence to expose the effectiveness of the MSS is required and to be promoted.

The new notion of forest industry cluster is in line with the conception of MSS/MFM, which will depend on establishing silvicultural land uses that inflict low disturbance regimes (Chazdon et al., 2016; Hernández, Pingarroni, & Ramos, 2016; Payn et al., 2015). Forest industry cluster (FCI) opens the concept of adding management unit of Non-Timber Forest Products (NTFPs) in the Forest Management Unit of Production Forests and Services (Chen & Innes, 2013; Dalemans et al., 2015; Rist et al., 2012; Shackleton & Pandey, 2014). In this regard, the evaluation of MSS in IUPHHK-HA PT. Sarmiento Parakantja Timber (PT. Sarpatim) in Central Kalimantan, which focuses on the development of timber based product was re-simulated by adding the unit development of NTFPs for rubber and sugar palm (Mochlis, 2013; Suryanto & Andriansyah, 2013). This paper evaluates and strengthens the MSS recommendation through re-simulation of MSS product in IUPHHK PT. Sarpatim. It is hoped that this paper strengthening the notion of MSS as a solution to increase the performance of forest production in Indonesia.

II. MATERIAL AND METHOD

A. Material

Two outcomes have been produced to support MSS; a criteria and indicator to guide selection of the appropriate silvicultural system and, supersilvik, a model to help develop the best business plans in production forest venture. The results of analysis and validation have been finished for the study cases of PT. International Timber Corporation Indonesia Kayan Hutani (PT. IKANI), PT. Balikpapan Forest Industries (PT. BFI) (Suryanto, 2010) and PT. Sarpatim (Suryanto & Andriansyah, 2013; Mochlis, 2013). In 2013-2015 period, supersilvik models were upgraded by integrating NTFPs management unit as part of the data processing operation. Simulation and validation have been completed by Suryanto and Wahyuni (2015) for the case study at PT. International Timber Corporation Indonesia Kartika Utama (PT. ITCIKU). The next simulation presented in this study was the result of analysis and validation of the data collected in 2012 in PT. Sarpatim, Central Kalimantan. Some of other data, especially with regard to the financial data is adjusted to match updated unit price and finance of the year 2016.

B. Methods

Both primary and secondary data were collated for this study. Secondary data were obtained from the documents of business workplan, annual workplan and periodical comprehensive forest inventory (PCFI) as well as digital maps including operational maps, land cover maps, PCFI maps and topographic maps. Primary data were ground checked for forest potency in four 4-ha sample plots to represent each type of forest cover (Peck, Zenner, Brang, & Zingg, 2014). The data were collected from the identification of species and measurements of tree diameter and height. Field measurement data were processed into data structure including composition, height dominant trees, form factor and correction factors. Other primary data were the minutes of in-depth discussion with practitioners in forest concession of PT. Sarpatim and some experts. The ArcGIS program had been run for the analyses of criteria and indicators while Stella 9.0.2 for processing data entry and analysis using *supersilvik* modeling.

C. Data Analysis

1. Criteria and indicator

Seven criteria and its associated indicators were used in the process of area delineation and silvicultural system selection. These include topography, forest production potential,

Table 1. Indicators and score in the topography criteria and the forest production potential criteria as well as, the selection of silvicultural system based on the total scores

a. Topography

Slope Class	Level	Weighting	Score
0-8% (Flat)	1	15	15
9-15% (Sloping)	2	15	30
16-25% (Light Steep)	3	15	45
26-40% (Steep)	4	15	60
40% Up (Very Steep)	5	15	75

b. Forest Production Potential (FPP)

FPP Class (m^2/ha)	Level	Weighting	Score
0-20 (Very Low)	1	35	35
20-40 (Low)	2	35	70
40-60 (Medium)	3	35	105
60 Up (High)	4	35	140

c. Total Score

Silviculture System, Protection area	Score	Remarks
Clear Cutting With Planting (THPB) and or Non Timber Forest Products (NTFPs)	< 90	Low stand potency zone and topography of 0-25% Low stand potency zone and flat topography
Selective Cutting and Line Planting (TPTJ)	90-155	Very low potency zone along with steep slope Low stand potency zone along with topography of 9-40% Medium stand potency zone along with topography of 0-25%
Indonesian Selective Cutting and Replanting (TPTI)	155-200	Medium stand potency zone along with steep slope High stand potency along with topography of 0-40%
Protection Area	-	Very steep slope zone Other area with protection typology

Source: Muchlis (2013)

soil type, annual rainfall, village distribution, accessibility and regulator or owner decisions.

In the early stages, topography and forest potency criteria were used in the processing of area delineation into business units that correspond to the natural carrying capacity. The materials used were topography and land cover maps that were digitized with the data of forest production potential from PCFI and sampling results. The criteria of topography and forest production potential were classified into five and four indicators respectively. Map data processing used the scoring system with overlay techniques and followed by weighting and summing the value scores as presented in Table 1.

Criteria of soil type, rainfall, village distributions and accessibility, subsequently were used as consideration in several alternative forms of management, such as alternative of plant species, harvesting techniques, labor and others (Mochlis, 2013; Suryanto & Andriansyah, 2013). Lastly, the decision criterion was used to select an alternative form of management. This decision criterion includes two indicators in two repetitive processes, namely the decision regulator (The Ministry of Environment and Forestry, MoEF) and the decision of the board of directors (owners). The system accomodates the subjective nature of expert judgment to select the best option (FOERDIA-MoEF, 2015a).

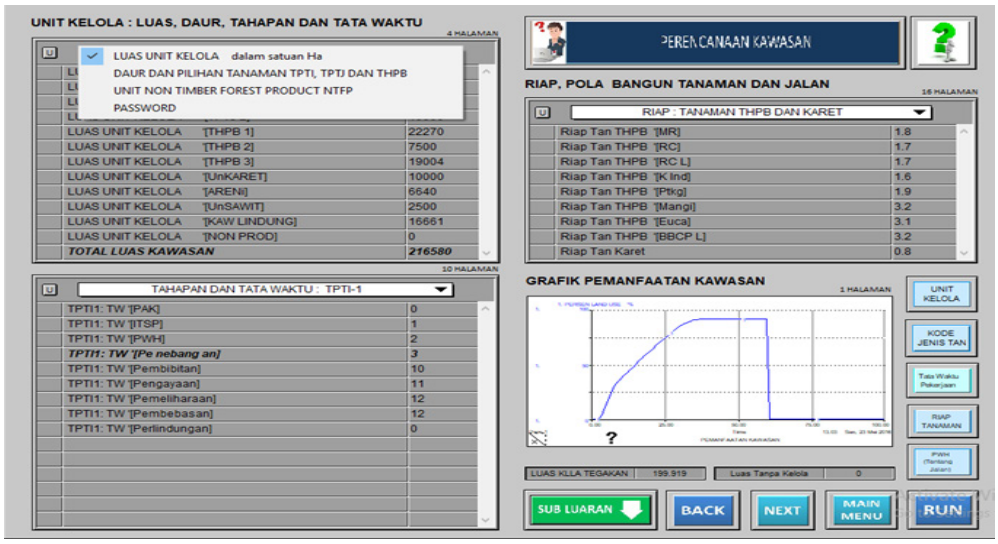
2. *Supersilvik* modelling

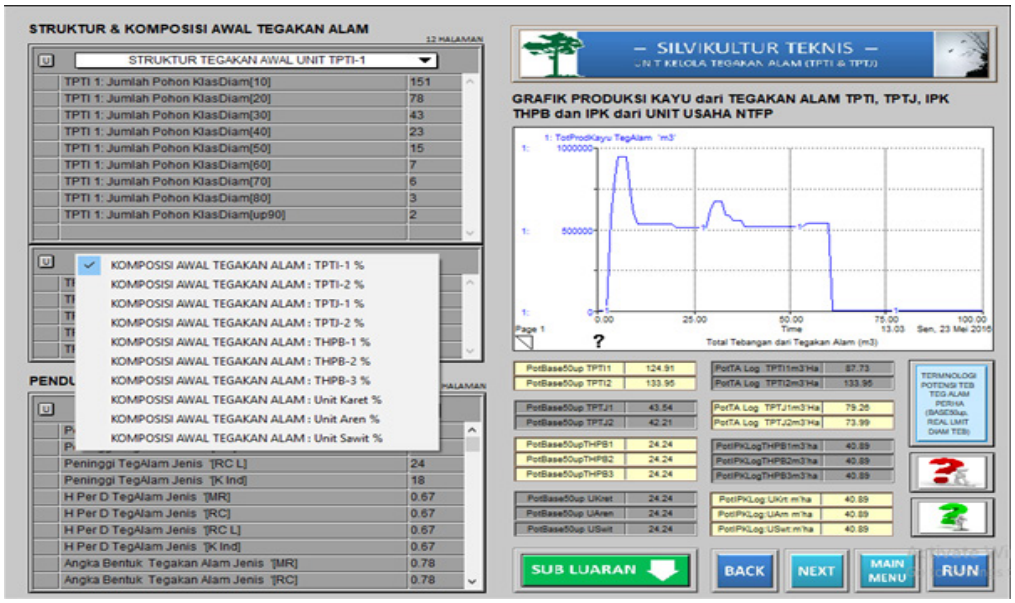
Supersilvik stands for *Suryanto Permodelan Silvikultur* (Suryanto Model's on Silviculture), which is a model built using stella software. The model is formulated applying variety of differential equations to project future outcomes based on business planning inputs of the present and other factors as feedback (Jo, Lee, Suh, Kim, & Park, 2015). It receives input of various data related to forest production ventures by groundwork of natural forests, timber estate and NTFPs (FOERDIA-MoEF, 2015b; Taylor, Chen, & Vandamme, 2009). *Supersilvik* models were used to simulate all business alternatives (Madureira, Nunes, Borges, & Falcão, 2011). Simulation produces five primary data output needed, namely:

a. Land use, including three output data i.e., land use (%LU), land productivity for wood products (PL-HHK) and land productivity for non-timber products (PL-NTFPs) (Bouchard & Garet, 2014; Payn et al., 2015).
b. Contribution to provision of production, includes 4 output data, the cumulative production of wood (Pd-KumHHK) and NTFPs (Pd-KumHHBK) over a span of utilization and average annual production (μPd-HHK and μPd-NTFPs) (Kartodihardjo, 2009; Kastner, Erb, & Nonhebel, 2011; Obidzinski & Dermawan, 2012; Szulecka, Obidzinski, & Dermawan, 2016; Warman, 2014).
c. Contributions to the company, comprise of four output data i.e., NPV, BCR, IRR and supplemented with data on annual average of margin between revenue (benefit) and financing (cost) before discount (μ (B-C)) (Buongiorno, Rougieux, Barkaoui, Zhu, & Harou, 2014; Hildebrandt & Knoke, 2011; Jo, Lee, Suh, Kim & Park, 2015).
d. Contributions to the state from the tax sector and others, includes two data outputs, which are the average annual (μTax) and present value of the cumulative amount of tax (PV-KumTax) during the time span of exploitation (Lebedys & Li, 2014; Locke & Rissman, 2012; Nurfatriani, Darusman, Nurrochmat, Yustika, & Muttaqin, 2015).
e. Employer contributions to employment, comprised of one output data, i.e., the average annual employment (SerTK) (Purnomo & Prasetyo, 2006; Whiteman, Wickramasinghe, & Piña, 2015).

The model is a complex model, yet comprehensive, good layout (Figure 1), easy to use (user friendly) and using variables that are familiar in the business of forest production. In addition to the five main groups of data output, the supersilvik model also provides other output data which could be query and provide more detailed information related to


SUPERSILVIK
Suryanto Permodelan Silvikultur
Supersilvik adalah perangkat pemodelan yang membantu mendetailkan rencana pengelolaan kawasan hutan produksi dalam konsep Multisistem Silvikultur
Sebuah perangkat model yang membantu anda menetapkan rencana pengelolaan terbaik
suryantoflitce@gmail.com ; +62 821 5716 2990
DAFTAR ISI
klik untuk proses masukan data
PERENCANAAN KAWASAN
SILVIKULTUR TEKNIS
ALAT & BANGUNAN
TENAGA KERJA
FINANSIAL
SAVE
OPEN
CLOSE
SAVE as
EXECUTIVE SUMMARY
EXIT
untuk tampilan layar yang proposional, disarankan menggunakan resolusi komputer 1024 x 768
klik untuk ringkasan data luaran


UNIT KELOLA : LUAS, DAUR, TAHAPAN DAN TATA WAKTU
LUAS UNIT KELOLA dalam satuan Ha
DAUR DAN PILIHAN TANAMAN TPTI, TPTJ DAN THPB
UNIT NON TIMBER FOREST PRODUCT NTFP
PASSWORD
LUAS UNIT KELOLA [THPB 1] 22270
LUAS UNIT KELOLA [THPB 2] 7500
LUAS UNIT KELOLA [THPB 3] 19004
LUAS UNIT KELOLA [UnKARET] 10000
LUAS UNIT KELOLA [ARENI] 6640
LUAS UNIT KELOLA [UnSAWIT] 2500
LUAS UNIT KELOLA [KAW LINDUNG] 16661
LUAS UNIT KELOLA [NON PROD] 0
TOTAL LUAS KAWASAN 216580
TAHAPAN DAN TATA WAKTU : TPTI-1
TPTI1: TW [PAK] 0
TPTI1: TW [TSP] 1
TPTI1: TW [PWH] 2
TPTI1: TW [Pe nebang an] 3
TPTI1: TW [Pembibitan] 10
TPTI1: TW [Pengayaan] 11
TPTI1: TW [Pemeliharaan] 12
TPTI1: TW [Pembebasan] 12
TPTI1: TW [Perlindungan] 0
PERENCANAAN KAWASAN
RIAP, POLA BANGUN TANAMAN DAN JALAN
RIAP : TANAMAN THPB DAN KARET
Riap Tan THPB [MR] 1.8
Riap Tan THPB [RC] 1.7
Riap Tan THPB [RC L] 1.7
Riap Tan THPB [K Ind] 1.6
Riap Tan THPB [Ptkg] 1.9
Riap Tan THPB [Mangi] 3.2
Riap Tan THPB [Euca] 3.1
Riap Tan THPB [BBCP L] 3.2
Riap Tan Karet 0.8
GRAFIK PEMANFAATAN KAWASAN
UNIT KELOLA
KODE JENIS TAN
Tata Waktu Pekerjaan
RIAP TANAMAN
PWH (Tambang Jalan)
LUAS KLLA TEGAKAN 199.919
Luas Tanpa Kelola 0
SUB LUARAN
BACK
NEXT
MAIN MENU
RUN


STRUKTUR & KOMPOSISI AWAL TEGAKAN ALAM
STRUKTUR TEGAKAN AWAL UNIT TPTI-1
TPTI 1: Jumlah Pohon KlasDiam[10] 151
TPTI 1: Jumlah Pohon KlasDiam[20] 78
TPTI 1: Jumlah Pohon KlasDiam[30] 43
TPTI 1: Jumlah Pohon KlasDiam[40] 23
TPTI 1: Jumlah Pohon KlasDiam[50] 15
TPTI 1: Jumlah Pohon KlasDiam[60] 7
TPTI 1: Jumlah Pohon KlasDiam[70] 6
TPTI 1: Jumlah Pohon KlasDiam[80] 3
TPTI 1: Jumlah Pohon KlasDiam[up90] 2
KOMPOSISI AWAL TEGAKAN ALAM : TPTI-1 %
KOMPOSISI AWAL TEGAKAN ALAM : TPTI-2 %
KOMPOSISI AWAL TEGAKAN ALAM : TPTJ-1 %
KOMPOSISI AWAL TEGAKAN ALAM : TPTJ-2 %
KOMPOSISI AWAL TEGAKAN ALAM : THPB-1 %
KOMPOSISI AWAL TEGAKAN ALAM : THPB-2 %
KOMPOSISI AWAL TEGAKAN ALAM : THPB-3 %
KOMPOSISI AWAL TEGAKAN ALAM : Unit Karet %
KOMPOSISI AWAL TEGAKAN ALAM : Unit Aren %
KOMPOSISI AWAL TEGAKAN ALAM : Unit Sawit %
Peninggi TegAlam Jenis [RC L] 24
Peninggi TegAlam Jenis [K Ind] 18
H Per D TegAlam Jenis [MR] 0.67
H Per D TegAlam Jenis [RC] 0.67
H Per D TegAlam Jenis [RC L] 0.67
H Per D TegAlam Jenis [K Ind] 0.67
Angka Bentuk Tegakan Alam Jenis [MR] 0.78
Angka Bentuk Tegakan Alam Jenis [RC] 0.78
SILVIKULTUR TEKNIS
GRAFIK PRODUKSI KAYU dari TEGAKAN ALAM TPTI, TPTJ, IPK THPB dan IPK dari UNIT USAHA NTFP
Total Tebangan dari Tegakan Alam (m3)
SUB LUARAN
BACK
NEXT
MAIN MENU
RUN

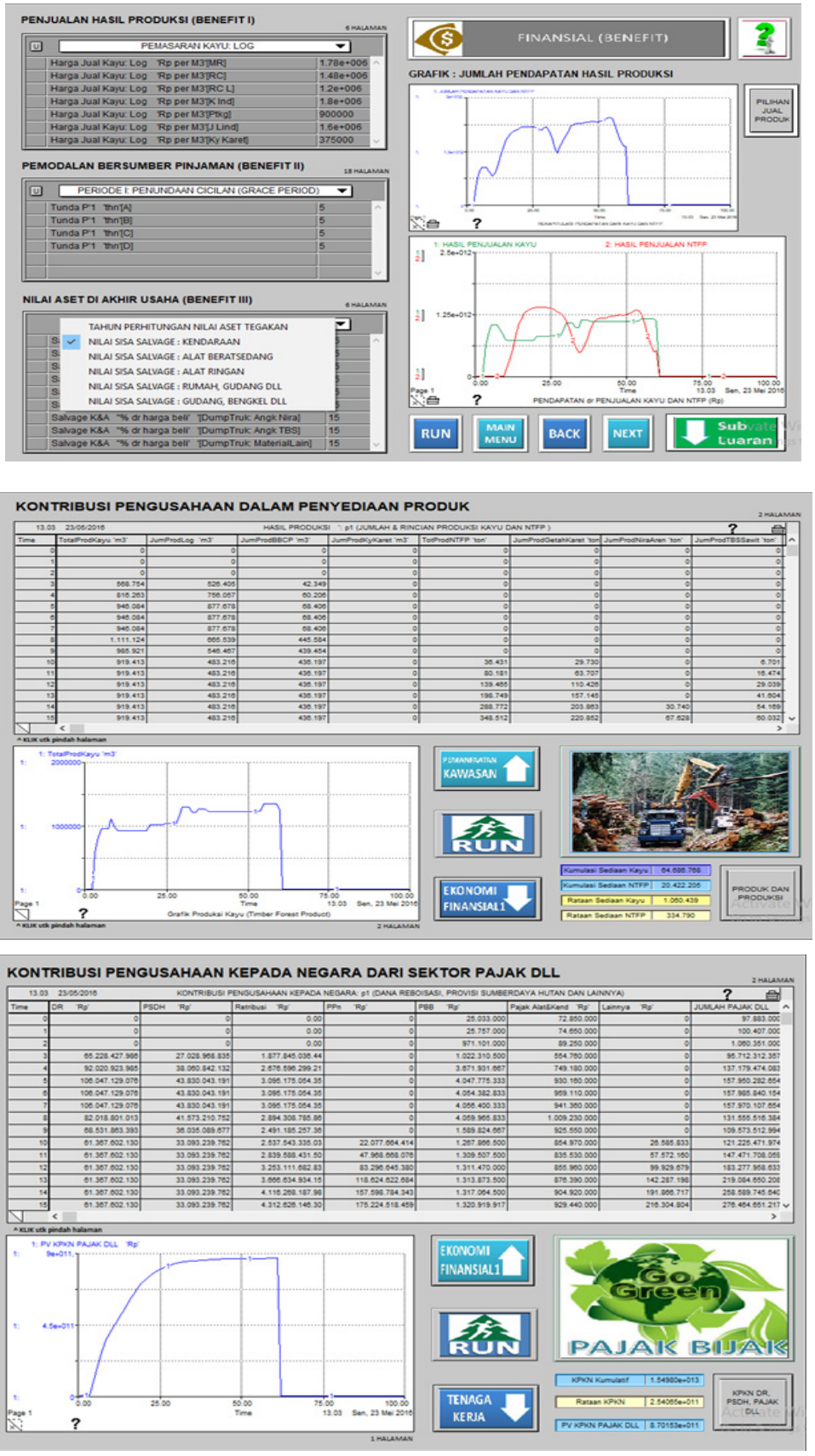
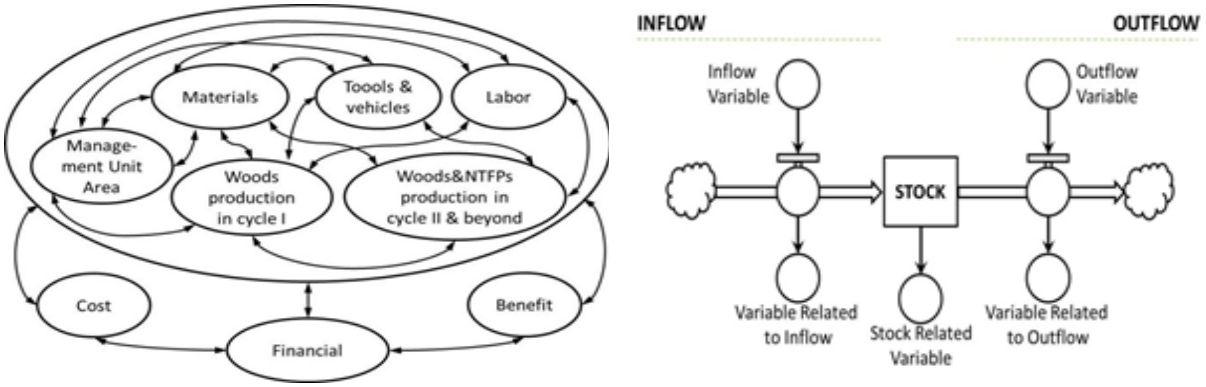


Figure 1. Six examples of 165 display screen in supersilvik model



(a) (b)

Figure 2. Model conceptualization (a) and notation and basic structures used in model construction (b)

all aspects of the enterprises (presented in 165 output data tables and 31 output data graphs).

Supersilvik model was constructed by the conceptualization as presented in Figure 2a. The model specification used some notations to describe the stock, inflows, outflows, source, discharge, flow of information and variables (Figure 2b). Conception and specification is based on the results of literature studies, validation and in-depth discussions with many experts and practitioners in relation to the production of forest exploitation. Model was finished in 2013 and enhanced in 2014 by supplementing numerous sub models of NTFPs exploitation. The model was built by incorporating more than 200 functions of differential equations for interconnected data processing, which were grouped into basic functions and many sub-models.

3. Sub-model of area management

The managed forest area in year *t* (LK_t) was formulated at equation 1 that it is function of time span of exploitation (d_u), cutting cycle (d_i), cluster size in the i^{th} business unit (LK_i), and road density in the i^{th} business unit (Kj_i).

$$LK_t = \int_{t=1}^{du} \sum_{t=1}^{n} \left(\frac{LKli}{d_i} x\left(1 - Kj_i\right) \right) \quad \text{.....(1)}$$

Where:

LK_t	:	Managed forest area in year *t*
du	:	time span of exploitation
d_i	:	cutting cycle/plantation for wood production business unit or biological cycle for NTFP business unit
n	:	Number of business units
LKl_i	:	Cluster size in the i^{th} business unit
Kj_i	:	Road density in the i^{th} business unit

The sub-model of area management was provided with sub of sub model that processing the data on real time activity is a variable with the use of silviculture system of Indonesian Selective Cutting and Replanting (TPTI), Selective Cutting and Line Planting (TPTJ), Clear Cutting With Planting (THPB) and NTFPs.

4. Sub-model of production

The sub-model of production collects calculation functions for timber production based on natural and plantation stands as well as primary production and its products for NTFP commodities. Some of the basic functions used in this sub model are as follows.

a. Timber production from business unit of natural stands

Timber production comes from log-size wood harvested from the business unit of

TPTI and TPTJ throughout the span of the operations and all sizes of timber on land clearing of natural stands at the establishment of THPB, NTFPs and line planting of TPTJ. Timber production of TPTI and TPTJ unit in between path was calculated based on the volume of every single tree, and was approached by limit felling variable, stand structure and composition as well as the total management area of each business unit. Stand structure (*kd*) is divided into 10 diameter classes (*y*), covering 0-10 cm, 10-20 cm, ..., >100 cm and species composition (*kj*) divided into four groups (*z*), covering meranti, mixed forest, other mixed forest and fancy wood. Some used important variables are kd^{th} middle class diameter (*Dt*) into kj^{th} species groups of that contained in the logging limit, height (*Pt*), number of trees (*JP*), tree form factors (*AB*) of each species group, a safety factor *(FP*) and the exploitation factor (*FE*). The calculation of wood production from business unit of natural stand in year *t* ($Ptta_t$) is assembled in the following function (Equation 2).

$$Ptta_t = \int_{t=1}^{du} \sum_{t=1}^{n} \left(\sum_{kd;kj=1}^{y;z} \frac{1}{4} \pi \left(Dt_{kd;kj} \right)^2 \times Pt_{kj} \times JP_{kj} \times AB_{kj} \right) \times FP_i \times FE_i \times LK_i \quad \text{...(2)}$$

b. Wood production from business unit of plantation stands

Wood production data were obtained from harvesting standing trees in the THPB unit of short of crop medium or long cycle; either thinning or final harvest cycle. Final production cycle is corrected by thinning percentage if the thinning was done between crop cycles. Production calculations based on the data processing of every single tree volume that was approached by calculation of the projected number of crop plants per ha (*Jt*), percentage of tree survival (*Jtp*), increment (*r*), thinning age or plant cycle (*dup*) as well as height (*Pt*), form factor (*AB*), safety factor (*FP*) and exploitation factor (*FE*) according to the plant species and the planted area. Sub of sub models offer nine choices (*w*) of plant species (*j*) with cycle and increment variables that follow the chosen species. Species selection that available are meranti, mixed forest, other mixed forest, fancy wood, other furniture wood, Eucalyptus, Acacia, other wood producing raw materials for chips/pulp and rubber. The timber production from business unit of plantation stand in year *t* ($Pttt_t$) is assembled in the following functions (Equation 3).

$$\text{Pttt}_t = \int_{t=1}^{du} \sum_{i=1}^{n} \left(\sum_{j=1}^{w} \frac{1}{4} \pi \left(r_j \times \text{dup}_j \right)^2 \times \text{Pt}_j \times \text{AB}_j \right) \times \text{Jt}_i \times \text{Jtp}_i \times \text{FP}_i \times \text{FE}_i \times \text{LK}_i \quad \text{...(3)}$$

c. Primary production (and its by product) of the NTFPs

Supersilvik model was developed by offering three choices (*w*) of plant species (*j*) and nine choices (*y*) of primary/derivate product (*k*), namely: rubber plantation with latex and/or wood, sugar palm plantation with nira (sweet liquid) and oil palm plantation with fresh fruit bunches (*FFB*) as primary production. The derivatives product is processed sap, nira X_1 and nira X_2 as well as core palm oil and crude palm oil (CPO). The production calculation is based on processing data from primary production of every single tree, which was approached by the productivity of each commodity. Productivity is divided into three periods, i.e. the initial productivity, peak productivity and an end-cycle productivity. The calculations used the basic functions, such as Equation 4.

$$Pntfp_t = \int_{t=1}^{du} \sum_{i=1}^{n} \left(\sum_{j;k=1}^{w;y} \left(Prph_y \times Jt_j \times Jtp_j \right) \right) \times \left(LK_i + LKpr_i \right) \quad \text{..(4)}$$

where *Jtj* is the number of plants per ha; Jtp_i is the percentage of survival rate; $Prph_j$ is a species productivity and $Lkpr_i$ is harvesting progressive area. Progressive area is the total area change of harvesting that was fitted with time of harvesting from block to block of plantation.

d. Sub-models of materials, equipment, vehicles, buildings and labor

Each material, equipment, vehicle, building and labor ($V_{bakbtkt}$) is calculated by using the basic functions of performance, i.e. the volume and/or workload ($VB_{bakbtkt}$) divided by job performance ($VB_{bakbtkt}$), as Equation 5.

$$V_{bakbtkt} = \frac{VB_{bakbtkt}}{Pk_{bakbtkt}} \quad \text{.....(5)}$$

Materials are defined into five groups comprising plant materials (provide 11 alternatives; appropriate species selection); fuel (1 type: diesel), fertilizer and means of enhancing plant growth (4 type; LiquidJell, NPK, TSP, herbicides), 9 staple food and other materials every single items were calculated.

Equipments are defined into four groups, comprises of five types in heavy equipment (machine for road construction, log extraction, land preparation, loading and timber extraction); 1 type of medium for planting; four types of lightweight (chainsaw and others). Vehicle is defined in six types, namely logging truck, dump truck, small cars, motorcycles, buses and other transportation.

Building is defined into 12 types, namely the head office, the base camp office, officer housing, residence barracks, working barracks, public facilities, nurseries, workshops, warehouses, fire tower and fuel depot. Further, labors are defined into seven groups adapted to the level of the workforce, namely commissioners, directors, managers, supervisors, staff, contract worker and daily workers. All calculations connected with the variable output of the other sub-models which presents the amount of volume and workload of each variable that requires the need of materials, equipments, vehicles, buildings and labors.

The basic functions in the financial sub model; consists of sub of sub models as follow:

e. Financing

Financing covers all financial in detail associated to all types of work at each stage of work at each business unit and time unit. Some examples include cost of rearranging plots, stands inventory, forest clearing, harvesting and enhancement of natural stands, planting and improvement of plantation stands, harvesting and post-harvest processing. Further financing is the procurement, maintenance and operational materials, equipments, vehicles and buildings. Labors financing includes salary, benefits, bonuses, ration and medical benefits. Other financing is procurement financing and documents processing, stationery and office equipment, human resources development, payment of interest on debt and loan, reforestation funds, commission, fees, taxe, and others. All financing is calculated based on the basic functions of multiplication and addition, also the unit price. The unit price used in this paper is the unit price at the beginning of the project, which is the year of 2016.

f. Revenue

Revenue is including income from loans, sale of products, salvage of tools and vehicles that was rejuvenated in-business cycle time. All revenue is calculated based on multiplication of volume and unit price that was adjusted to the time analysis at the beginning of the project.

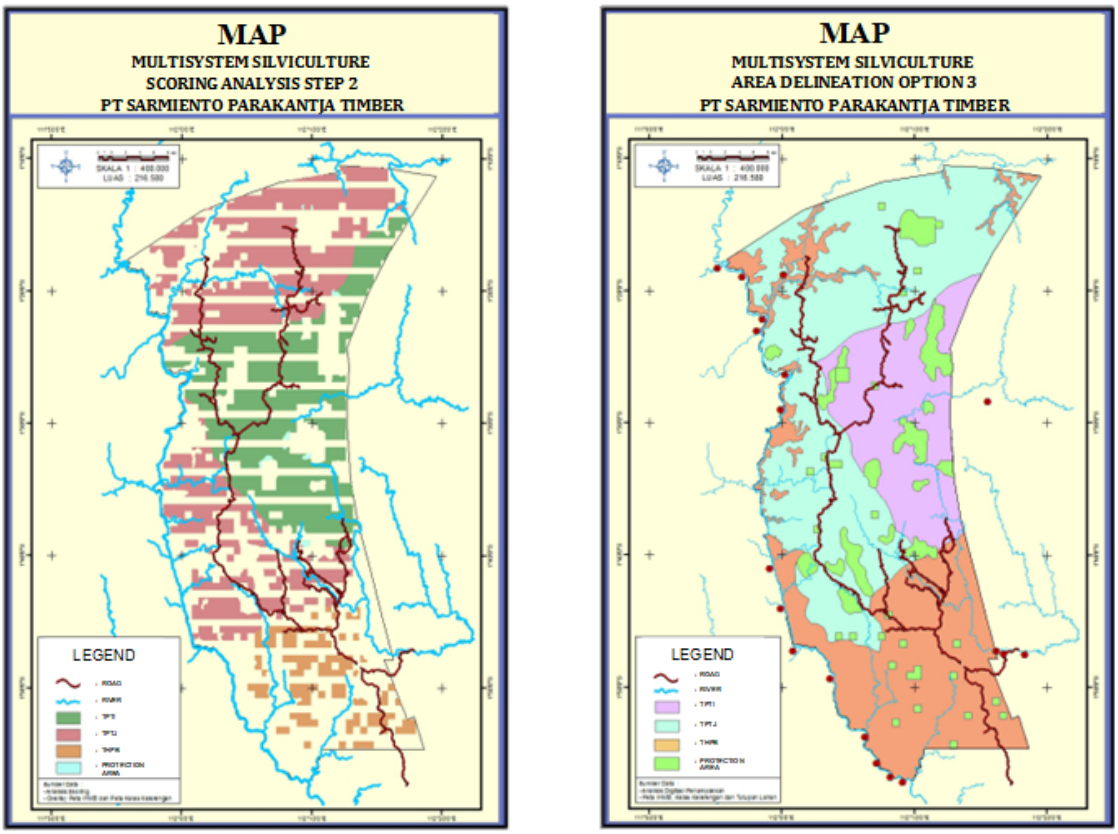
g. The asset value at the end of the business

The asset value is at the end of the business, including the residual value of tools, vehicles, buildings and value of stand asset is at the end of the business (project). Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were calculated using the common basic functions in the calculation of NPV, BCR and IRR.

III. RESULT AND DISCUSSION

A. Site Delineation and Business Unit Development

Tropical natural forests have declined over time (Brandt, Nolte, & Agrawal, 2016; Gunggut, Saufi, Zaaba, & Liu, 2014; Keenan et al., 2015). In Indonesia, this matter was caused by unsustainable management (Tsujino, Yumoto, Kitamura, Djamaluddin, & Darnaedi, 2016), deforestation (Gaveau et al., 2016; Margono, Potapov, Turubanova, Stolle, & Hansen, 2014), occupation (Gatto, Wollni, & Qaim, 2015; Maladi, 2013), illegal logging (Linkie, Sloan, Kasia, Kiswayadi, & Azmi, 2014; Maryudi, 2016; Schmitz, 2016), forest fires (Herawati & Santoso, 2011) or other damage have resulted in fragmented forests, including those happened in production forest concessions (MoEF, 2017). Many experts have identified earlier



(a) (b)

Figure 3. The raw data as a result of overlaying (a) and the assumed allowable alternative by MOEF (b)

Table 2. Four options of concessions in multisystem silviculture (MSS) used and the control

No.	Unit	Details	The options and area (Ha)				
			Control	Option I	Option II	Option III	Option IV
1.	TPTI	TPTI 1	92,835	92,835	92,835	92,835	92,835
2.	TPTJ	TPTJ 1	39,170	39,170	39,170	39,170	39,170
3.	THPB / HHBK	THPB1	-	67,914	48,910	29,770	29,770
		THPB 2	-	-	19,004	38,144	19,004
		NTFP 1 (rubber)	-	-	-	-	12,500
		NTFP 2 (sugar palm)	-	-	-	-	6,640
4.	KL&PL	-	16,661	16,661	16,661	16,661	16,661
5.	Un-used Land		67,914	-	-	-	-
	Total		216,580	216,580	216,580	216,580	216,580

that there were many non-forested clusters in the Indonesian production forest concessionk known as fragmented forest and the number is increasing (Faculty of Forestry IPB, 2003; Rusli, 2008). At present in Sumatera, the fragmented forest reached 63.28% while in Kalimantan reached 37.22% (MoEF, 2015). In natural production forest concessions, exploitation under limited use of the selective silvicultural cutting system (MoF, 2009a, 2009b) in the

fragmented condition caused the deforested cluster without treatment because there was no valuable tree to cut which is not possible to exploit.

Even though the conditions were slightly better than the other common condition, forest exploitation at PT. Sarpatim conducted since 1969 has also resulted in fragmented forest. About 83.88% of their forested area was divided into four classes of production potentials, namely high, medium, low and very low. High and medium potency was dominant in the north with small patches of primary forest. Meanwhile, the southern side was dominated by low and very low potency.

In terms of topography, up to 68% of the concession area was flat. The finding of the overlay of topography criteria and forest potency is presented in Figure 3a. These results illustrate that a portion in the southern part of the area was unfavorable to development of business unit for planting with silviculture system of THPB or enrichment planting with NTFPs commodity. The soil type and rainfall supports the enrichment planting, which is also supported by the existing social typology. Over four decades, most of the company's activities were assessed from the southern part (Ferraz et al., 2014). Consequently, demographic and social conditions were developed faster in the southern part then in the northern part. The negative side of this typology is a higher social pressure. So, developing a business unit for planting with THPB or NTFPs directly creates a high work volume that provides many employment opportunities for local residents. Employment indirectly reduces the social pressure for TPTI or TPTJ business unit in the north.

Based on the six criteria analysis, further delineation produce three alternatives were selected namely, business unit of TPTI in the north, TPTJ in the middle and THPB or NTFPs in the south. It is recommended that the selected alternatives are endorsed only by the authority of MoEF as regulator. However, the value of the forest ecosystem services is at best an indication of the different multifunctional objectives that should be met by the management (Edwards, Tobias, Sheil, Meijaard, & Laurance, 2014; Hansen & Malmaeus, 2016). In this paper, the selected alternative are assumed as the delineations presented in Figure 3b, which are in details as follows: 92,835 ha for TPTI unit, 39,170 ha for TPTJ unit, 67,914 ha for THPB/ NTFPs unit and 16,661 ha for protected areas and unproductive land.

Further in-depth discussions with experts produced four development options to improve the performance as compared to "business as usual" (control option) (Table 2). Options I, II and III were optional to develop timber estate cluster on un-used land (67,914 ha) due to the low yield potency of commercial timber i.e., 24.24 m^3 per ha. Option I is an option to convert all un-used cluster to become timber estate of acacia of 1650 tree per ha with six years of cutting cycle. In this case diameter increment rate of 3.2 cm per year were used to estimate the yield. Target and other asumptions were discussed with personel of forest planning division.

Options II and III were options to develop timber estate on the very low potency cluster by using two species of short cutting cycles i.e, acacia and eucalyptus. Meanwhile, option IV is the most challenging option i.e., by using part of the un-used land especially in the south side which were near to the village with access to develop NTFP of rubber (12,500 ha) and sugar palm (6,640 ha). Projected duration to establish the two clusters of NTFP was five years along with colaboration scheme to the surrounding community.

B. Recommended Five Options

Four options and the control are available for further analysis using the *supersilvik* model. Several groups of important variables were used as data input as described below. Simulation that is often used in natural resource management planning provides a projection as shown in Table 3 (Bouchard & Garet, 2014; Thompson et al., 2011).

1. Land use

The land use at TPTI and TPTJ units only used one variant venture each with 35 and 25 years cycle. TPTJ unit using, row spacing and line width of 5 m x 5 m x 5 m. Meanwhile THPB/NTFPs units offer four development options. THPB 1 for trees crops for production of chip and pulp with eucalyptus species, six years cycle and the total number of 1320 plants. THPB 2 was using meranti, 200 plants per ha and 30 years cycle to produce timber. NTFPs commodity include rubber and sugar palm (Arenga), the cropping pattern 143 plants per ha which was built in the 5-year and a time for rejuvenation was respectively 25 and 30 year.

2. Production

Diameter limit for cutting of TPTJ and TPTI were 50 and 40 cm up respectively. Using the equations of improvement, *fe*, *fp* and others, the potential harvest in TPTI and TPTJ unit cycle I is 124.91 and 71.64 m^3 per ha of commercial timber. Meanwhile, the potential harvest from land clearing in THPB/NTFPs unit cycle I amounted to 33.31 m^3 per ha for all tree species. Planting meranti is in TPTJ unit with diameter increment of 1.9 cm per year, in THPB1 2.5 cm per year and THPB2 1.8 cm per year. Meanwhile, rubber and sugar palm after five and eight years old respectively were assumed to start production, with peak production per tree per year at 55 kg and 400 liters.

3. Financial

Total or time range of analysis is 60 years with an interest rate of 15% and without borrowing investment.

4. Tax and others

As a large business, production forest enterprises in Indonesia have to pay many kind of taxes and fees as contribution to the government and surrounding communities (CSR fund). Each of them was defined in the form of goods and services used and product generated. For example for each cubic meter of meranti wood extracted from natural forest is charged reforestation fund amounting to IDR 148,000 and provision of natural resources amounting to IDR 66,000. The tariff is different from mixed forest type, which are IDR 120,900 and IDR 48,800. In this analysis, all taxes and other expenses are calculated, including calculated property tax and value added tax (VAT) of buildings, vehicles, equipment and services and CSR fund in the form of levy and grant.

5. Labor

An example is the employment for planting THPB 1 with a performance of 500 ha/team/year with six people in a team. The simulation found that existing forest stand was in good condition indicating that business performance of PT. Sarpatim was still good. However performance was not reaching the optimum level yet. Therefore, the improvement by developing some other business units can be accomplished. As shown in Table 3, control options as a form of light development scale, was projected to yield an annual average timber production (μ Pd-HHK) of 488 thousand m^3, an increase of 270 thousand m^3/year (interview data) from the existing average production. The total production obtained from TPTI and TPTJ cutting up to the 25th year is expected at 334 thousand m^3 per year, after the 25th year, the additional cutting in planting lines of TPTJ generates an average annual production of 556 thousand m^3. Projected control option provides a healthy performance of the financial aspects. Benefit and cost provides an average profit margin (μ (B-C)) of up to 86 billion rupiah a year (before the discount interest factor). The NPV along 60 years of analysis is IDR 1,066 billion with the BCR value of 1.9 and an IRR of 48.81%.

The production forests ventures are closely linked to the land and silviculture of the plant. Table 3 shows that the control options are not at the most optimal operation. This option is still ignoring the area of 67,914 ha of non-forested land and could be occupied by local resident. Furthermore, the employment is still low, only up to 490 persons. Simulation shows that the

Tabel 3. Concession indicators in five primary data output

No.	Indicator	Detail	Unit of measurement	Control	Development options with MSS			
					Option I	Option II	Option III	Option IV
1.	Land use	% LU	%	60.95	92.3	92.3	92.3	92.3
		PL-HHK	m^3/ha	123.13	146.50	152.27	161.37	151.37
		PL-HHBK	ton/ha	-	-	-	-	18.65
2.	Production	Pd-HHK Kum	million m^3	29.79	121.81	101.99	82.29	78.29
		Pd-HHBK Kum	million m^3	-	-	-	-	20.38
		μ Pd-HHK	thousand m^3	488	1,999	1,671	1,344	1,283
		μ Pd-HHBK	thousand m^3	-	-	-	-	334
3.	Financial	BCR	-	1.90	1.66	1.71	1.78	1.58
		IRR	%	48.81	69.86	65.38	60.63	64.43
		NPV	IDR. billion	1,066	1,931	1,759	1,592	2,062
		μ (B-C)	IDR. billion	351.77	539.70	592.67	647.84	814.34
4.	Tax for State	PV-KumTax	IDR. billion	361.09	667.42	598.78	529.56	850.83
		μTax	IDR. billion	86.47	127.45	128.47	129.45	266.78
5.	Labor absorption	μ Ser-TK	person/year	490	1,820	1,534	1,235	3,690

four other options could be used to overcome the employment problem. Development of non-forested land into THPB/NTFPs business unit results an increased use of land from 132,005 ha into 199,919 ha (151% increment). This additional land use directly not only increases the amount of production (μ Pd-HHK in 263-410% of increment) and employment (μ Ser-TK in 252-753% increment) but also increases the indicators of healthy financial (NPV in 181-193% increment) and tax contributions to the state (147-308% increment). Out of the four additional options, option IV is recommended to be used. When being compared with the control options, option IV increase the total production of wood over 60 years (Pd-Kum HHK) by 236% that were obtained from additional production of THPB1 and THPB2 business unit. Parts of wood production were obtained from land clearing for timber estate and NTFPs, which can be used as capital at the beginning of the venture. Although, BCR is decreasing, option IV will increase the profit margins (μ (B-C)) up to IDR 814.34 billion per year (an increase of 232%) and total NPV over 60 years amounted to IDR 2,062 billion (an increase of 193%).

Land is the one enduring asset the value of land for forest uses necessarily stems from the future forest crop or other services it can produce (Mattheus, 1935 as cited in Davis & Johnson, 1987). In response to changing societal pressures, it depends on various socio-economic reasons and has many adverse effects on the sustainability of forest and forest existence (Özden & Ayan, 2016). Simple forests are now being managed to meet multifunctional objectives including biodiversity, recreation and landscape values (Mason & Zhu, 2014).

The simulation results in PT. Sarpatim concession illustrates that the potential wealth of production forests in Indonesia are actually quite high. The simulation was also promoted to leave the old viewpoint of "natural forest stands (trees) as a factory". The old theory lead to pessimistic forest venture when existing natural forest stands were not sufficiently available. It has become an expert concern, which states that the Indonesias production forest productivity is very low, in 2007 no more than 1 m^3/ha/year (Petrokofsky et al., 2015; SoFS, 2015; SoFS, 2016b; SoFS, 2017; Soekotjo, 2009). Then, Soekotjo (2009) brought the concept of intensive silviculture (SILIN) as a solution. In

this case, MSS which also accommodate the concept of SILIN therein, intends to strengthen the theory that the management of production forests is a land and plant-based enterprises, which should put a "land as factory or major capital; and silviculture aspects as the driving engine for production". Build stands and other forest services in forest land are the spirit.

MoEF as the regulator has the opportunity to reawaken interest in investing with regulations that propel the implementation of MSS in the field. In developed countries, the MSS concept has been applied in Canada (LORC, 1999), in the Province of Ontario three silviculture systems are used, i.e. selection system, the shelter wood system and clear-cut system. The key factors are against a variety ranging from intricate technical trade-offs to economies of scale in forestry production, and marketing (Fernández et al., 2008). At the end, it provides better results in terms of timber production (Baskent, Keles, & Yolasigmaz, 2008). According to MFM, MSS lead to better foreign exchange, as shown in the simulation in the sample concession above (Dalemans et al., 2015; Herrero-Jáuregui et al., 2013). The implementation of MSS concept will increase state revenue from taxes and non-tax sector and increase the number of employment. In the example of a comparison between control option and the option IV above, the annual average foreign exchange (μTax; before discounts) increased to 308%, or if calculated with present value, total tax over a span of 60 years (PV-KumTax) it increases up to 236%. While, employment increased by 753%. These impacts also bring ripple effect to other good effects. Among them are wood industry that will regain the excitement due to better supply of raw materials, improving the welfare of communities around the concession and more importantly, re-position the forestry sector as a sector that contributes significantly to Indonesian development.

IV. CONCLUSION

Conception of MSS affirms the principle of production forest governance which puts lands and crops as capital factors and aspects of silviculture as a driving factor. The application of this concept is projected to increase the performance of production forest management in Indonesia. MoEF as the regulator needs to encourage the implementation of MSS in each concession unit to better improve the management and productivity of forests. Improved performance for each concession is certainly influenced by the typology and business development selection respectively.

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SOCIAL CAPITAL IN MANAGING MANGROVE ECOTOURISM AREA BY THE MUARA BAIMBAI COMMUNITY

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SOCIAL CAPITAL IN MANAGING MANGROVE ECOTOURISM AREA BY THE MUARA BAIMBAI COMMUNITY. The success of managing the natural environment by involving the community is strongly influenced by the local social conditions. This paper analyzes social capital inherent in the Muara Baimbai Community in Sei Nagalawan Village to manage the mangrove forest as an area valued for tourism. The study was conducted in Muara Baimbai Mangrove Area, Sei Nagalawan Village, Perbaungan District, Serdang Bedagai Regency on June until December 2014. Data were collected by observation, interview using a structured questionnaire, and in-depth interviews. The Muara Baimbai Community has strong social capital in managing the mangrove ecotourism area. An indicator of a strong social capital is a community institution which is run properly. The success of the community to rehabilitate the mangrove area in Sei Nagalawan and to utilise its resources in a sustainable manner is the result of high levels of participation of the members and the role of active cadres as symbolic power that encourage, drive, and motivate the community in their struggle. Strong motivation, fair work allocation and benefits among the members, strong internal connection, and wide external network are very important to strengthen social capital. Furthermore, the increasing welfare gained by the coastal community through increasing economic income, job opportunities, and knowledge are the benefits derived from the sustainable forest management that can maintain the existence of the community and their natural resource.

Keywords: Community, social capital, ecotourism, mangrove

MODAL SOSIAL DALAM PENGELOLAAN KAWASAN EKOWISATA MANGROVE OLEH KOMUNITAS MUARA BAIMBAI. Keberhasilan pengelolaan lingkungan melalui pelibatan masyarakat dipengaruhi oleh situasi sosial. Penelitian ini bertujuan untuk menganalisis modal sosial yang dimiliki oleh Komunitas Muara Baimbai di Desa Sei Nagalawan dalam mengelola kawasan mangrove secara ekowisata. Penelitian ini berlokasi di kawasan mangrove Muara Baimbai, Desa Sei Nagalawan, Kecamatan Perbaungan, Kabupaten Serdang Bedagai, Sumatera Utara pada bulan Juni hingga Desember 2014. Data dikumpulkan melalui observasi lapangan, pembuatan kuesioner terstruktur, dan wawancara mendalam. Komunitas Muara Baimbai memiliki modal sosial yang tinggi dalam mengelola kawasan ekowisata mangrove. Indikator dari modal sosial yang kuat ditunjukkan dengan berjalannya institusi kelompok sesuai dengan yang diharapkan. Keberhasilan kelompok merehabilitasi kawasan mangrove di Desa Sei Nagalawan dan memanfaatkan sumberdaya tersebut secara berkelanjutan merupakan hasil dari tingkat partisipasi yang tinggi dan peran kader-kader aktif sebagai symbolic power yang mendorong dan memotivasi para anggota dalam perjuangan mereka. Motivasi yang kuat, alokasi kerja dan pembangian keuntungan yang adil, ikatan internal yang kuat, dan jaringan yang luas sangat penting dalam menguatkan modal sosial. Selanjutnya, peningkatan kesejahteraan yang didapat oleh masyarakat melalui peningkatan pendapatan, lapangan pekerjaan, dan pengetahuan adalah manfaat yang diperoleh dalam pengelolaan hutan berkelanjutan yang dapat memelihara keberadaan komunitas dan sumber daya.

Kata kunci: Komunitas, modal sosial, ekowisata, mangrove

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I. INTRODUCTION

Mangrove area has been degraded massively as a result of rapid development globally and nationally (Carter, Schmidt & Hirons, 2015; Bonita & Nizar, 2014; Rizal, Sahidin, & Herawati, 2018). In 2010, the Indonesia mangrove area was 5,209,543.16 hectares and the area declined rapidly to 2,496,185 hectares in 2016 (Rizal, et al., 2018). These degradations are caused by lack of proper utilization of mangrove land such as forest clearing for fish and shrimp ponds and the utilization of mangrove wood as raw material for charcoal and firewood by the community in coastal area to meet their economic needs (Carter et al., 2015; Baderan, 2017; Farley, J., Batker, D., Torre, I. & Hudspeth, T., 2010; Setyawan, 2002). The degradation is likely to continue faster if these conditions are not controlled.

The management of mangrove forest as a protected area adjacent to the areas occupied by communities is not an easy matter. The problem is on how to strike the balance between the conservation of the mangrove forest and communities' livelihood (Ekayani, 2014; Ekayani & Nuva, 2012). People around the forest area usually increase their income by utilizing mangrove forests, but they have limited knowledge on understanding the life cycle of wetland in mangrove ecosystem (Carter et al., 2015). Therefore, the involvement of people in the conservation management especially for sustainable rural development is an important issue. Approach models of forest management based on rural community are needed to support sustainable environment of rural communities for the next generations in the long-term (Trukhachev, 2015).

Ecotourism is one of the potential forest management for rural development, especially in fragile environments (Duangjai et al., 2014). Introduced in the 1980s, ecotourism has rapidly growth since the early 1990's between 20 and 34 percent annually (Piper & Yeo, 2012). It has been considered as the fastest growing sub-sector of the tourism industry and as a supplementary source of economic development (Erdogan, 2017). By the high public interest on environmentally friendly products including tourism, tourism industries often use eco-label such as 'green' or 'eco-friendly' in their marketing strategy in which the World Resources Institute noted that at least 40 of 340 international eco-labels geared toward tourists and the travel industry (Piper & Yeo, 2012). Hingham (2007) then argued that not all those responsible' forms of tourism were categorised as ecotourism but they were formed as an elaborate ruse and effective marketing tool for building further demand for tourism by clothing itself in the green mantle of mass tourism.

By the vast growth of the eco-friendly tourism terms and labels, public should be made aware that ecotourism already has a globally agreed definition and principles. The International Ecotourism Society (TIES) defines ecotourism as a responsible travel that conserves the natural environment and improves the well-being of local people (Ghosh, Siddique & Gabbay, 2003; Kiper, 2013). Principles of ecotourism are responsible for the preservation of natural environment (Ekayani & Nuva, 2013; Miller, 2017), beneficial to the society economically, socially and culturally by providing job opportunities, generating income, and preserving local cultures and traditions (Ekayani & Nuva, 2013; Blaj, 2014; Miller, 2017). Lastly, ecotourism also provides environmental education to both tourists and people (Issac & Wuleka, 2012; Kaplan, 2013; Wuleka et al., 2013). Ecotourism acts as an alternative to environmentally degrading livelihood methods, contributing to both conservation and sustainable community development (Miller, 2017)..

Community-based ecotourism is one of the models of environment management for the application of forest management or other conservation areas as tourist area (Kaplan, 2013). It is an unique type of tourism which was introduced as a way of alleviating the impact of tourism activities on the environment as well as striking balance between local people and

the natural environment (Musavengane, 2015). The success of environmental management is achieved by involving community which will be strongly influenced the social conditions such as norms, trust, cultures, cooperation, lifestyle, and relationships among people called social capital (Nurrochmat et al., 2012; Nurrochmat et al., 2016).

Social capital is defined as a set of informal values and norms shared among members of a community group that allow the cooperation among them (Iravani & Sharifi, 2012; Magson et al., 2014; Putnam, Leonardi & Nanetti, 1993; Vial, 2011). From the definition, it can be seen that social capital inheres in the structure of social relationships (Portes, 2000). It concerns primarily with the values of a network which binds and bridges people with the norms of the reciprocal cooperation exchange to encourage the achievement of common goals (Jones, 2005; Nurrochmat et al., 2017). Based on this definition, there are three main elements in the social capital: i.e. trust, reciprocal and social interactions. As with Putnam et al. (1993) and Ansari (2013) argued that trust and norms of reciprocity embedded in social networks facilitate all kinds of collective action. Social capital is used for a number of productive uses. It can make easier to transfer a relevant practice from one part of an organization to another (Lesser, 2000) and in intervening public good or common resources (Lesser, 2011; Ansari, 2013).

Like physical and human capital, social capital requires maintenance. Social bonds have to be periodically renewed and reconfirmed, or else they lose efficacy (Alder & Kwon, 2000; Lesser, 2000). It is because that social capital is sometimes rendered obsolete by contextual changes and unpredictable (Alder & Kwon, 2000). Social capital also emphasizes on social interaction in which the actors may appropriate to use in their interests, but it should be noticed that social capital is a public good which is vulnerable to "tragedy of the commons" risks. Thus, it takes mutual commitment and cooperation from parties to build social capital. It means that no one player (actors) has exclusive ownership rights to social capital. A defection by only one party will destroy it.

Analysis of social capital is required to evaluate a social institution (Jones, 2005). Evaluation of social capital refers to the quality and quantity of social interactions horizontally which is shown by positive relationships between community members, and vertically, characterized by unequal power distribution among members and ability to cope with negative as well as positive association (Coleman, 1990). The interactions were also deeply examined in the Muara Baimbai community, a community in a coastal village in Sei Nagalawan of North Sumatera, Indonesia.

Sei Nagalawan is a coastal village which experienced significant changes on biophysical conditions in the 80's due to the conversion of mangrove forest into large scale shrimp farmings at the eastern coastline of North Sumatera to increase shrimp production. As stated by Kustanti et al. (2014), the rapid land use change of coastal areas caused a rapid deterioration of the environment, abrasion and sea water intrusion into agricultural lands which eventually damaged the coastline. Massive deforestation of motivate environmentalists government and NGO associations to initiate rehabilitation projects of coastal areas.

The rehabilitation activities at eastern coastline of North Sumatera have been conducted since 1992, the main purpose of the activity is to carry out the rehabilitation of coastal areas by involving local communities. As a result, a lot of mangrove trees are growing along the coast and at the mouth of the rivers, including in Sei Nagalawan Village. Mangrove area is then managed independently by local community in Sei Nagalawan Village as mixed mangrove-fisheries by the establishing Nelayan Kayuh community since in 1998. In 2009, the Nelayan Kayuh community and women group joined forces to manage about 56 hectares of mangrove area as ecotourism area (Situmorang & Barus, 2016). Furthermore, the community also integrated the management of tourist areas

with the production of various mangrove foods for visitors and food stores. In order to promote the region and improve the coordination between interested parties, the community has built networks to the Government of Serdang Bedagai Regency, schools, universities, and NGOs (Situmorang & Barus, 2016).

The perceived success of Muara Baimbai community in managing the ecotourism area independently is very interesting to be further researched thoroughly because the various environment management programs involving communities often fail. Failures sometimes happen because of hasty government agenda which less involvement of communities in identifying their basic needs (De Royer, Pradhan & Juita, 2016). Chomba, Treue and Sinclair (2006) added that the program more lead to political realm. The government programs community forest program, but it is not followed by issuing a proper regulation about access to land and forest. Another reason is the fail to pay sufficient attention to the importance of smallholder business organization and related capacity-building, and to product value-chain development (FAO, 2016).

The success of involving communities commonly indicated by the existence of community's self-reliance in overcoming their social and economic problems, which according to Syahra (2003) it could be achieved if society has strong social capital in managing the organization. Therefore, the study aims to analyze the social capital owned by Muara Baimbai community in managing the mangrove ecotourism area.

II. MATERIAL AND METHOD

A. Study Site and Time

The research was carried out at Sei Nagalawan Village, Perbaungan District, Serdang Bedagai Regency, North Sumatera Province (Figure 1). The study was conducted from June until December 2014.

B. Data Collection and Sampling Technique

Primary data were gathered through observations, filling out questionnaire, and in-depth interview to the members of Muara Baimbai community. The Muara

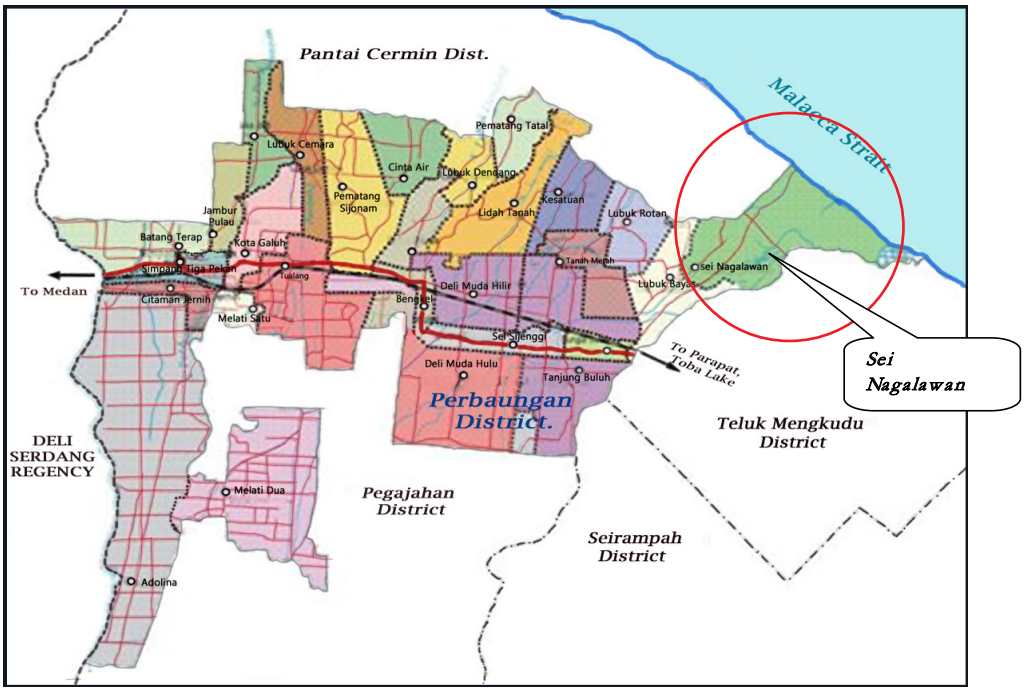

Figure 1. Perbaungan District and Sei Nagalawan Village Map
(Source: Serdang Bedagai Statistical Bureau, 2014)

Baimbai community is joined community of fishermen and women groups who managed the mangrove area in Sei Nagalawan Village. Total number of the community member is 56 households. Twenty six respondents (head or representative of household) were randomly selected from community members to fill out the questionnaire form, and 12 respondents of managers and founders of Muara Baimbai community were interviewed to gain deeper information. The total number of respondents were 38.

C. Data Analysis

The measurement of social capital and the assessment of its contribution are important to measure social capital that accurately quantifies the extent of bonding, bridging, and linking capital as individual possession (Magson et al., 2014). Van and Jan (2003) suggested that existing measurement of social capital are subjected to criticism because researchers often define terms differently, then it is difficult to develop concrete, tangible evidence of social capital that lends itself to quantitative analysis. Furthermore, Onyx and Bullen (2000) has developed a method in a study in New South Wales (Australia) to quantify the social capital criteria. The model uses many factors as the criteria of social capital such as participation at local community level, feeling of confidence and security, activities in social context, connection of neighborhood, tolerance of differences and the values of life. The criteria provided in this method are available to be adopted because they can measure the social capital in an institutional scale and its effects on the development of public participation. Based on some criterias above, the parameters used to measure the social capital in Muara Baimbai community were: level of participation; level of trust; internal and external connections (network); and values and benefits.

Data from various parameters were tabulated and interpreted using percentage table. While all the results and the information gained during the interview were interpreted and analysed descriptively by a deductive approach.

III. RESULT AND DISCUSSION

A. Level of Participation

Faham et al. (2008) stated that level of social participation could be influenced by motivation. Motivation is shown as the willingness to take part to be a member of community when joining and running the group. By addressing the motivation of the community members of the Muara Baimbai community, the level of participation could also be determined (Table 1).

Table 1 describes that most of the community members have high level of participation on community activities. The participation consists of preparation and implementation of tour packages, placement of personnel for the tour

Table 1. Level of participants

No.	Level of participants	Number of respondent		Description of the respondents, motivation and activities
		n	(%)	
1.	Very high	15	39.47	Founder of the group, managers, and active cadres
2.	High	21	55.26	Management board and active members
3.	Moderate	2	5.26	Less active members
4.	Low	0	0.00	-
5.	Very low	0	0.00	-
	Total	38	100.00	

packages and at several spots (picket, food-court and parking area), processing of food and snacks, participating in the strengthening of financial, repairing of facilities, as well as planting and maintenance of mangrove. Those activities are mostly done as side job, while their main jobs are fishermen and farmers. The roles, personnel placement, and work schedules are determined by the agreement of the members. Furthermore, the profit gained from each activity will be collected as a joint benefit and distributed monthly in accordance with the outpouring of the work time and the workload to get the fair share.

Sandefur & Laumann (2000) stated that one of the characteristic of social capital is in providing benefits to the members. From the ecotourism at Sei Nagalawan, the community members are not only get economic benefit but also in social and environment benefits which can stimulate their participation and motivation to join since 1992. It also can be interpreted that the strong motivation comes from their understanding and the benefits gained during the long involvements in conservation of mangrove through ecotourism management.

Besides influenced by the people interest on benefits, the strong participation and motivation of the community members can be seen by the people willingness to maintain the organisation (the community) to go through the structural and institutional changes since 1998. The local community firstly formed the Nelayan Kayuh Baimbai (fishermen group) community and then the Muara Tanjung Women's Group. Internal conflict had made the Nelayan Kayuh Baimbai be dissolved. Therefore, initiated in 2006, the former members of the Nelayan Kayuh Baimbai Community consisting of fishermen merged with the Muara Tanjung Woman Group members to establish the Muara Baimbai Community by issuing the Decree of the Head of Sei Nagalawan Village No. 18.40.22/08/SK/2009 in 11th June, 2009 as well as the establishment of the community as the manager of about 56 ha mangrove area. To strengthen the community business in financial term, the merging community collected money and formed the Business Multipurpose Cooperative in 2012 namely Muara Baimbai Business Multipurpose. The cooperative also formed to complete some of needed administrative requirements when activities of community and the networks were growing.

The long journey of the Muara Baimbai community in repairing damaged mangrove forests and managing the ecotourism and its institutional arrangement shows that the group has gone through various challenges that ultimately created social independence and strong motivation in managing mangrove area and human resources. According to Bartol and Martin (1998), the right motivation is a powerful tool that reinforces behavior and triggers the tendency of continuation. The nature of willingness to participate in the group can also be seen by the main source of funding of the community which is presented in Table 2.

Table 2 shows that operational budget of the community was mostly obtained from individual contributions (62.64% from principal fund and 9.40% from mandatory dues). The principal

Table 2. Main source of the Muara Baimbai community funding in 2012

No.	Funding categories	Amount (IDR)	Percentage(%)
1.	Principal fund (IDR 200,000 x 56 members)	11,200,000	62.64
2.	Mandatory dues (IDR 10,000 x 56 members)		9.40
	* October, November, December	1,680,000	
3.	Other funds	5,000,000	27.96
	Total	17,880,000	100.00

Source: Financial report of Muara Baimbai Community (2012)

fund is the fund paid by the members (families) when joining the group, while mandatory dues is the monthly charges for the members. The fund are used for productive activities such as making of food, selling of food and souvenirs, and guiding services to visitors. The total revenue from the activities is shared among the members and partially set aside to the business modal.

A concept revealed by Knapp et al. (2013) described that community could participate in budgeting such as conducted by Muara Baimbai community. The participatory budgeting concept is a decision-making process which is done deliberately through negotiating among the community or citizens on distribution of public resources. Benefits gained by citizens in participatory budgeting are to increase their access to public decision-making activities, to gain access to information, and to obtain the direct relationship between participation and the quality of services provided. The explanation above confirms that the Muara Baimbai community members have the willingness to pay because they have obtained many benefits directly and indirectly from ecotourism activities. These activities also can fulfill the purpose of communities' livelihood in the area. A high participation in financial contribution donates that the community has a good capital in adherence to rules (norm) and reciprocity which will maintain the operation of the community in the future. This is in accordance with the opinion of Afify (2011) and Situmorang and Sukmana (2014) that high participation in a community is an important asset to be used for local government on sustainable management of the environment.

B. Level of Trust

Yu (2013) stated that trust is more important than the structural social capital. It is obvious that if actors in the network do not trust each other, no matter how dense the network is, and the high degree the actors owned, they will not be willing to share valuable information and help each other. Thus, level of trust is needed to be assessed in the community.

Table 3 shows that the level of trust between the board and members of community as well as among the members was very high (55.26% strongly agreed). While, fairness in the distribution of jobs, satisfaction on profit sharing, and willingness to help among the members were high (42.11%, 50% and 60.53% respectively agreed). It can be concluded that the community has strong trust among members and this is a good social capital in developing the community.

Trust among members, particularly of the management group, is usually strongly influenced by the acceptance of members on consistency of responsibility and cost transactions. The management of the Muara Baimbai community mostly consists of active cadres who have joined in many activities to restore mangrove areas. Bourdieu (1989) stated that the people who has power to impose

Table 3. Assessments on level of trust of Muara Baimbai community

No.	Descriptions	Percentage (%)				
		SA	A	N	DA	SDA
1.	Management of the group can be trusted	55.26	36.84	7.89	0.00	0.00
2.	Management has treated the members fairly in sharing activities	39.47	42.11	13.16	5.26	0.00
3.	The members are satisfied in distributing profit sharing based on the contribution of each member	31.58	50.00	15.79	2.63	0.00
	Members are willing to help each other					
4.	Other	23.68	60.53	2.63	13.16	0.00

Notes: SA = Strongly agree A = Agree N = Neutral DA = Disagree NA = Strongly disagree

upon other minds a vision, old or new, of social divisions depends on the social authority acquired in previous struggles are called as symbolic power. As happen in Sei Nagalawan, most of the members placed their trust in them because the active cadres play a role as symbolic power that have shown their responsibility to restore the damaged mangrove area and to seek many opportunities from many networks to develop their village. In terms of finance, the managers have given acceptable financial transactions and they have also given a fair profit sharing among the members. Otherwise, unfair benefit sharing and marginalization of some groups in ecotourism development and its operation could destroy trust followed by the damage of the community (Ketema, 2015). By the activities sought by the managers and the active cadres to develop the community, Avant et al. (2013) stated that this leadership style creates a culture based on openness, trust, and respect and inspires team spirit. Therefore, high social trust is required to maintain the survival of the community.

Even tough the community members generally have high level of trust to the leaders and at the sharing of activities and benefit, there are still members which are unsatisfied. Those people are mostly the less active members. The application of rules within the group about the division of activities and the benefits which is evaluated by the spending time of each member in the activity sometimes can not be accepted by the members who are less active because they get less. Level of trust to the leaders also can not be achieved perfectly because the delivery of information that sometimes can not reach all members and internal issues in the social environment that can occur. Another thing which can potentially lead to internal problems is the influence of villagers who are not members of the community. They can slowly affect members, especially members who are less active. This needs to be watched by other members or leaders to carry out the evaluation as Lesser (2000) and Alder & Kwon (2000) argued that community needs maintenance in organization to strengthen the social capital.

C. Internal and External Connection (Network)

Putnam (2000) argued that the core idea of social capital is that social networks have value. Social capital is formed through the relationship between individuals and group (internal connection) (Milana & Maldaon, 2015) which forms social structures (Baker, 1990) and between individuals and group to other actors or organisations (external connection). The internal connection of the Muara Baimbai community is presented in Table 4.

Based on Table 4, the community has a strong internal connection among the members not only socially but also economically. The

Table 4. Internal connection as a social capital

No.	Points of assessment	Percentage (%)				
		SA	A	N	DA	SDA
1.	Greeting each other among fellow members inside and outside of group meetings	92.11	7.89	0.00	0.00	0.00
2.	Sharing many experiences within the group	42.11	39.47	18.42	0.00	0.00
3.	Lending and borrowing of goods or money among members	21.05	55.26	23.68	0.00	0.00
4.	Providing economic support among members for the needy families	18.42	68.42	7.89	5.26	0.00

Notes: SA = Strongly agree A = Agree N = Neutral DA = Disagree NA = Strongly disagree

homogeneous social life pattern of the people in the village has made the needs and lifestyles of the villagers are not much different. The people in Sei Nagalawan are mostly fishermen and their wife as farmers and housewives. The religion and tribe dominated by Islam (religion) and Malay tribe have created the homogeneity of the society that strengthen the social interaction among members both in group activities and outside.

Relationship occurring outside of defined groups in networks is also important to improve the development of rural community. Social networks have value if there are interactions and connections in developing shared norms, trust, and reciprocity in turn foster to achieve common goals (Jones, 2005). Community members need to be involved in order to verify themselves for the validity of the new beliefs, examine consequences for themselves as an individual and to explore how they can contribute to change the effort (Belias & Koustelios, 2014). Furthermore, Munshi (2014) stated that community networks may provide useful benefits to their members and they can give rise to inefficiencies of their own. Strong

Table 5. External interactions of the community

Type of interactions	Type of interactions	Comments
Central government	Mangrove Agency sector II Medan	- The Muara Baimbai community is one of the target groups in management of mangrove in the coast line of North Sumatera. - Many activities collaborated with the community have been done in the village.
Local government (Serdang Bedagai's Government Regency)	1. Department of Forestry and Plantation 2. Department of Tourism 3. Department of Trading 4. Government of Sei Nagalawan Village	- Mangrove areas managed by the community became one of the ecotourism area promoted by the local government in many events and occasions - The government has given support in strengthening the community, providing several production equipments, organizing trainings and promoting food products by the community.
Non-Governmental Organisation	United Nations Development Programme (UNDP) Indonesia	- Initiator in rehabilitation of mangrove area including in Sei Nagalawan Village - Fostering society to be environmentally active cadres - Facilitators of the community to manage the ecotourism mangrove area - Supporting financially many activities of the community
Trading institutions	Hotels and various marketing agencies in Pasar Bengkel	Marketing results of mangrove processed food products produced by women's groups
Visitors	Groups of students from various schools in Serdang Bedagai Regency, universities, researchers and environmentalists	Conducting excursions, studies and researches in the mangrove areas

social ties may solve commitment problems within communities, while capable individuals outside these communities can be left out.

In addition to the importance of strengthening the internal network, a community also requires external network to expand the community. The patterned relationships connecting citizens with those outside of established groups are called social networks (Stolley, 2005). In Table 5, there are some stakeholders and institutions which have networking with the Muara Baimbai community.

Table 5 shows the interactions of the community with various stakeholders both government and non-government. This shows that the Muara Baimbai community in managing the mangrove ecotourism already has strong networks which are maintained since they have been involved in the restoration and promotion of the mangrove area as their successful job. Furthermore, after the area has been managed as tourism area by showing the beautiful scenery of the mangrove ecosystem, education on the area of tides and its ecosystem, and attractions around the area, attracts visitors and creates a new network between the parties and the community.

D. Benefits

Another purpose of forming groups is to get benefits both economically and socially conforming to the needs of the community. Essendi and Madise (2014) emphasized that development plans are prioritised based on communities' needs and how rural poor perceive development. Economic benefits can be obtained if such activities are done by management of certain capital for profit, while social benefits can be gained by many activities involving members. As regard the Muara Baimbai community, there are several advantages that can be obtained by activating ecotourism in the mangrove area. Table 6 indicates the benefits of ecotourism operating in the mangrove areas.

Based on Table 6, management of mangrove areas in Sei Nagalawan gives many benefits socially and economically not only for individuals but also for the group. The experiences gained by each member involved in establishing and managing the mangrove during approximately 18 years have given social benefits in increasing their knowledge in environmental and organizational management. Various activities carried out in the village have promoted the village to receive many attentions from various parties. This area has been used to be one of the pilot villages of mangrove management which is well known at the district, regional, and provincial levels. Economically, mangrove management has increased people's income either from revenue of tickets for excursions, tourist assistance, sale of food products, or other services/products. These activities also created new jobs for some members of the group. However, most of the income from the tourist areas are side income because the main income of the people is still derived from the fishing and agricultural activities.

IV. CONCLUSION

The Muara Baimbai community has strong social capital in managing the mangrove ecotourism area. Strong social capital owned by the group is an indicator of a public institution which is run properly. The success of the community to rehabilitate the mangrove area in Sei Nagalawan and to utilise its resources in a sustainable manner is the result of high levels of participation of the members and the existence of active cadres which played a role as symbolic power on encouraging, driving, and motivating the community in their effort. Strong motivation, fair work allocation and benefits among the members, strong internal connection, and wide external network are very important to strengthen social capital. The increasing of the welfare of the Muara Baimbai communities through increasing economic income, job opportunities, and knowledge is the benefits derived from the sustainable mangrove forest management.

Table 6. Benefits of ecotourism operating in the mangrove area

No	Benefits	Percentage (%)
I.	*Personal benefits*	
1.	Increasing personal knowledge through training	94.74
2.	Enhancing experiences	85.84
3.	Getting jobs and permanent income	15.79
4.	Increasing of income	81.58
	Average	*69.49*
II.	*Community's benefits*	
1.	Self-reliance on institutional arrangements	73.68
2.	Increasing community's income by any attraction or offered tour packages	97.37
3.	Increasing technical capabilities in mangrove ecotourism	73.68
4.	Getting financial support on development of the group	65.79
5.	Enhancing network expansion	50.00
	Average	*72.11*
III.	*Benefits to the village*	
1.	Increasing village's income	42.11
2.	Decreasing coastal erosion	89.47
3.	Improving people's welfare	60.53
4.	Supporting in the improvement of village facilities	21.05
	Average	*53.29*

Remark: n = 38 respondents

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THE PHYSIOLOGICAL AND NUTRITIONAL CONTENT CHANGES OF JELUTUNG (*Dyera polyphylla* (Miq.) Steenis) SEED THROUGH DRYING AND STORAGE

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THE PHYSIOLOGICAL AND NUTRITIONAL CONTENT CHANGES OF JELUTUNG (*Dyera polyphylla* (Miq.) Steenis) SEED THROUGH DRYING AND STORAGE. Seed deterioration is the process of deteriorated seed in view of viability that has changed its physiological and nutritional content. This paper studies the effect of seed drying and seed storage to the viability and biochemical content of jelutung (*Dyera polyphylla* (Miq.) Steenis) seeds. Completely Randomized Design was used for different level of seed drying time, i.e. 0, 24, 48, 72, 96 and 120 hours, and Completely Randomized Factorial Design was used for the combination of seed drying treatments of 0, 24, 48, 72, 96 and 120 hours in different rooms for seed storage (ambient room, air conditioned room, refrigerator) with variables of moisture content, germination percentage and nutritional content. Result shows that seed drying and seed storage treatments pursue the change of seed viability and nutritional content of jelutung seed. The period of time in seed drying and seed storage siginificantly influence the moisture content, germination percentage and nutritional composition (lipid, carbohydrate, protein). The longer time of seed drying will effect significantly to the moisture content and germination percentage, increasing the lipid and protein and decreasing carbohydrate. Jelutung seed that was stored in air conditioned room had better viability compared to ambient room and refrigerator.

Keywords: Jelutung seed, viability, nutritional, seed drying, seed storage

*PERUBAHAN FISIOLOGI DAN KANDUNGAN NUTRISI BENIH JELUTUNG (*Dyera polyphylla *(Miq.) Steenis) PADA PROSES PENGERINGAN DAN PENYIMPANAN. Secara alami benih jelutung seiring dengan bertambahnya waktu akan mengalami kemunduran mutu benih yang dapat menyebabkan perubahan baik fisik, fisiologis maupun nutrisi yang mengakibatkan menurunnya viabilitas benih. Tujuan penelitian ini adalah untuk menguji pengaruh lama pengeringan dan ruang penyimpanan terhadap viabilitas dan komposisi nutrisi benih jelutung (*Dyera polyphylla *(Miq.)* Steenis). *Penelitian pengeringan dirancang dengan menggunakan Rancangan Acak Lengkap dengan waktu pengeringan selama 0, 24, 48, 72, 96, dan 120 jam, sedangkan pengujian viabilitas dan kandungan nutrisi benih terhadap lama pengeringan dan ruang penyimpanan menggunakan RAL pola faktorial dengan dua faktor, yaitu faktor lama pengeringan benih (0, 24, 48, 72, 96, dan 120 jam) dan faktor ruang simpan (ruang suhu kamar, AC, kulkas). Kedua tahapan penelitian menggunakan peubah kadar air benih, daya berkecambah dan kandungan nutrisi benih. Hasil yang diperoleh yaitu lama pengeringan dan ruang penyimpanan mengakibatkan perubahan viabilitas dan kandungan biokimia pada benih jelutung. Interaksi lama pengeringan dan ruang penyimpanan berpengaruh nyata terhadap nilai kadar air, daya berkecambah, dan kandungan nutrisi (lemak, karbohidrat, protein) benih jelutung. Semakin lama pengeringan, akan menyebabkan menurunnya nilai kadar air dan daya berkecambah, meningkatnya kadar lemak dan protein, serta menurunnya kadar karbohidrat pada benih jelutung. Benih jelutung yang disimpan di ruang AC dapat menghasilkan viabilitas benih yang lebih baik dibandingkan dengan penyimpanan di ruang kamar dan kulkas.*

Kata kunci: Benih jelutung, viabilitas, nutrisi, pengeringan, penyimpanan

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I. INTRODUCTION

Jelutung (*Dyera polyphylla* (Miq.) Steenis) belongs to the family of Apocynaceae, which includes 366 generas that were recognized and placed in five subfamilies, 25 tribes and 49 subtribes based on the recent morphological and molecular, mainly in phylogenetic-based results (Endress, Shumann & Meve, 2014). Jelutung naturally growth in swamp-land area through seed dispersal from the mother trees in some locations in Kalimantan and Sumatera including West Kalimantan, Central Kalimantan, West Sumatera, South Sumatera, Bengkulu, Jambi and Aceh (Perdana, Sofyuddin, Harun & Widayati, 2016; Tata, Noordwijk, Jasnari & Widayati, 2015a). The biological cycle of this species is more than 30 years and the economic cycle between 6 to 30 years for tapping jelutung latex and harvesting its wood after 30 years (Bastoni, 2014). Jelutung latex could be used as raw material for producing edible gum, a mixture of automobile tyre manufacture, making paints, adhesives and varnishes (Waluyo, Wahyudi & Santosa, 2012). Jelutung wood is suitable for pencils, interior design material and wood carving (Perdana, Sofyuddin, Harun & Widayati, 2016).

Considering its growth potential and the use of its wood, jelutung is a promising species for timber plantation. High seed quality is required in large numbers for the planting programme and seed improvements can be achieved through the right time for seed collection, a good seed handling and secure storage. The plant propagation of jelutung has been using seed and there is no information yet about using vegetative method (Danu & Wijaya, 2012; Tata, Bastoni, Sofiyuddin, Mulyautami, Perdana & Janudianto, 2015b). Jelutung can be planted in various mixed agroforestry systems, with other plants including rubber, coffee or oil palms (Tata, Noordwijk, Jasnari & Widayati, 2015a) and this species has been promoted in peatland rehabilitation and restoration programs (Gunawan et al., 2016; Perdana, Sofyuddin, Harun & Widayati, 2016).

The jelutung trees has fruiting season every year with good year every two years in Sumatera. However, the flowering usually takes time in November and the mature fruit will be found some times between April and May. However, after 2005 the flowering and fruiting season is unpredictable (Bastoni, 2014). The flowering season for jelutung trees in Central Kalimantan is grouped into two seasons from March to April and from July to December. The development of flower to a mature jelutung fruit may need 5.5 months (Pramono, 2011). Jelutung seed is categorized as intermediate in terms of the initial moisture content of the fresh seed, close to 14%, and it can be stored for up to six months (Kartiko & Danu, 2016).

One of the problems encountered in providing high quality seed is the maintaining of the seed viability during storage, which can be done by lowering the rate of respiration. High respiration rate leads to rapid loss of seed reserves of energy and food supplies, especially in the embryo. It reduces germination rate and may induce deterioration process of the seed (Widajati, Murniati, Palupi, Kartika, Suhartanto & Qadir, 2012). Naturally, viability of jelutung seed declines over time. In general, the seeds will face deterioration symptoms (Yuniarti, Syamsuwida & Aminah, 2008b). Thus a safe seed storage is intended to maintain seed viability which should remain high until the seeds are used for planting.

Some of the factors that affect the viability of the seed during storage are the temperature, moisture content of seeds, relative humidity and oxygen. Their fluctuation during storage can cause changes in respiration rate. Respiration rate continues to increase when the ambient temperature rises that will affect the inactivation of enzymes, nutrients or oxygen reserves can be finished and carbon dioxide will be accumulated. During storage, the seeds that contain more fat are more perishable than those containing more starch or protein (Sudjindro, 1994). By knowing the biochemical content, the proper seed storage techniques and the proper

testing can be prescribed for the seed. This paper studies the effect of seed drying time and room seed storage on moisture content, viability and biochemical content of jelutung seeds (*Dyera polyphylla* (Miq.) Steenis).

II. MATERIAL AND METHOD

A. Place and Time

Seed quality testing was conducted in the laboratory and greenhouse of Research and Development Institute for Forest Tree Seed Technology (06°38'07.6" S and 106°02'49'32.2 E), Bogor. The nutritional analysis (e.g. carbohydrate, protein, and fat) were performed in the laboratory of Southeast Asian Regional Centre for Tropical Biology (SEAMEO)-Biotrop (06°35'54.7" S - and 106°48'41.3" E) in Bogor. The research was conducted over four months from April to August 2014.

B. Materials and Equipment

The materials and tools used in the study were the jelutung seed, top soil and sand that have been sterilized as germination medium, aluminium foil, silica gel, sprayer, distilled water, space with room temperature and air conditioning, refrigerator, alcohol, and stationery. The germination medium was sterilized by frying it for two hours on a hot plate.

C. Method

Location of seed collection of jelutung was in the Research Forest Area of Tumbang Nusa, Central Kalimantan. Administratively, the location is in Tumbang Nusa Village, Sub district Jabiren Raya, Pulang Pisau Regency, Central Kalimantan Province (02°18'37"-02°22'34"S and 114°02'48" - 114°06'46"E). the forest research area is managed by the Banjarbaru Environment and Forestry Research Development Institute.

Seed collection of jelutung was conducted by climbing the trees. The fruit is physiologically ripe when its colour is brown. The seed collection had been conducted in October, 2014 for 4 days. The seed was then sent to Bogor in one day. The seed extraction was done by drying the fruit in the sun for 7 days. Once dry, the seed was removed from the pod and the seed wing was then cleaned.

1. Testing I: Effect of seed drying time on seed viability and biochemical content

Seed drying time treatments used in this research were 0, 24, 48, 72, 96 and 120 hours of four replicates of each treatment in which the seeds were placed on top of nyiru (tray made of rattan) covered by rice paper in ambient room with temperature that varied from 27°C to 30°C.

Determination of seed moisture content, seed germination testing, and analysis of nutritional content (protein, fat, carbohydrates) were conducted at every stage of seed drying time. The number of seed in each treatment required seeds of four replicates @ 5 g for determination of moisture content, four replicates @ 100 g for analysis of nutritional content (protein, fat, and carbohydrate), and four replicates @ 100 seeds for seed germination testing. The determination of seed moisture content was conducted by using the oven method at the constant temperature of 103 $\pm$ 2°C for 18 hours.

Seed germination testing of jelutung used sand and soil mixture media (1 : 1 v/v) in the greenhouse. The analysis of nutritional content was conducted in the laboratory of SEAMEO-Biotrop in Bogor. Variables observed in this research were seed moisture content, nutritional content (carbohydrate, protein and fat) and germination percentage.

2. Testing II: Effect of seed drying time and storage type on seed viability and biochemical content

Two factors were used, namely seed drying time (0, 24, 48, 72, 96, 120 hours) in which the seeds were placed on top of nyiru (tray made of rattan) covered by rice paper in ambient room with temperature that varied from 27°C to 30°C and storage rooms (ambient room, air conditioned room and refrigerator). Each treatment had four replicates, and each replicate

required the following number of seeds: 5 g seeds for testing moisture content, 100 g seeds for nutritional content analysis (carbohydrate, protein, and fat), and 100 seeds for seed germination testing. Each seed was inserted into bag calico cloth. Seeds in the bag cloth were put in a rectangular box that was given silica gel of the same weight as the seeds, and the seeds were placed in the middle. At bottom layer, silica gel was placed and dried for 0, 24, 48, 72, 96 and 120 hours in temperature range from 27°C to 30°C.

The seeds were stored in each storage room, i.e. ambient room (temperature 28-31°C, RH 70-80%), air conditioned room (temperature 18-20°C, RH 50-60%) and refrigerator (temperature 0-5°C, RH 40- 50%), using a closed aluminium foil container for two weeks. The seeds were then tested for moisture content by using the oven method at 103 ± 2°C for 18 hours, germination testing with media (sand and soil mixture (1: 1 v/v)), and analysis of nutritional content (carbohydrate, protein, fat). The experimental design used was Factorial Randomized Complete Random (RAL) with two factors, i.e. seed drying time (0, 24, 48, 72, 96, 120 hours) and storage room (ambient room, air conditioned room, refrigerator). The variables to be observed were seed moisture content, germination percentage, and nutritional content (carbohydrate, protein, fat).

D. Data Analysis

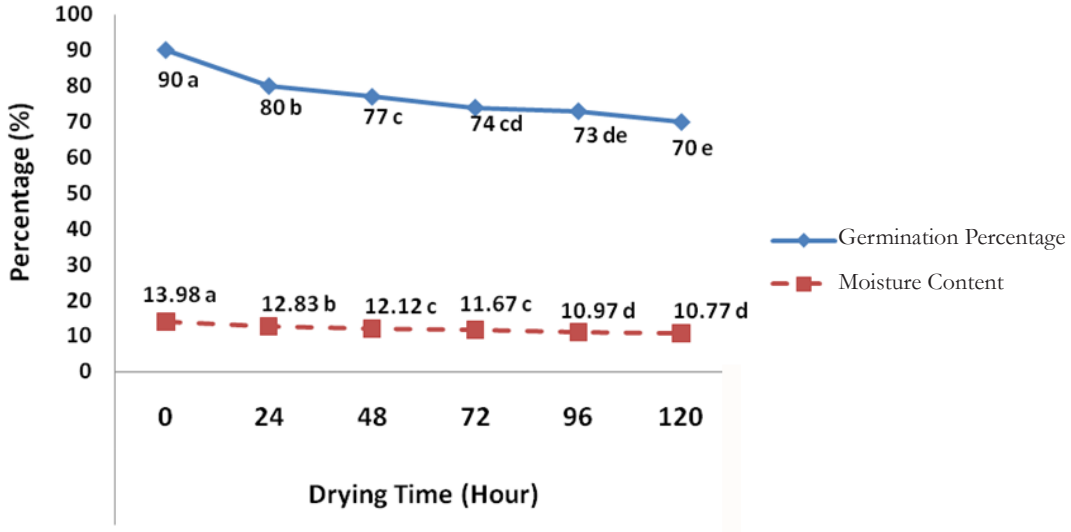
Data were analyzed by analysis of variance using a completely randomized design (CRD). The LSD test was conducted to reveal significant factor of treatments in statistics that influenced the moisture content, germination percentage and nutritional content of jelutung seed.

III. RESULT AND DISCUSSION

A. Testing I: Effect of Seed drying Time on Seed Viability and Nutritional Content

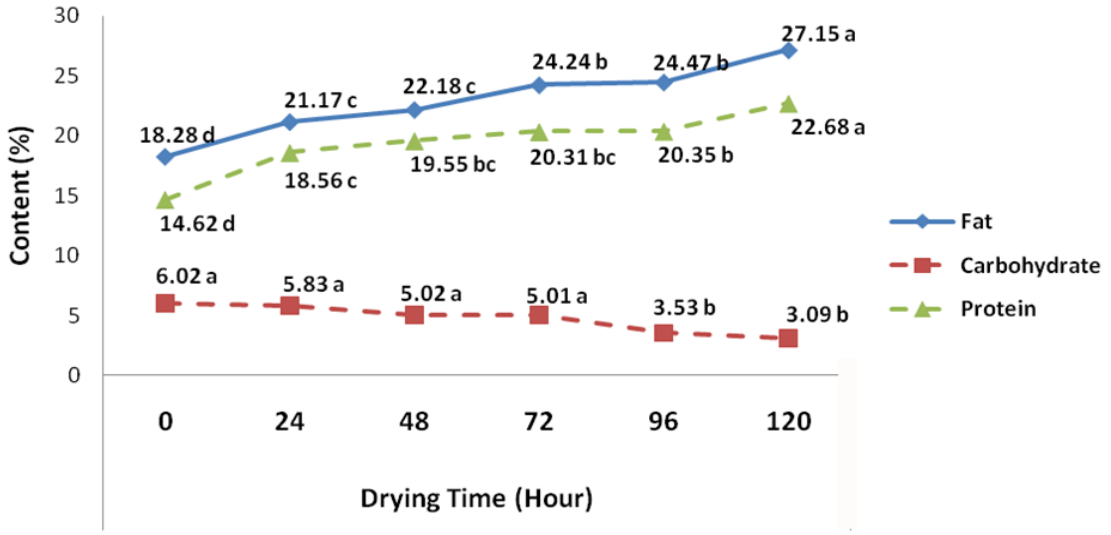
The analysis of variance showed that the drying time significantly affected the moisture content (F calculation 293.24), germination percentage (F calculation 52.13), fat content (F calculation 38.5), carbohydrate content (F calculation 12.82), and protein content (F calculation 27.32) (Figure 1 and 2).

Seed viability, moisture content and nutritional content of jelutung seeds changed because of seed drying. Figure 1 shows the longer the



Notes: Values followed by the same letter are not significantly different at 95% confidence level based on Least Significant Difference Test

Figure 1. Moisture content and germination percentage of jelutung seeds based on drying time



Remarks: Values followed by the same letter are not significantly different at 95% confidence level based on Least Significance Difference Test

Figure 2. Fat, carbohydrate and protein content of jelutung seed based on drying time

drying time the lower the moisture content and germination percentage of jelutung seeds. The initial moisture content and germination percentage of jelutung seed under control treatment were 13.98% and 83%, respectively. The germination percentage decreased along with decreasing of moisture content.

The longer drying time led to a slight increase in fat and protein contents, and a slight decrease in carbohydrate content. In the process of drying (moisture reduction) the fat content of the seeds tended to increase contrasting with decreasing water content and germination. (Yuniarti, Syamsuwida & Aminah, 2008a). The lower moisture content increased the fat content in terms of seed weight, but it decreased seed germination when the seed needed water uptake that was identical to oxygen uptake to germinate (Bonner, Karrfalt & Nisley, 2008).

In Figure 1, it is known that the nutritional content of the initial (control) jelutung seed has a higher fat content compared to carbohydrate and protein content. During seed drying, jelutung seed increased the levels of fat and protein, and

Table 1. Moisture content of jelutung seed based on interaction of drying time and storage room

Drying Time (Hour)	Room Storage											
	AC				Ambient Room				Refrigerator			
	Average		±	Standard Deviation	Average		±	Standard Deviation	Average		±	Standard Deviation
0	9.220	ab	±	0.255	9,440	a	±	0.028	7.325	e	±	0.219
24	8.990	b	±	0.127	9,100	ab	±	0.170	6.360	f	±	0.127
48	8.995	b	±	0.092	9,000	b	±	0.113	5.615	g	±	0.219
72	8.890	bc	±	0.099	8,915	bc	±	0.007	5.700	g	±	0.028
96	8.180	d	±	0.184	8,940	b	±	0.014	5.405	g	±	0.007
120	8.545	cd	±	0.544	8,900	bc	±	0.028	5.425	g	±	0.049

Notes: Values followed by the same letter are not significantly different at 95% confidence level based on *Least Significant Difference Test* , AC= Air conditioned room, temperature 19-20%, relative humidity 50-60%; Ambient room= temperature 28-31%, relative humidity 70-80%; Refrigator=temperature 0-5%, relative humidity 40-50%

Table 2. Germination percentage of jelutung seed based on interaction of drying time and storage room

Drying Time (Hour)	Room Storage											
	AC				Ambient Room				Refrigerator			
	Average		±	Standard Deviation	Average		±	Standard Deviation	Average		±	Standard Deviation
0	84.333	a	±	1.155	80.000	b	±	2.000	83.000	ab	±	2.000
24	75.333	c	±	2.517	70.333	de	±	2.517	66.333	ghi	±	4.933
48	72.000	d	±	1.000	67.000	fgh	±	1.000	70.000	def	±	1.000
72	69.333	defg	±	2.082	64.333	hij	±	2.082	67.333	efgh	±	2.082
96	67.333	efgh	±	2.082	63.000	kj	±	1.000	66.000	hij	±	1.000
120	65.333	hij	±	0.577	60.333	k	±	0.577	63.333	ijk	±	0.577

Notes: Values followed by the same letter are not significantly different at 95% confidence level based on *Least Significant Difference Test , AC= Air conditioned room, temperature 19-20%, relative humidity 50-60%; Ambient room= temperature 2831%, relative humidity 70-80%; Refrigator=temperature 0-5%, relative humidity 40-50%*

Table 3. Content of fat, carbohydrate, and protein of jelutung seed treated by interaction of drying time and storage room

Drying Time (Hours)	Rooms Storage								
	AC			Ambient room			Refrigerator		
	Fat (%)	*Carbohydrate* (%)	Protein (%)	*Fat* (%)	*Carbohydrate* (%)	Protein (%)	*Fat* (%)	*Carbohydrate* (%)	Protein (%)
0	24.8 g	13.1 a	19.5 bc	18.6 j	9.6 g	19.9 bc	15.3 k	12.7 ab	18.7 c
24	26.2 ef	11.1 c	19.9 bc	21.3 i	9.2 gh	19.9 bc	25.7 f	12.0 b	19.4 bc
48	29.2 c	10.9 c	20.2 b	21.4 i	8.3 h	19.9 bc	25.9 ef	10.9 c	19.5 bc
72	29.6 bc	10.8 cd	20.2 b	23.3 h	7.2 i	20.4 a	26.6de	10.6 cdef	19.6 bc
96	30.3 ab	10.8 cde	20.3 a	24.3 g	7.4 i	20.4 a	26.8de	9.9 efg	20.1 b
120	30.8 a	9.9 defg	20.4 a	24.7 g	4.0 j	20.5 a	27.4 d	9.9 fg	20.1 b

Notes: Values followed by the same letter are not significantly different at 95% confidence level based on *Least Significant Difference Test*, AC= Air conditioned room, temperature 19-20%, relative humidity 50-60%; Ambient room= temperature 28-31%, relative humidity 70-80%; Refrigator=temperature 0-5%, relative humidity 40-50%

reduced the level of carbohydrates. Sudjindro (1994) reported that the seeds which contain high fat, tends to be more easily deteriorated and could decrease the germination percentage.

B. Testing II: Effect of Seed Drying Time and Storage Room on Seed Viability and Nutritional Content

The analysis of variance shows that interaction of drying time and rooms for storage significantly affected the moisture content (F calculation 6.84), germination percentage (F calculation 2.22), fat content (F calculation 122.41), carbohydrate content (F calculation 28.52), and protein content (F calculation 3.82). Least Significant Difference test has been applied to learn more about treatments that pose a real difference (see Table 1, Table 2 and Table 3).

Based on the results, it is indicated that time of seed drying and type of storage changed the viability and nutritional content of jelutung seed. Moisture content and germination percentage decreased along with drying time and storage.

Jelutung seeds that were stored in air conditioned room had better viability compared to ambient room and refrigerator. High temperature and high humidity in tropical regions causing rapid reduction of seeds during storage. The main importance of recalcitrant seeds in storage is to maintain viability over time. Some of the factors that affect seed viability during storage are temperature, moisture content, relative humidity and oxygen. Relative humidity directly influences the moisture content of the seeds, while temperature may increase the rate of biochemical reactions. The storability of seeds in storage is influenced by four factors: genetic (characteristics or seed varieties), viability of the seeds before storage, temperature and relative humidity of room storage and moisture content of the seeds (Harnowo, 2006). Changes of temperature and relative humidity of room storage during storage cause changes in respiration rate of the seeds. Respiration rate continues to increase when the ambient temperature rises. The current speed is inhibited because of things like the inactivation of enzymes, nutrients or oxygen reserves have been consumed or because carbon dioxide accumulated, reaching a level that inhibits the seeds (Sudjindro, 1994). The best way to maintain the viability of recalcitrant seeds is to keep it at low temperatures where most recalcitrant seeds maintain moisture and reduce contamination with fungi (Berjak & Pammenter, 2008).

After storage, content of fat and protein of jelutung seed increased, while content of carbohydrates decreased. The decline of bio-chemical seed content indicated by change in enzyme activity, changes in respiration rate, changes in food reserves, changes in the membrane, chromosome damage and accumulation of toxins. The fatty acids can result in damage to the cell membrane (Tatipata, 2008). Increasing fat and protein content in the seed was possibly due to seed retention mechanism against moisture content reduction.

The nutritional content changes during storage of sandalwood seed showed an increase in carbohydrate, protein and electric conductivity (EC) and decreasing fat content (Syamsuwida & Aminah, 2007). The proportion of fatty acids in the membrane phospholipids is higher for recalcitrant seeds compared to orthodox seed. In some cases it was found that fat content increased because of mold during storage in humid conditions such as occurred to jatropha curcas seed (Worang, Dharmaputra, Syarief & Miftahudin, 2008).

According to Sudjindro (1994) the seeds that have high fat content will easily be damaged during storage. The high content of fatty acid is also an indication of high respiration process which causes loss of energy for seed germination. During storage, the seeds high in fat are more perishable than seeds containing starch or protein. The decline in water levels and an increase in free fatty acids cause a decrease in viability and vigor.

During seed storage, protein content of jelutung seed also tends to increase along with the decrease of water content and germination. The anticipated increase in the protein content of seeds is a defense mechanism to decrease the moisture content and storage time. It also indicates the defense of seeds in optimal conditions. In addition, the synthesis of specific proteins is needed to maintain dormancy of the embryo (Gifford, 1993). Carbohydrate content of jelutung decreased in the seeds during storage. The presence of carbohydrates in the seed component consisting of sugar (sucrose) as a substrate forming carbohydrates resulted in resistance to drying as well as protein. The decrease indicates a decrease in carbohydrate content meaning decreasing defense of seed viability. This was shown by the jelutung seed germination during storage.

IV. CONCLUSION

During the seed drying and storage, seed deterioration occurs in viability and nutritional content of jelutung seed. Drying time and type of room storage significantly affected the seed moisture content, germination, and

nutritional contents (fat, carbohydrate, protein) of jelutung seeds. The longer drying time and storage decreased the moisture content and germination, increased content of fat and protein, but reduced carbohydrates content of the jelutung seed. Jelutung seed that was stored in air conditioned room (temperature 18-20°C, RH 50-60%) had better viability than in the ambient room (temperature 28-31°C, RH 70-80%) and refrigerator (temperature 0-5°C, RH 40-50%).

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FINANCIAL ANALYSIS ON AGROFORESTRY SYSTEM OF COFFEE WITH MARRANGO TREE (*Azadirachta excelsa* Jack.) IN REJANG LEBONG REGENCY, BENGKULU PROVINCE, INDONESIA

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FINANCIAL ANALYSIS ON AGROFORESTRY SYSTEM OF COFFEE WITH MARRANGO TREE (*Azadirachta excelsa* Jack.) IN REJANG LEBONG REGENCY, BENGKULU PROVINCE, INDONESIA. Marrango tree (Azadirachta excelsa Jack.) has been introduced as a shade tree for coffee plantations that also produces valuable timber for construction and energy. This paper analyzed the financial aspect of an agroforestry system of marrango tree and coffee plantations, including observations of land management, costs and revenues, financial feasibility and sensitivity analysis. The study was conducted in Rejang Lebong Regency, Bengkulu Province through field observations and interviews. Data was collected through direct observations, household surveys and in-depth interviews of several key actors to deepen the information and verify the collected data. Descriptive quantitative and financial analyses were employed to analyze the data. The results showed that the land management of marrango tree and coffee plant agroforestry in Rejang Lebong Regency was conducted in the traditional way. However, the agroforestry system of coffee plants and marrango tree was financially feasible at the level of 8% discounted rate (NPV = 76,250,582 IDR; BCR = 2.28 and IRR = 22%). This agroforestry system also has good resistance to changes in coffee price, coffee production and marrango tree price. The agroforestry system remained feasible although if coffee production declined by 30% and timber production declined up to 30%. The changes in coffee production and price were the most influential factors on the feasibility of the agroforestry system. This agroforestry system is beneficial for the farmers. Hence, the local government should encourage the community to apply this system.

Keywords: Agroforestry, coffee, financial analysis, marrango tree

ANALISIS FINANSIAL PADA SISTEM AGROFORESTRI KOPI DENGAN KAYU BAWANG (Azadirachta excelsa Jack.) DI KABUPATEN REJANG LEBONG, PROVINSI BENGKULU, INDONESIA. *Kayu bawang (*Azadirachta excelsa Jack.*) telah diperkenalkan sebagai pohon penaung untuk tanaman kopi. Selain itu pohon ini juga menghasilkan kayu yang cukup bernilai terutama untuk kayu pertukangan dan kayu energi. Tulisan ini bertujuan untuk melakukan analisis finansial sistem agroforestri kayu bawang dan tanaman kopi. Termasuk diantaranya melihat pengelolaan lahan yang diterapkan, mengetahui biaya dan pendapatan, kelayakan finansial dan melakukan analisis sensitivitas terhadap sistem agroforestri yang diterapkan. Penelitian ini dilaksanakan di dataran tinggi Kabupaten Rejang Lebong, Bengkulu, dengan metode observasi lapangan dan wawancara. Data dikumpulkan melalui observasi, survei rumah tangga dan wawancara mendalam dengan beberapa aktor kunci untuk memperdalam informasi dan memverifikasi data yang telah diperoleh. Data dianalisis dengan menggunakan analisis deskriptif kuantitatif dan finansial. Hasil penelitian menunjukkan bahwa pengelolaan agroforestri kopi dengan kayu bawang di Kabupaten Rejang Lebong masih belum intensif. Petani mengelola lahan dengan cara tradisional. Meskipun demikian, sistem agroforestri tanaman kopi dan kayu bawang layak secara finansial pada tingkat faktor diskonto 8 % (NPV = Rp76.250.582; BCR 2,28 dan IRR 22%). Sistem agroforestri ini juga memiliki ketahanan yang baik terhadap perubahan harga kopi, produksi kopi dan harga kayu bawang. Sistem agroforestri masih layak meski produksi kopi menurun 30%, dan produksi kayu turun sebesar 30%. Perubahan produksi dan harga kopi adalah faktor yang paling berpengaruh terhadap kelayakan agroforestri tanaman kopi dan kayu bawang. Sistem agroforestri ini menguntungkan bagi petani. Oleh karena itu, pemerintah daerah harus mendorong masyarakat untuk menerapkan system ini.*

Kata kunci: Agroforestri, kopi, analisis finansial, kayu bawang

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I. INTRODUCTION

Coffee is the main commodity at the upland areas of Rejang Lebong Regency, Bengkulu Province especially along the mountainous region of Bukit Barisan Selatan. According to BPS Rejang Lebong (2013), coffee plantations are the major income source for 17,402 households and contributed substantially to the Gross Domestic Product (GDP) of the regency. About 29.99% GDP came from coffee, while 16.66% came from 16 other plantation crops in 2012 (BPS Rejang Lebong, 2013). Coffee plantation covers about 23,656 ha with annual production of 14,344 tons (BPS Bengkulu, 2013). Coffee has an important role in the local economy of this area.

Coffee grows well under a canopy of tropical forest plants such as *Erythrina lithosperma* and *Gliricidia sepium* (Wrigley, 1888 in Sari, Santoso, & Mawardi, 2013). The cultivation of coffee under shade tree is a form of agroforestry system which increases the overall yield of the land and also combines the production of agricultural crops and forest plants on the same unit of land (King & Chandler, 1978). Jose (2009) mentioned that agroforestry system is able to enhance and maintain long-term soil productivity and sustainability, improve air and water quality, and increase biodiversity conservation that in the long run can reduce poverty. Agroforestry can improve the quality of mammal's habitat, so that it can be a strategy for conserving wildlife and protecting biodiversity (Caudill, Declerck, Husband, & Rica, 2014). Furthermore, agroforestry system can also provide a source of income for farmers. Hence, it can increase food sufficiency for the community (Pandit, Shrestha, & Bhattarai, 2014). The use of shading tree improve coffee beans' productivity and enhance soil nutrient cycle (Evizal, Tohari, Prijambada, & Widada, 2012; Perfecto, Rice, Greenberg, & Voort, 1996; Lin, 2008). Furthermore, Muschler, (2008) explained that there is a substantial improvement of coffee quality, such as higher weights of fresh fruits, larger beans, and higher rating for visual appearance, by shading tree. Therefore, agroforestry system provides not only an ecological advantage but also socio-economic and cultural advantages (Beer, Muschler, Kass, & Somarriba, 1998).

Shade trees which are commonly used for coffee plants in Rejang Lebong Regency are *Erythrina lithosperma* (dadap), *Leucaena leucephala* (lamtoro), *Falcataria mollucana* (sengon), *Melia azedarach* (mindi), and *Gliricidia sepium* (gamal). Those trees belong to Leguminosae family and have capability in binding N elements in the soil. In the last few years, marrango tree (*Azadirachta excelsa* Jack.) has been introduced in this regency as a shade tree for coffee plantations because marrango tree has been widely planted and generated high income in North Bengkulu Regency and Central Bengkulu Regency. The marrango tree has a mild-to-moderate canopy density (<30%). Thus, coffee plants can still receive enough sunlight to grow and produce coffee beans. Furthermore, marrango tree produces wood that can be used as construction timber and fuel wood. The demand of marrango tree wood is increasing, whereas the availability of this timber is getting scarce; consequently, the price of marrango tree is becoming expensive. Many farmers do not know yet the advantages of using marrango tree as shade trees for coffee plantations in agroforestry systems. Therefore, some promotional efforts to show that this practice can be a profitable and alternative ways are necessary. Because profit is one of the considerations in the process of innovation adoption and practice of agroforestry to be accepted by farmers (Franzel, Coe, Cooper, Place, & Scherr, 2001).

Financial analysis on agroforestry practiced by farmers is based on silviculture aspects or cultivation systems. This research is intended to find out whether the use of marrango tree for shading trees of coffee is profitable. Therefore it can be used to encourage farmers in practicing this cultivation system. This paper aims to analyze on agroforestry system of coffee with marrango tree. Moreover, the

analysis also included (1) calculation of financial feasibility of the agroforestry system, and (2) sensitivity analysis to find out the resistance of agroforestry of coffee with marrango tree to the changes of coffee price, coffee production and wood price of marrango tree.

II. MATERIAL AND METHOD

A. Study Sites

Field research was conducted in Rejang Lebong Regency, Bengkulu Province, and Pal 100 village and Dataran Tapus village in Bermani Ulu Raya Sub-district were selected for data collection (Figure 1). The two villages were selected purposely because people has applied agroforestry of coffee plants with marrango tree. Coffee is the main source of income for people who live in these two villages. The number of households was 389 in Pal 100 Village and 323 in Dataran Tapus Village. The area is located at 102019' – 102057' East Longitude and 2022'07" – 3031' South Latitude. Rejang Lebong Regency is located at altitude between 500 and 2000 meters above sea level (BPS Bengkulu, 2013). Topographical conditions of Rejang Lebong Regency are hilly and mountainous.

B. Data Collection

The data collection was carried out in May and October 2013. It included direct observations, household surveys, and in-depth interviews. Key actors for in-depth interviews included village head, forest extension, and head of farmers, and it was conducted to deepen the information and verify the collected data.

The number of respondents from the household survey was 27. They were purposely selected on condition that they planted or had at least 30 trees on each farmland. Since Rejang Lebong Regency is not the native growing area of marrango tree, farmers who plant marrango tree as shade tree for coffee is still limited, and some of them could not give enough information for this research. The collected data consists of respondents' characteristics (e.g. age, occupation, education, income, and owned land), land and crop management system, land prices, commodity prices, wood prices, and labor wage. Concurrently, secondary data, such as village monographs, community forest area, and other supporting data, were collected.

C. Data Analysis

Quantitative descriptive analysis, financial analyses, and sensitive analysis were employed to analyze the collected data. Quantitative

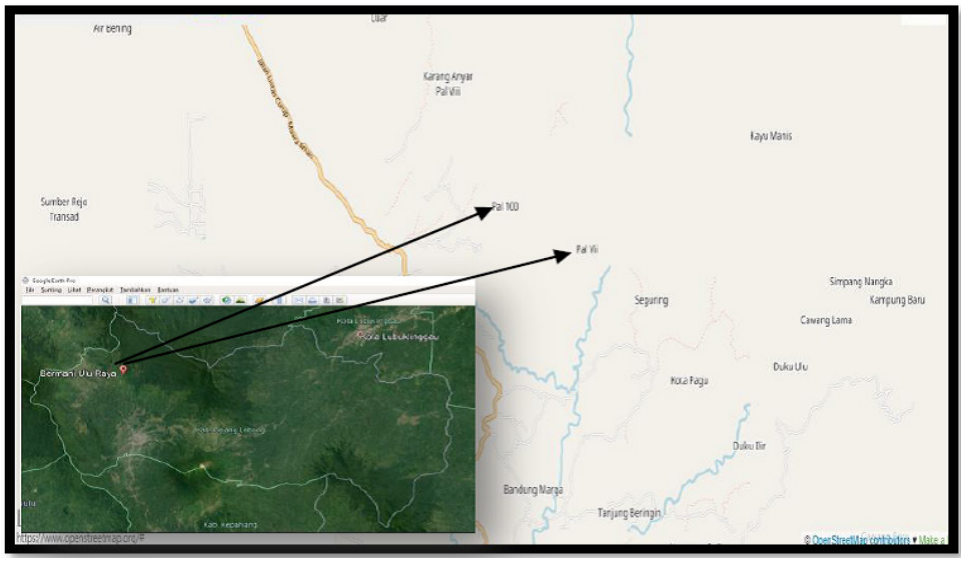

Figure 1. Map of the study area

Sources: https://www.openstreetmap.org; https:/www.google.com/ earth/

descriptive analysis was used to explain the management and cultivation practices carried out by the general farmers in the study site. Financial analysis was utilized to calculate the feasibility of agroforestry system applied by the respondents. The indicators of the financial analysis included Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit Cost Ratio (BCR) (Gittinger, 1982; Kadariah & Gray, 1999). In this study, the financial analysis was carried out by using the method of cash flow from the costs and revenues that were discounted. According to the key informants and most of the respondents, the rotation cycle of coffee was 20 years and marrango tree was 18 years. The stream of inputs (i.e. costs) and outputs (i.e. income) was adjusted based on the management undertaken by the farmers in the study area. Costs were calculated from the amount of the costs incurred from land clearing/land preparation through maintenance until the harvesting of marrango tree and the perennial crop. Costs incurred from land clearing for the annual maintenance of coffee and marrango tree were joint cost.

Assumptions for financial analysis (NPV, IRR, BCR) used in the study as incomes and expenses were based on key informants interview. The assumptions are as follows:

1. Price of land used in accordance with the conditions in the study site was IDR 20,000,000 depending on the location of the land and road access.
2. The maintenance was performed from the first year until the end of the cycle.
3. Labor wage per day in the location of study was IDR 50,000 - for men and IDR 35,000 for women.
4. Business analysis of coffee plant was until the age of 20 years and marrango tree will be harvested at 18 years with estimated results in cubic was 0.607 m^3 per tree.
5. The volume of marrango tree was calculated by using growth model of V = -0.9280-5.9624/A + 0.7295LnSi 1.1365LnN (Siahaan, Sumadi, & Saefuloh, 2012), where V is volume, A is age of the tree; N is number of marrango tree, and Si is the site quality with value of 19.5 (location of the study).
6. Coffee plants produced the fruit started at the age of 2-3 years, reached the harvesting peak at the age of 4-5 years, then decrease and reached a stable production at the age of 7 years. After 7 years, the coffee will be rejuvenated to get a new branching and will begin to bear fruit after 1.5 years. At the age of 20 years, timber and coffee will be harvested simultaneously and replaced with new plants.
7. Coffee price based on the market price received by farmers during the study time, i.e. IDR 15,000 per kilogram for dried coffee bean (after removing the skin).
8. The price of marrango tree was the standing tree price that the volume is estimated by the buyer. Price of processed wood (sawn timber) at the farm level was IDR 2,000,000 per m^3.
9. The cost of harvesting and processing the timber to get processed wood (board) was IDR 550,000 per m^3.
10. The yield of processing wood into processed wood (board) was 0.6 because one tree with a volume of 1 m^3 when processed into processed wood will produce 0.6 m^3.
11. The interest rate for consumer loans at Local Government Bank at Bengkulu Province was 12.39% (Bank of Indonesia, 2013). The inflation was 4.39 in 2008-2012 (BPS, 2013). The discount factor used for the analysis is the commercial bank interest rate (12.39%) – the annual inflation rate (4.39) = 8% (the real interest rate).

The sensitivity analysis was employed to determine the level of risk on conducting the agroforestry farming system. The indicators included the fluctutation of coffee and marrango tree production and price by 10% and 30%, either simultaneously or separately. Those levels of sensitivity were chosen based on the information from the farmers about the current condition.

III. RESULT AND DISCUSSION

A. Agroforestry System of Coffee with Marrango tree in Rejang Lebong Regency

In Rejang Lebong Regency, seasonal harvesting time of coffee is between April and August, and the peak of harvesting time is from May to June. The production ranged from 850 to 950 kg/ha and it depended on the managements by each farmer in which the number of coffee plants ranged from 2,500 to 4,400 per hectare. However, in the off-season, the coffee trees bear fruits in smaller amounts. Thus, farmers usually conduct intensive management and maintenance of the coffee plantations only a few months per year before and during the fruit season (i.e., harvest time). Because routine maintenance, such as weeding and fertilizing, does not require a huge number of labor, it was done by only housemakers. Outside the harvest season, the heads of farmer households would try to find additional income from off-farm activities, such as construction workers, farm workers and carpenters, both inside and outside of their village. This situation affects the condition of the land and coffee production of the farmers because they do not have enough time to take care of their land.

Marrango tree grows naturally in North and Central Bengkulu Regencies, and the local people cultivate marrango tree on their private land for long time. Marrango tree is planted as intercrops, alley cropping and borders plants, with main crops such as rubber, oil palm, cocoa, and coffee. Marrango tree is suitable tree plants for mixed-cropping system because it has a mild-to-moderate canopy and root system that do not interfere with the main crops. According to the District Office of Forestry and Plantation of Rejang Lebong Regency, marrango tree has been widely introduced to the farmers through land rehabilitation program by this institution since 2000.

The first step of agroforestry of coffee with marrango tree was land preparation, either by clear cutting or by line cutting. Generally the lands that will be planted by the crops are covered by shrubs. After land preparation and lands were ready for plant, planting of coffee and the timber were conducted. The planting of these plants were started simultaneously the beginning of rainy season. Planting space commonly used for coffee was 1.5m×1.5 m or 2m×2m and marrango tree was 6m×7m or 10m×10m. Farmers manured before or after planting to accelerate the growth of coffee plants.

Weeding was carried out by cleaning the grass and other weeds in both manually and chemically ways. This activity was performed depending on the conditions in the land. Most farmers did this activity four times per a year and more intensively when the harvest season of coffee is almost coming. Trimming of coffee plants was conducted once per a year after the harvesting process was completed. Trimming was implemented to reduce leaves and increase coffee fruits. Thinning of the shading plants was conducted when the plants were attacked by disease and to prevent the spread of disease. Pesticide is usually applied to protect from pests and diseases. However, only some farmers implemented all of these management activities due to their lack of knowledge, skill, and economic capabilities.

Farmers obtained information and knowledge about farm management from fellow and elders of farmers, extension workers as well as from traders of fertilizers and seeds. Farm management in coffee and marrango tree agroforestry was applied at the same time, so that the cost structure of coffee and timber in this agroforestry model cannot be calculated separatedly. The cost is counted as a joint cost for both coffee plants and marrango tree, for example coffee crop fertilization activities were conducted at the same time with the fertilization of marrango tree plants.

Simultaneous management of marrango tree and coffee plants could reduce labor costs and inputs such as fertilizers and herbicides. The standard recommended dosage and use of fertilizer was not followed by some farmers due

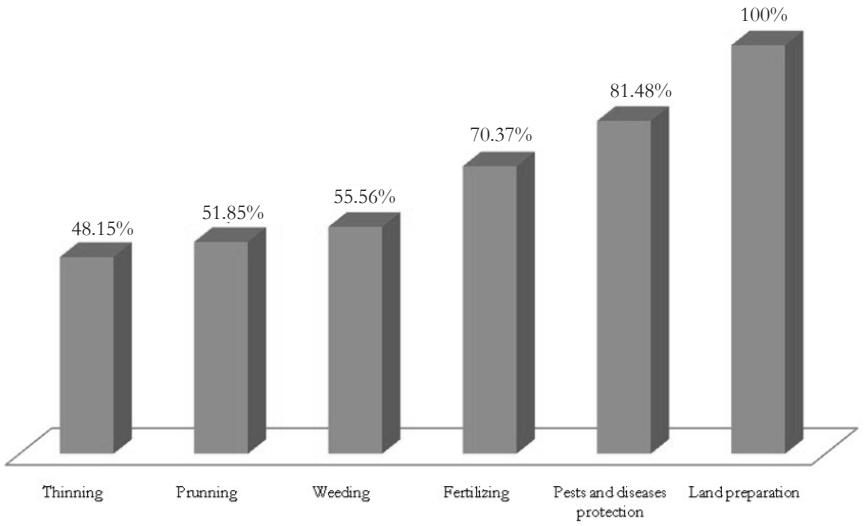

Figure 2: Distribution of respondents according to implemented management of coffee and marrango tree agroforestry

Sources: Processed data (2013)

to their lack of capital, both economical capital and human capital. Maintenance of marrango tree is conducted intensively at the age 1-3 years after planting. Routine maintenance was only for weeding and pruning branches, because marrango tree is more resistant to pests and disease. In terms of silviculture, intensification techniques, Bell et al.(2008) mentioned that the coffee plants and marrango tree agroforestry management could be categorized as the basic level cultivation headed toward intensive silviculture.

Figure 2 show that all respondents implemented land preparation (100%), 81.48% of them applied pest and disease protection/ control, and 70.37% of them conducted fertilization. However, thinning and pruning were conducted only by 48.15% and 51.85% respondents respectively. Based on interviews with some respondents, they did more intensive maintenance activities to coffee (pest and desease protection, and also fertilization). On the other hand, in terms of marrango tree, the maintenance activities were very limited. This result explains that agroforestry practice in Rejang Lebong Regency is still simple and semi-commercial, for which cultivation aspects to increase productivity such as selection of seeds, fertilization, weeding, thinning, pest control and proper harvesting system have not yet been conducted properly by farmers. Lack of information, knowledge, capital and access to markets are the limiting factors of farmers to apply the proper cultivation techniques.

B. Cost and Revenue of Agroforestry of Coffee with Marrango Tree

The cost of agroforestry of coffee with marrango tree consists of many inputs. Land preparation to get ready for planting takes some time, around 3-4 months, depending on the condition of the land, starting from the cutting of trees and stems, land clearing and fencing. Revenue of the agroforestry was calculated from the production of coffee and marrango tree as the major components. For other products income (e.g., vegetables, chili, tomato, etc) was not calculated because there were no accurate data available and they were only for self consumption. Moreover, it was only done by a few farmers in small quantities. The costs and revenues of agroforestry of coffee with marrango tree are presented in Table 1.

Establishment costs of the agroforestry of coffee with marrango tree included land investment, land preparation, seed procurement, planting, weeding, fertilizing and harvesting. The highest expenditure was harvesting of

Table 1: Cost and revenue from coffee and marrango tree agroforestry

No.	Cost Component	Unit	Frequency (Year)	Value (IDR/ Ha)	Proportion (%)
1.	Land investment	IDR/Ha	0	20,000,000	20.25
2.	Land preparation	IDR/Ha	1	3,350,000	3.39
3.	Seed	IDR/Ha	1	2,687,500	2.72
4.	Planting	IDR/Ha	1	10,400,000	10.53
5.	Handling	IDR/Ha	Yearly	6,300,000	6.38
6.	Fertilizing	IDR/Ha	Yearly	18,270,000	18.50
7.	Equipment	Unit	Yearly	2,240,000	2.27
8.	Harvesting				
	- Coffee	IDR/Ha	Average per year	2,121,000	2.15
	- Marrango tree	IDR/Ha	Once	33,385,000	33.81
	Sub Total			98,753,500	100
	Revenue				
	1. Coffee	IDR/Ha		227,250,000	65.18
	2. Marrango tree	IDR/Ha	The rotation is 18 years	121,400,000	34.82
	Sub Total			348,650,000	100
	Revenue - costs			249,896,500	

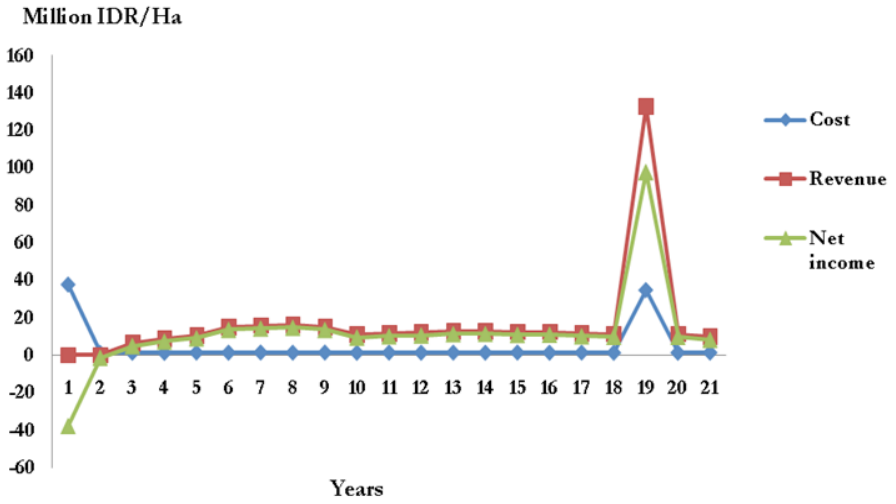

Figure 3. Cash flow of coffee and marrango tree agroforestry

Sources: Processed data (2013)

timber (33.81%), while the second was land investment (20.25%). Fertilization activities (inputs and wages) were relatively not too costly (18.50%) because this agroforestry model can maintain the soil fertility and nutrient availability. According to Mindawati, Kosasih, and Heryati, (2006), planting several types of forest crops can improve soil fertility by increasing the number and activity of microorganisms, and increasing the number of functions in the soil. This condition was in line with research results conducted by Lakshmi and Ammini, (2016); Sudomo and Handayani, (2013); Rao, Nair, and Ong (1998) who stated that agroforestry could improve the biophysical condition of the soil and also improve soil fertility. Land was included as a cost component because it was acquired by purchase and became part of the investment in which the value of the land will increase at the end of the cycle. Although some

Table 2. NPV, BCR and IRR of agroforestry coffee and marrango tree at discounted factor 8%

(Interest rate %)	Nominal value			Discounted value		NPV (IDR)	BCR	IRR (%)
	Total Cost (IDR/Ha)	Total Revenue (IDR/Ha)	Profit (IDR/Ha)	Total Cost (IDR/Ha)	Total Benefit (IDR/Ha)			
8	98,753,500	348,650,000	249,896,500	59,591,294	135,841,875	76,250,582	2.28	22

Sources: Processed data (2013)

farmers inherited the land from their ancestors without buying the land, this analysis assumed that all the farmers purchased the land.

Cash flow in the agroforestry of coffee with marrango tree is very dependent on the production of coffee crops per year, coffee commodity prices that often fluctuate during the harvest season, the price of marrango tree and climate that affect the quality and production. According to Slingo et al., (2005), climate change can affect the temperature and extreme precipitation that can influence the production and quality of crops, including coffee. Coffee production is the most influential factor in the analysis because it will be affected by climate and the management system. In addition, the price level also have an influence on the analysis as it is related to the availability/abundance of the commodity. Cash flow on the land use pattern also is influenced by the pattern of timber harvesting, land management systems, and biophysical conditions. Therefore, all of the risks that may affect the cash flow should be taken into account in the sensitivity analysis.

C. Financial Analysis of Coffee and Marrango Tree Agroforestry

Revenues were all incomes received from the perennial crop and timber (coffee plants and marrango tree). Income derived from intercrops in the early stages of the plantation, such as chilli, tomato and vegetables, was not included because data was not available at the time of the study. The amount of the revenue depends on the prices and production of coffee and timber. Perennial crop production varied each year depending on the age of the plant. It increases up to a certain age and decline the following year. In addition, the weather also affects the production and harvesting time of coffee. The production depend on the maintenance of the farmers, such as fertilization, weeding and pest control.

Units used in the assessment were per hectare unit. At 8% interest rate (discount factor), the NPV of the agroforestry of coffee and marrango tree was IDR 76,250,582; the BCR was 2.28 and the IRR was 22% (Table 2). These results showed that the agroforestry system of coffee with marrango tree was financially feasible to be developed.

The result of this financial analysis was in line with Siregar, Rachmi, Massijaya, Ishibashi, and Ando (2007), in which in East Java, agroforestry of sengon plants and agricultural crops also had a fairly high rate (17.53%) of benefits. Various studies also claimed that planting trees in coffee agroforestry is more profitable compared to the monoculture cultivation of coffee (Mehta & Leuschner, 1997; Kiyingi & Gwali, 2012; Ginoga, et al, 1999, Miller & Schaal, 2006; Schaller, et al, 2003). Other study mentioned that coffee agroforestry with different shading woody plants and Multi Purpose Tree Species (MPTS) also provides advantages from the standpoint of the farmers (Prasmatiwi, Irham, Suryantini, & Jamhari, 2010). In contrast, Saxena, (1991) expressed the opposite opinion that planting trees with annual crops would give negative results. Therefore, in the tree planting, the biophysical conditions, plant spacing and plant density should be considered to avoid the diminishing of the annual crop production. Bosselmann et al., (2009) and Schaller et al.

(2003) also stated that shading trees in coffee agroforestry reduce the production of coffee.

The proportion of revenue from timber was 34.82% and 65.18% from coffee. Wood product in this agroforestry model provided a large income at the end of the cycle even though wood is not the primary object to serve as a source of revenue. The quality and quantity of timber in this agroforestry model was not a major focus of the farmers due to the length of harvesting time. Wood products have functions to meet non-periodic needs and as savings.

Agroforestry systems can support better timber growth compared to natural forests, due to better input and also because of the reduction of light competition by setting desired plant density and plant canopy (Nath, et al, 2011). Furthermore, Nath et al. (2011) revealed that native tree planting is better than exotic trees. Campanha et al. (2005) stated that the growth of trees in agroforestry systems of coffee is quite good but the production of coffee is smaller than in monoculture cropping systems. Worku et al. (2015) explained that coffee production life will be longer and resistant to disturbances such as climate change in agroforestry system along with the trees. Those findings could be applied by farmers in agroforestry of coffee plants and marrango tree.

D. Sensitivity Analysis of Coffee and Marrango Tree Agroforestry

Sensitivity analysis is intended to examine a variety of potential changes and errors, as well as the impact of decisions described from the model (Baird, 1989 in Pannell, 1997). The sensitivity analysis was performed to see the flexibility and/or resistance and sensitivity of the business due to the change in inputs and outputs. Farmers are often faced with uncertainty in business due to the limited ability to predict the changes of the weather, the price and the biological response that affected their business practice (Pannell, Malcolm, & Kingwell, 2000). Climate change that has occurred in recent years led to a decrease in coffee production. According to Rosenzwei et al. (2001), climate change will affect crop production and the breeding of pests and diseases significantly. Coffee prices were fluctuating during the last few years, so it can affect the results of the analysis. In general, the price of wood including marrango tree has increased each year that were affected by the transportation costs and scarcity of wood. Results of the sensitivity analysis on agroforestry of coffee with marrango tree was shown in Table 3.

Table 3. Sensitivity analysis of coffee and marrango tree agroforestry at 8% discount rate

Agroforestry of coffee plants and marrango tree	Change (%)	Investment Criteria		
		NPV (IDR/Ha)	BCR	IRR (%)
Coffee production	-10	60,804,425.72	2.05	20
	-30	39,504,253.70	1.69	16
Marrango tree production	-10	68,804,425.72	2.19	22
	-30	64,144,783.82	2.11	21
Coffee and marrango tree price	-10; +10	58,263,261.40	2.01	20
	-10; +30	67,592,545.20	2.17	20
	-30; +10	41,835,574.65	1.73	16
	-30; +30	46,500,216.55	1.81	17
Coffee and marrango tree production	-10	58,263,261.40	2.01	20
	-30	32,506,290.84	1.56	15
Coffee and marrango tree production and price	-10; +10	56,001,908.45	1.97	18
	-10; +30	67,197,049.02	2.17	19
	-30; +10	22,254,182.61	1.39	12
	-30; +30	33,449,323.17	1.58	14
	-30, -30	9,772,886.98	1.17	10

The analysis showed that the decline in coffee production by 30% and a decrease in the production of marrango tree by 30% can still provide feasibility. From the NPV results above, we can observe that changes in the production and price of coffee is the most influential factor on the feasibility of agroforestry of coffee plants with marrango tree. This decrease in production is generally due to pest attack, season and plant maintenance. Based on the sensitivity analysis, the model of agroforestry was not sensitive to the changes that occurred when the production of coffee and marrango tree decreased up to 30% and the price only increased by 10%. Accordingly, it can be considered to be applied in the farmers' lands.

Since agroforestry system of coffee with marrango tree was beneficial for the farmers, local and central government can support the development of agroforestry system in the regency by utilizing their power, budget and regulation. In case of Japan, the government gave subsidy in order to improve people's timber business (Ota, 2001 in Rohadi, 2012). Thus, the community will have more eagerness to plant timber tree because there was an incentive for farmers in the form of loan with low interest rate and high quality seeds to increase productivity. In Rejang Lebong Regency as the study location, department of forestry and plantations had provided timber seeds to the communities in the 2000s with the consideration that marrango tree has good wood quality and can be used as shade trees for coffee plants.

IV. CONCLUSION

Farmers obtained information and knowledge about farm management from fellow farmers, the elderly, extension workers and also from traders of fertilizers and seeds. Management of agroforestry includes land preparation, planting, fertilization, weeding, pruning, thinning, pest and disease protection, and harvesting. However, only 21.62% of farmers implemented all of these farming management activities, due to their lack of knowledge, skill and economic capabilities.

Cost incurred for the development of agroforestry of coffee plants and marrango tree is IDR 98,753,500 per hectare for one cycle (20 years), while the revenue obtained during one cycle is IDR 348,650,000. The proportion of revenue from timber was 34.82% and from coffee 65.18%. Marrango tree has a smaller portion of the revenue than coffee, however, marrango tree still provided a quite large income at the end of the cycle.

Agroforestry of coffee plants and marrango tree was financially feasible at the level of 8% discounted rate. In which the NPV, BCR and IR were IDR 76,250,582; 2.28 and 22% respectively. The coffee and marrango tree agroforestry has a good resistance to the changes in coffee price, coffee production and wood price of marrango tree. Changes in the production and price of coffee are the most influential factors on the feasibility of the agroforestry system of coffee plants and marrango tree. Since agroforestry system of coffee with marrango tree is beneficial for the farmers, the local government should encourage the community to apply this system. However, this result applies only in Rejang Lebong Regency, Bengkulu province. Therefore, further analysis is needed if it will be applied to other locations.

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NUTRITIONAL COMPOSITIONS OF SIX EDIBLE INSECTS IN JAVA

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NUTRITIONAL COMPOSITIONS OF SIX EDIBLE INSECTS IN JAVA. Nutritional deficiency is still a problem faced by many families in Indonesia. One of the important issues is the level of protein consumption that is still below the minimum required standard. Edible insects could be one alternative of protein sources since their availability in the nature is quite abundant. This paper analyses six edible species of both cultivated and wild insects for its proximate compositions to measure their nutritional value. The cultivated insects consist of cricket (*Gryllus* sp.), giant mealworm (*Zophobas morio* F.), yellow mealworm (*Tenebrio molito*r L.), and silkworm (*Bombyx mori* L.), and the wild insects consist of javanese grasshopper (*Valanga nigricornis* Burm.) and paddy locust (*Nomadacris succincta* L.). Results shows that the nutritional composition of insects varies widely. Each 100g of dry weight contains of 32.59-76.69% of protein, 6.9-29.47% of fat, 0.92-30.76% of carbohydrate, 2.80-5.79% of ash, 407.34- 517.50 kcal of energy, and minerals about 24.82-31.22 mg of calcium (Ca) and 3.15-4.1 mg of iron (Fe). Some species such as grasshoppers, silkworm pupae and crickets have high protein content which potentially can be utilized as an alternate protein sources to fight against malnutrition and to increase nutritious food consumption. Efforts should be made to encourage the consumption of edible insects as an alternative source of protein. It is especially important to those who live in and around the forest, since the forest area is an excellent habitat for various species of insects.

Keywords: Insect, proximate analysis, nutritional value, food

*KANDUNGAN NUTRISI ENAM JENIS SERANGGA LAYAK KONSUMSI DI JAWA. Kekurangan pangan dan nutrisi masih menjadi persoalan yang dihadapi banyak keluarga di Indonesia. Salah satu persoalan penting dalam permasalahan tersebut yaitu tingkat konsumsi protein yang masih di bawah standar kebutuhan minimum. Serangga dapat menjadi alternatif terbaik penyedia protein hewani mengingat ketersediaannya di alam cukup melimpah. Tulisan ini mempelajari komposisi proksimat, potensi nutrisi, dan nilai gizi enam jenis serangga layak konsumsi, baik yang berasal dari kegiatan budi daya maupun yang berasal dari alam. Serangga hasil budi daya terdiri dari jangkrik (*Gryllus *sp.), ulat jerman (*Zophobas morio *F.), ulat hongkong (*Tenebrio molitor *L.), dan pupa ulat sutera (*Bombyx mori *L.), adapun serangga hasil tangkapan dari alam terdiri dari belalang kayu (*Valanga nigricornis *Burm.) dan belalang jerami (*Nomadacris succincta *L.). Hasil penelitian menunjukkan kandungan nutrisi masing-masing jenis serangga sangat bervariasi. Setiap 100g berat kering specimen serangga mengandung protein 32,59-76,69%, lemak 6,9-29,47%, karbohidrat 0,92-30,76%, abu 2,80-5,79%, energi 407,34-517,50 kkal, serta mineral Ca dan Fe sekitar 24,82-31,22 mg dan 3,15-4,1 mg. Beberapa jenis serangga seperti belalang, pupa ulat sutera, dan jangkrik memiliki kandungan protein yang tinggi sehingga sangat potensial untuk dimanfaatkan sebagai alternatif sumber protein dalam upaya memerangi masalah malnutrisi dan meningkatkan konsumsi makanan bergizi. Berbagai upaya perlu dilakukan untuk mendorong pemanfaatan serangga sebagai alternatif sumber protein hewani. Pemasyarakatan konsumsi serangga perlu dilakukan bagi masyarakat pedesaan dan yang tinggal di sekitar hutan mengingat kawasan hutan merupakan habitat beragam jenis serangga.*

Kata Kunci: Serangga, analisis proksimat, nilai nutrisi, makanan

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I. INTRODUCTION

Nutritional deficiency is still a problem faced by many families in Indonesia. Basic Health Research in 2013 revealed that malnutrition rates in infants reached 19.6%, consisting of 5.7% severe malnutrition and 13.9% moderate malnutrition. In 2010 it was recorded that about eight million children under five years old were stunted (body height is lower than normal child) due to less nutritional prevalence (Asthami, Estiasih, & Maligan, 2016). Hariyadi (2015) stated that the impact of malnutrition is not only related to inadequate consumption of calories but also the lack of various nutrient' intake which affect widely to the quality of life.

Protein is a source of nutrients that has an important role in the metabolism and biological functions in the body. Indonesia is one of the countries with low consumption of animal source protein, even at ASEAN level. Based on Protein Sufficient Value (PSV) derived from the population composition of 2010, it was obtained that the national PSV was about 57 g per person per day with 25% of them is recommended coming from animal source protein (Hardinsyah, Riyadi, & Napitupulu, 2013). The daily protein intake value is much lower than in developed countries that reach 96 g per person per day with much greater proportion of animal source protein with at least 65% of it is coming from meat (Mlcek, Rop, Borkovcova, & Bednarova, 2014). This situation occurred because of the inadequate supply of livestock in the country coupled with the low purchasing power of the local society.

Since there are risks that may occur in the future, various efforts should be continuously committed to improve the quality of dietary intake, including the need for animal protein from various sources which have not been utilized. Insects could be one of the best alternative animal protein source since their availability in the nature is quite abundant and many of them can be cultivated at a cheaper cost, both economically and environmentally (Payne, Scarborough, Rayner, & Nonaka, 2016).

Insect is a class of organisms that are very dominant among living creatures that exist on earth. Their number both species and population account for the greatest amount of biodiversity in the forest and many of them have long been harvested for food (Durst & Shono, 2010). It is estimated that more than 2000 species of insects are edible (Kouřimská & Adámková, 2016). These insects are dominated by the order of Coleoptera (beetles) 31%, Lepidoptera (butterflies) 18%, Hymenoptera (bees/wasps) 14%, Orthoptera (crickets/grasshoppers) 13%, and other orders about 23% (van Huis et al., 2013). As tropical country and owned the third largest forest areas in the world, Indonesia is a home of insects biodiversity and many of them are edible which could be utilized to fulfil the need of protein inadequacy.

Entomophagy (eating insects) has became a common practice in some African, Asian and Latin American countries (Pal & Roy, 2014). Currently, entomophagy is practiced in 113 countries in the world (Kouřimská & Adámková, 2016). Thailand is the most successful country in Asia that provide insects as food commodity, even a popular menu in their daily meal (Halloran, Vantomme, Hanboonsong, & Ekesi, 2015). There are at least 164 arthropod species sold and traded in the traditional markets to super market in Bangkok (Pal & Roy, 2014).

The habit of eating insects has long been done by some people in some regions in Indonesia (Bodenheimer, 1951). In some areas, entomophagy is still practiced nowadays such as in teak forests in Central and East Java Provinces during caterpillar (*Hyblaea puera* Cramer) attack, local communities are looking for the pupae for food (Lukiwati, 2010). In Molucca Islands and Papua, some people commonly consume the larvae of sago beetle (*Rhynchophorus bilineatus* Montrouzier) (Ramandey & van Mastrigt, 2010). While in some areas of Gunung Kidul Regency, Yogyakarta Special Province, grasshoppers became daily menu of dishes and sold everyday.

Insects are well known for being rich in nutrients, containing proteins, carbohydrates, fats, minerals and vitamins (Durst & Shono, 2010; Mlcek et al., 2014). Some species are

known to have nutritional value comparable to meat and fish, some of which contain higher levels of protein, fat and energy values (Alamu, Amao, Nwokedi, Oke, & Lawa, 2013). Each type of insect contains protein in different percentages, which generally is of high quality and easily digested (Ramos-Elorduy et al., 1997). This paper studies the nutritional value of insects commonly consumed by some communities and some species that have been cultivated for other purposes (primarily as animal feed) but considerably appropriate for human consumption.

II. MATERIAL AND METHOD

A. Study Site

This study was conducted in October and November 2016. Six specimens of insect were collected. Four species were cultivated insects, namely crickets (*Gryllus* sp.), yellow mealworm (*Tenebrio molitor* L.), giant mealworm (*Zophobas morio* F.), and silkworm (*Bombyx mori* L.). Two other species were captured from the nature i.e. javanese grasshopper (*Valanga nigricornis* Burm.) and paddy locust (*Nomadacris succincta* L.). These species were considered as edible insects according to several authors (Feng et al., 2018; Paul et al., 2017; Payne et al., 2016; Rumpold & Schlüter, 2013).

Samples of cultivated insects were collected from the area around Bogor, West Java. Cricket, yellow mealworm, and giant mealworm were purchased from pet shop, while silkworm pupae was obtained from silkworm farm. Samples of wild insects were obtained from Wonosari, Gunung Kidul Regency, where wild grasshoppers are traded and consumed daily.

B. Methods

All samples were oven-dried at 60-70°C for 12-24 hours (Makore, Garamumhango, Chirikure, & Chikambi, 2015; Tiroesele, Seletlo, & Moreki, 2013). Dry specimens were grounded separately and each specimen weighed 100 g for proximate analysis purposes. Proximate analysis were performed for the insect's body contents of protein, fats, carbohydrates, ash and energy. In addition, minerals were also analyzed for their content of iron (Fe) and calcium (Ca). The analysis of proximate and mineral compositions was conducted at the laboratory of Indonesian Center for Agricultural Post-Harvest Research and Development, The Agricultural Research and Development Agency, The Ministry of Agriculture.

The analytical method followed the procedure established by the Association of Offical Analytical Chemist (AOAC, 2005). Crude protein was determined using Kjeldahl method, fat analysis was performed using soxhlet method, ash was determined using gravimetry method, and the minerals were analyzed using AAS (atomic absorption spectrophotometer) method. The analysis of carbohydrate value was performed through calculation of the difference between 100 and the sum of the percentages of water, protein, fat and ash. The energy was calculated by multiplying the mean values of fat, protein, and carbohydrate contents by their respective calorific value based on conversion factor from Atwater, that is 9 Kcal/g for fat, 4 Kkal/g for protein, 4 Kcal/g for carbohydrate.

C. Analysis

Data were tabulated and analyzed descriptively by comparing the nutritional value of insects between species obtained in the study with similar species obtained from other research results, both domestically and abroad, as well as with other food stuffs.

III. RESULT AND DISCUSSION

Result showed that nutrient content of insect varied widely between species. Proximate analysis showed that the nutritional value of insects varies among species. Table 1 shows the value of insect proximate compositions (protein, fat, carbohydrate, ash, and total energy) in 100 g dry weight.

The results of this study reconfirm the results of previous research (Ghosh, Lee, Jung, & Meyer-Rochow, 2017; Payne et al., 2016), suggesting that the nutritive value of insect

Table 1. Nutritional contents of some edible insects in 100 g dry weight

Specimen	Stadia	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)	Energy (Kcal)
Javanese grasshopper (*Valanga nigricornis* Burm.)	Imago	76.69	6.90	9.62	2.80	407.34
Paddy locust (*Nomadacris succincta* L.)	Imago	65.42	10.91	15.48	3.26	421.79
Cricket (*Gryllus* sp.)	Imago/nymph	32.59	29.16	30.76	4.25	515.84
Silkworm (*Bombyx mori* L.)	Pupae	60.03	29.47	0.92	5.79	509.03
Giant mealworm (*Zophobas morio* F.)	Larvae	49.96	28.98	14.21	3.41	517.50
Yellow mealworm (*Tenebrio molitor* L.)	Larvae	38.30	26.72	26.25	4.10	498.68

varies greatly among the species. In fact, the same species but from different regions have different nutritional values as shown in Table 2. According to Kouřimská and Adámková (2016) and Adámková et al. (2017), the nutritional value of insects is influenced by many factors such as diet, climatic condition and stage of insect (egg; larvae; nymph/pupae; adult/imago).

A. Protein

The protein content of the insect samples ranged from 32.59 to 76.69%. Grasshoppers was found to have the highest percentage

Table 2. Nutritional composition of some insects from different region

Species	Species	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)	References
Valanga nigricornis	-	-	-	-	-	No data available
Nomadacris succincta	Indonesia	24.40	1.50	-	-	Lukiwati (2010)
	Thailand	27.60	4.70	-	-	Yhoung-aree (2010)
Gryllus sp.	Indonesia	56.00	32.00	-	-	Adámková et al. (2017)
	South Korea	58.32	11.88	-	9.69	Ghosh et al. (2017)
	Unknown	20.10	15.06	-	-	Payne et al. (2016)
Bombyx mori	South Korea	52.58	19.21	23.41	4.80	Kim et al. (2017)
	Thailand	9.60	5.60	2.30	-	Sirimungkararat et al. (2010)
	Thailand	14.70	8.30	-	-	Yhoung-aree (2010)
	India	48.70	30.10	-	8.60	Rumpold & Schlüter, (2013)
	Mexico	58.00	35.00	-	4.00	Rumpold & Schlüter, (2013)
	Unknown	14.80	8.26	-	-	Payne et al. (2016)
Zophobas morio	Indonesia	46.00	35.00	-	-	Adámková et al. (2017)
	USA	43.13	40.80	-	3.50	Rumpold & Schlüter, (2013)
	USA	46.79	42.04	-	2.38	Rumpold & Schlüter, (2013)

Species	Species	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)	References
Tenebrio molitor	Indonesia	52.00	31.00	-	-	Adámková et al. (2017)
	Indonesia	48.00	40.00	-	3.00	Yulianingsih & Al Awwaly (2015)
	South Korea	53.22	15.36	-	3.88	Ghosh et al. (2017)
	South Korea	49.80	37.11	9.60	3.50	Kim et al. (2017)
	USA	47.18	43.08	-	3.08	Rumpold & Schlüter, (2013)
	USA	49.43	38.07	-	2.84	Rumpold & Schlüter, (2013)
	USA	49.08	35.17	-	2.36	Rumpold & Schlüter, (2013)
	Mexico	47.70	37.70	-	3.00	Rumpold & Schlüter, (2013)
	Belgium	-	31.97	-	-	Paul et al. (2017)
	Belgium	-	6.90	-	-	Poma et al. (2017)
	Unknown	19.40	12.30	-	-	Payne et al. (2016)

of crude protein for every 100 g dry weight, while cricket had the lowest. The difference of protein content between the lowest and the highest values is quite big which is about twice of the lowest.

Insects are highly effective organisms in converting food into body proteins (Feng et al., 2018). Protein is the main content of insects and its percentage varies depending on the species, level of individual development, sex, feed type, climate, and geographical location. Among six species of insects analyzed, crickets have the lowest protein content, which is about 32.59%. Nevertheless, the percentage is much higher than the lowest value of insect protein content recorded by researchers such as Banjo, Lawal and Songonuga (2006), Chen, Feng and Chen (2009), Rumpold and Schlüter (2013). This suggests that all six specimens tested are considered viable to be used as an alternative protein source, since the highest protein content of vegetable sources is only 35.8%, ie soybean (Rumpold & Schlüter, 2013).

B. Fat

Similar to protein, total fat content was also found to vary between 6.90-29.47%. Silkworm pupae contained the highest body fat in each 100 g dry weight, while the smallest was of the javanese grasshopper. The difference of grasshoppers' body fat with other insects is considerably high. Grasshoppers have much lower fat content, which is only a quarter or one third of other insects.

Fat is a large nutritional component found in insects after protein. Fat is important not only because it could act as an energy producer, but also as a provider of essential fatty acids and some types of fat-soluble vitamins (Paul et al., 2017). According to Rumpold and Schlüter (2013), the fatty acids content in most insects are predominantly unsaturated fatty acids. Binkoski, Kris-Etherton, Wilson, Mountain and Nicolosi (2005) mentioned that fatty acids of the PUFA (poly-unseturated fatty acids) group are important and indispensable for lowering cholesterol levels in the body. In this study, no measurements and calculations of the content of each type of fatty acids were recorded, so the value of saturated fat (SFA, saturated fatty acid) and unsaturated fat (UFA, unsaturated fatty acid) remain unknown, either in the form of PUFA or MUFA (mono-unsaturated fatty acid) in each insect sample. However, according to DeFoliart (1991), the type of fatty acid in

insects has a level of unsaturation comparable to poultry and fish but contains a higher type of PUFA. Siriamornpun and Thammapat (2008) reported that the fatty acids of edible insects in Thailand are mostly in the form of PUFA, but others are dominated by MUFA type. The authors said that the total concentrations of PUFA are comparable to those found in meat and some fish, and much higher than in fresh vegetables. Thus it can be said that in terms of fat content, insect is a healthy foods. However, although there is no evidence of any accumulation of fatty acids that are toxic, for food safety it is necessary to identify certain unknown constituents of fatty acids in insects (Paul et al., 2017).

C. Carbohydrate

Carbohydrate content varies between species of insects, ranging from 0.92 to 30.76% per 100 g dry weight. The lowest percentage was identified in the silkworm pupa, while the highest was found in crickets.

Insects generally contain low carbohydrates. Siriamornpun and Thammapat (2008) explained that the carbohydrate content of several species of insects in Thailand ranges from 7-16%, comparable to some insects in Nigeria which contain about 7-20%. In this study, it is below 20% on average except for cricket and yellow mealworm. According to Chen et al. (2009) as cited from Sun (2007) insects contain polysaccharides that is sufficient to increase the immune system in the human body. In addition, because it is classified as low-carbohydrate-high protein (LC-HP), insect diets are highly beneficial for reducing the risk of cardiovascular disease and for the purpose of weight loss (Siriamornpun & Thammapat, 2008).

D. Ash

Although ash content shows variation between insect species, the differences among the species are not too much. The percentage of ash content per 100 g of dry weight ranges between 2.8% (the lowest) and 5.79% (the highest). The lowest percentage was found in the javanese grasshopper, while the highest was in silkworms.

E. Energy

The value of energy shows that the number varies with the highest value reaching 517.5 kcal found in giant mealworm, and the lowest was found in paddy locust about 407.34 kcal. Energy is a result of protein, fat, and carbohydrate metabolism and its value mainly depends on the fat content. Sufficient energy in meals is important to fully utilize protein in the diet to energize the growth, temperature control and physical activities (Hardinsyah et al., 2013) The high value of caloric content of insects shows that they could be used as complement to the diet in order to increase the intake of high quality protein and to guarantee the use of protein completely.

F. Mineral

The body of insects contain micronutrient, both minerals and vitamins, each of which has an important role in various biological processes within the organism, including the human body. Various types of minerals are found in insects such as iron, zinc, copper, calcium, potassium, magnesium and others (van Huis et al., 2013). The study found that mineral content of iron (Fe) and calcium (Ca) varies between species of insects. Table 3 shows the weight of two types of minerals per 100 g dry weight. Ca content ranges from 24.82 to 31.22 mg, while the Fe content ranges from 3.15 to 4.10 mg. The highest content of Ca is found in javanese grasshopper and the lowest is found in the giant mealworm, while the highest Fe content is found in the yellow mealworm and the lowest is found in paddy locusts. Both are essential minerals for human to help the body perform regulatory and structural functions. Iron is not only important for energy metabolism, it is also needed in the immune system, cognitive development, and in physical performance (Abbaspour, Hurrell, & Kelishadi, 2014). While calcium is essential for the maintenance of bone

Table 3. Fe and Ca contents of some edible insects per 100 g dry weight

Specimen	Stadia	Ca (mg)	Fe (mg)
Javanese grasshopper (*Valanga nigricornis*)	Imago	31.22	3.20
Paddy locust (*Nomadacris succincta*)	Imago	27.10	3.15
Cricket (*Gryllus* sp.)	Imago/nymph	25.49	3.25
Silkworm (*Bombyx mori*)	Pupa	29.17	3.54
Giant mealworm (*Zophobas morio*)	Larva	24.82	3.19
Yellow mealworm (*Tenebrio molitor*)	Larva	27.61	4.10

health during growing phases, the preservation of bone mineral density in elderly individuals (Shin & Kim, 2015) and the function of nerves and muscles to perform normally (Soetan, Olaiya, & Oyewole, 2010).

Iron (Fe) is a mineral that serves an important role in the formation of red blood cells. Fe deficiency causes anemia, a disease declared by the World Health Organization (WHO) to be the most common among people in many parts of the world, especially in developing countries (van Huis et al., 2013). Iron is classified as micro (trace)-element, a category for an inorganic substance that is required in a small amount (less than 100 mg/dl) in the body to maintain certain physicochemical processe for normal life (Soetan et al., 2010). According to Abbaspour et al. (2014), the average adult stores about 1-3 g of iron in his or her body and needs daily intake to replace the loss of it through stools, urine, and sloughing skin and mucosal surfaces. The loss of iron is approximately 0.9 mg in adult male and 0.8 mg in adult female.

Iron is one of many minerals contained in insects. Some species, such as *Locusta migratoria* and *Gonimbrasia belina*, even contain Fe much higher than beef (Bauserman et al., 2015; Oonincx et al., 2010). Iron content of insects also has higher solubility rate than that derived from beef (Latunde-Dada, Yang, & Vera Aviles, 2016). Iron and calcium contents are lower than the average value of both minerals in insects and beef analyzed by Latunde-Dada et al. (2016). According to Oonincx and van der Poel (2011), the mineral content of insects depends on the type of food. Nonetheless, data in Table 3 shows the iron content of all samples are much higher than the average loss of Fe in the daily life of both adult male and female. It means that the amount of iron in each species of insects is readily available to replace the loss of Fe to maintain the balance of its storage in human body.

In general the insects have nutritional values that is adequate to be used as food in term of their contents of protein, fat, carbohydrate and energy potential. The result is similar with those of Feng et al. (2018), who has documented the nutritional value of 174 insect species in China many of them belonging to edible insects category. Some species in our study even have much higher value than other food materials that are commonly consumed in the society. Table 4 shows the nutritional content of meat, fish, eggs, tempeh (fermented soybean cake) and tofu, the food which is commonly consumed by the community. Therefore, insects deserve to be taken into account to combating problem of malnutrition, especially in areas of deprivation and low purchasing power, and to ensure food security (Belluco et al., 2015; Gahukar, 2011; Ghosh et al., 2017; van Huis et al., 2013). Insects are not only able to provide adequate protein and energy and meet the needs of the amino acids that humans require, but also provide unsaturated fatty acids in the form of mono- and poly-unsaturated fatty acids that are good for the body and rich

Table 4. Nutritional composition of some commonly consumed foods

Food Materials	Protein (%)	Lipid (%)	Ash (%)	References
Beef	55	41	-	van Huis et al. (2013)
	20	7.2	-	Sirimungkararat et al. (2010)
	21.07	0.87	1.37	Prasetyo et al. (2009)
	22.83-23.31	4.17-4.23	1.14-1.31	Muliana et al. (2016)
Sheep	14.6	30.5	-	Lukiwati (2010)
	28.22	-	-	Anna (2014)
Pig	13	33.3	-	Lukiwati (2010)
	14.1	35	-	Sirimungkararat et al. (2010)
Poultry	20.5	4.3	-	Lukiwati (2010)
	20.8	2.4	-	Sirimungkararat et al. (2010)
	18.71	13.74	-	Sundari et al. (2015)
Boiled egg	12.58	-	-	Anna (2014)
	13.79-14.76	-	-	Mawaddah (2010)
Mackerel fish	18.44	11.14	-	Sundari et al. (2015)
Tilapia/ cichlid fish	12.94-16.79	0.10-0.18	-	Ramlah et al. (2016)
Tempeh	13.84	6.78	-	Sundari et al. (2015)
Tofu	10.1	6.06	-	Sundari et al. (2015)

in vitamins and minerals (Rumpold & Schlüter, 2013). Insects also contain iron in sufficient quantities to overcome the problem of anemia due to deficiency of mineral Fe (Latunde-Dada et al., 2016).

Result shows that insects are very worthy to be utilized as much as possible to fulfill human needs of food, especially as an alternative source of animal protein. Though the nutritional composition of insects varyies widely, but in general it provides satisfactory nutrients for human (van Huis, 2015). Currently, the attention of the world community to entomophagy has grown, partly triggered by FAO publication in 2013 of "Edible insects: Future prospects for food and feed security" (Hartmann & Siegrist, 2017; van Huis, 2015), although the use of insects as food has been practiced in various countries, predominately in developing countries. It is time for Indonesia as a tropical country with a high diversity of insects to put more attention to the use of insects as food. No doubt in reality most people still feel disgusted and reluctant to eat insects, although the culture of eating insects actually has long been living in some communities in various regions in Indonesia. Awareness campaign and socialization need to be done to the community, especially to those who lives in the forest surrounding, to utilize thoroughly the richness of insects in their sphere. Further research and studies are required to make insects more attractive to wider communities to consume.

IV. CONCLUSION

Each species of insect has variety of nutritional content. Each 100 g of dry weight contains 32.59-76.69% protein, 6.9-29.47% fat, 0.92-30.76% carbohydrate, 2.80-5.79% ash, 407.34- 517.5 kcal energy, and minerals Ca and Fe about 24.82-31.22 mg and 3.15-4.1 mg.

As the main ingredient of insect nutrients, protein content of some types of insects is relatively high. Hence, it is a potential alternative

to animal protein source other than meat and fish to increase protein intake. In addition, it is not only insects that come from the nature, some of the insects that have been cultivated have also the potential to be utilized as food, including silkworm pupae and crickets.

Insects could also be taken into account as food to fight against malnutrition problem and to increase nutrient intake given the nutrition contained in it is quite adequate. Efforts should be made to encourage the consumption of edible insects as an alternative source of protein. It is especially important to those who lives in the forest surrounding, since the forest area is an excellent habitat for various species of insects.

Considering that not all species of insects are edible, even some of them could be harmful to human health, data collection and more in-depth research are continuously needed to produce a list of insects which are edible and worthy.

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CONSUMPTION BEHAVIOUR OF FARMER HOUSEHOLDS IN RURAL SUMBAWA, INDONESIA

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CONSUMPTION BEHAVIOUR OF FARMER HOUSEHOLDS IN RURAL SUMBAWA, INDONESIA. The welfare level of farmer in rural Sumbawa was steadily low although the potency of natural resources at their vicinity was high. This paper determines the consumption behaviour as well as the welfare level of farmer households in rural Sumbawa, Indonesia. The household size, years of education, and farming incomes were used as indicators of on-farm performance. This research was carried out in February until April 2015 at two separate forest areas which were administratively under Labuhan Badas village, i.e. community forestry (HKm) in the state production forest and private owned forests (POF). A number of 34 respondents per location were purposively selected. The multiple linear regression was implemented to analyze factors affecting farmer household consumption behaviour, while the exchange value for income earned by farmer (EVIF) was incorporated to measure the welfare level. The regression revealed that the consumption behaviour at two groups of respondents were positively related with three indicators, i.e. household size, years of education, and farming incomes. Meanwhile, the household size affected the consumption behaviour of the HKm farmers but not the POF farmers. Furthermore, the consumption is strongly affected by the income generated from both forest areas. The EVIF approach revealed that the welfare of whole farmers were still low (EVIF = 0.74-0.99). The government, therefore, should subsidize rain fed paddy and tobacco seeds varieties which are suitable with the local climate, while the farmers are trained to process the flesh of cashew fruit into wine or chips and encouraged to cultivate calliandra trees for apiculture development and wood pellet or charcoal production.

Keywords: Farmers, on-farm performance, private owned forest, state forest, welfare

POLA KONSUMSI RUMAH TANGGA PETANI DI PEDESAAN SUMBAWA, INDONESIA. Tingkat kesejahteraan petani di pedesaan Sumbawa tetap rendah meskipun potensi sumberdaya alam di sekitar mereka tinggi. Penelitian ini mempelajari faktor-faktor yang mempengaruhi pola konsumsi dan tingkat kesejahteraan petani pedesaan Sumbawa, Indonesia. Ukuran rumah tangga, lamanya pendidikan, dan pendapatan dari usaha tani digunakan sebagai indikator dari kinerja lahan pertanian. Penelitian ini dilakukan pada bulan Februari sampai April 2015 pada dua areal hutan yang terpisah dimana secara administrasi berada dalam Desa Labuhan Badas yaitu: hutan kemasyarakatan (HKm) di dalam area hutan produksi negara dan hutan milik (HR). Di tiap lokasi, sebanyak 34 responden dipilih secara sengaja. Analisis multilinear regresi digunakan untuk menganalisis faktor-faktor yang mempengaruhi pola konsumsi, sementara itu nilai tukar pendapatan rumah tangga petani (NTPRP) digunakan untuk mengukur tingkat kesejahteraan. Regresi mengungkap bahwa pola konsumsi petani di dua areal hutan berkorelasi positif dengan ketiga indikator. Sementara itu, ukuran rumah tangga mempengaruhi pola konsumsi petani di HKm, tetapi tidak di HR. Selanjutnya, pola konsumsi dipengaruhi oleh pendapatan usaha tani di kedua areal hutan. Melalui pendekatan NTPRP diketahui bahwa tingkat pendapatan seluruh petani masih rendah (NTPRP = 0,74-0,99). Oleh karena itu pemerintah sebaiknya mensubsidi bibit padi tadah hujan dan bibit tembakau yang varietasnya sesuai dengan iklim setempat, sementara itu petaniya sebaiknya dilatih untuk mengolah daging buah jambu mete menjadi anggur dan kripik, didorong menanam pohon kaliandra untuk pakan lebah madu dan bahan pembuatan pelet kayu atau arang.

Kata kunci: Petani, kinerja lahan pertanian, hutan milik, hutan negara, kesejahteraan

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I. INTRODUCTION

The behaviour of consumption could reflect more realistic depiction about farmer welfare levels (Larsen, 2007; Ibragimov, Ismagilov, & Molotov, 2014), as by scrutinizing those patterns it could be indicated what kind and amount of consumption they would perform. Until recently, poverty still becomes the major issue for rural communities in Indonesia. Like other places in Indonesia, Sumbawa also has strength and weaknesses in terms of natural resources potency. This island is even being famous with their specific non-timber forest products (NTFPs) such as bee's honey and cashew nuts. However, the income of forest farmers in rural Sumbawa was steadily low.

Food consumption behaviour of forest farmers in Indonesia was less ideal since farmers consumed only more rice than other carbohydrate sources to meet their nutrition need (Damora et al., 2008). This fact makes the government programme to reach food security goal in Indonesia is more difficult. They even like to spent more money to consume less healthy goods such as tobacco. The amount of income earned by particular households which was further spent on food items could be used as a reliable indicator to estimate their welfare. The greater the expenses of particular households for food consumption, the lower would be their welfare level, and vice versa (Purwantini, 2012).

The income level of surrounding forest community who managed the state production forest at Labuhan Badas village was suspected lower than the income level of the farmers who managed their private owned forest. This was due to the regulation for the state forest management which was more complicated than the ones for the private owned forest. In the state forest area, under specific regulation named community-based forest management (CBFM) which control some conditions such as tree composition, pattern of plantation, time of harvesting and forest yields sharing, the community-based forest (HKm) farmers received limited right and access in cultivating the land. Based on the rule, the HKm farmers must cultivate the land with vegetation ratio of 50%: 30%: 20% between trees: multipurpose tree species (MPTS): cash crops, respectively. Furthermore, the HKm farmers are not permitted to harvest trees before harvesting time, except the fruits from MPTS plants and cash crops. The situation was different for the private owned forest where farmers are able to harvest their forest products at any time they need. The low income of HKm farmers makes them very vulnerable falling into middlemen traps. Under middlemen control, their bargaining position is very low resulting lower farmer's annual income. Consequently, the welfare level of HKm farmers as well as the quality of forest environment is getting worse.

The amount of household consumption was affected by several factors, which comprised: income of household, household size, years of education (Kedir & Sookram, 2011), as well as, and availability of goods consumed (Hupkova et al., 2009). Those factors would affect the behaviour of consumption at different intensity. With those limiting factors, it prompts the farmers to make the best decision in order to fulfil their household's needs. By having information about consumption behaviour, the threat to the farmer's economy and the degradation of the environment could be anticipated earlier and therefore some solutions could be prepared.

Evidence has showed that HKm poverty could be successfully combated by implementing appropriate management programmes such as the HKm farmers in Lampung who could reach the prosperous level (Yulian et al., 2016). This fact encourages us to explore the determinants of consumption behaviour of HKm farmers at Labuhan Badas village in order to improve their welfare level as well as the environmental quality. This paper studies consumption behaviour of farmer households in rural Sumbawa, together with the assessment on the possible factors that might affect those behaviour.

II. MATERIAL AND METHOD

A. Site Description

The study was conducted at two separate forest areas, i.e. 1) the community forestry (HKm) in the state production forest, and 2) the private owned forests (POF) nearby the state production forest. Both of them were administratively under Labuhan Badas village (080 47.244' S, 1170 32.959' E), Sumbawa Regency (Figure 1). The study was carried out in February until April 2015.

The state production forest areas have been occupied by people originated from Lombok who inhabited the area to practice agroforestry system by cultivating teak, mahagony, maize, rice, sesame seeds, soybeans, green peas, and pigeon peas. They manage the state forest under a special regulation namely the community-based forest management (CBFM) issued by the local government authority (Dinas Kehutanan dan Perkebunan Kabupaten Sumbawa), and then they were called as HKm farmers. Some of the HKm farmers periodically migrate to Lombok to visit their hometown or to search other additional incomes.

Meanwhile, the private owned forest area was resided by land owners (local people) who were also practised agroforestry system; they were called private owned forest (POF) farmers. They manage their own forest without any strict regulation from elsewhere. They freely cultivate any species of plants such as teak, mahagony, cashew, maize, rice, green peas and pigeon peas and harvest them whenever they need.

The cashew trees were found almost at any block of the both forests areas (HKm and POF). However, the farmers have not utilized the whole part of the fruit yet, but the nuts. Until recently, the flesh of fruit have not been consumed or processed become other valuable products, but just left become waste.

B. Methods

The samples comprised farmers who resided at the area of Labuhan Badas village. The respondents were categorized into two groups, namely (1) the HKm farmers, who performed agroforestry practise at the state forest; and (2) the POF farmers, who performed agroforestry at their own land. The total of 68 farmers from those two groups were selected by performing

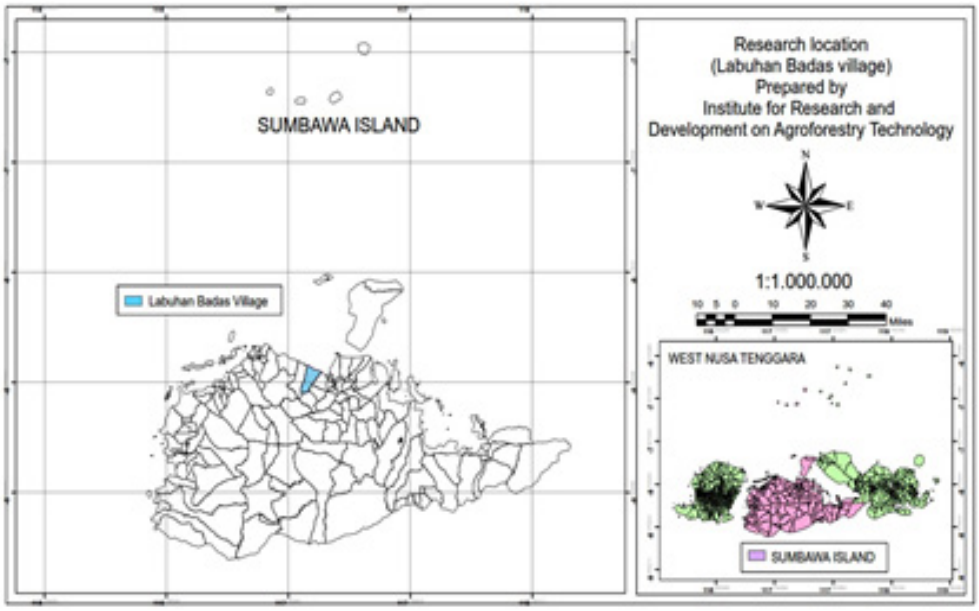

Figure 1. The research location (Labuhan Badas village) which administratively covers the HKm (in the state production forest) and the private owned forests (the POF)

the purposive sampling (Sugiyono., 2013). To become respondents, the farmers should meet some following criterias: a) being a member of the farmer group and practising agroforestry, b) understand the problems related with their plants, and c) cooperative. The number of respondents taken from each group (items 1 and 2) was equal (i.e. 34 farmers).

The primary data were obtained by performing interview and the focus group discussion (FGD) techniques, which were likely performed at qualitative and quantitative research approaches (Morgan & Harmon, 2001). Type of data consisted of (1) food and non-food consumptions, (2) years of education of the households head, (3) households size and (4) amount of income earned by households. The obtained data were grouped, commensurated with the research aims, tabulated and further analysed.

C. Analysis

The descriptive analysis was employed to provide a reliable illustration about the patterns of consumption spent by farmer households. The results would bring out information about the farmer consumption behaviour as well as the attempt that should be carried out by farmers to meet their consumption needs and the incentives associated with the aid strategies that should be provided by government.

The multiple linear regression (MLR) was implemented to examine the factors affecting the consumption behaviour by farmer households. In this method, the expenses for the consumption of food and non-food items - in IDR/year (Y) by farmer household was hypothesised to be influenced by household size - in persons (X_1), years of education of the households head - in years (X_2), and annual income - in IDR (X_3). The general formula for MLR equation with regard to the consumption behaviour $Y = f(X_1, X_2, X_3)$ together with the coefficient of determination (R^2) (Equation 1 and 2) were as follows (Misbahuddin & Hasan, 2013):

$$Y = \alpha + b_1X_1 + b_2X_2 + b_3X_3 + \varepsilon \quad \text{.....(1)}$$

$$R^2 = \frac{SSR}{SST} \quad \text{.....(2)}$$

where:
R^2= coefficient of determination; SSR= Sum square of regression; SST= Sum squares of total

The analysis was performed using the software package SPSS 13.0.

The quantitative analysis was also employed to analyse the welfare levels of farmer's household. The criteria regarding such welfares were modified from the Parity Ratio developed by Tomek and Kaiser (2014), using the quantitative measure of the so-called exchange value for the income of farmer households (EVIF). The EVIF value as such implied the capability measurement of farmer households in satisfying their subsistence needs. The EVIF value represented the ratio between total incomes and total expenses of households. Meanwhile, total incomes of farmer households referred to the summation results of all values generated from on-farm works (e.g. dry farming, farm worker, cattle raiser and off-farm works (e.g. stone/sand searcher, assistant, truck driver, trader, building laborer, employees, delivery from spouse or children). On the other hand, the expenses spent by farmers were the summation of their expenses for household consumption and their expenses for production costs. The EVIF was measured by calculating incomes earned from agriculture efforts (Y_p), plus incomes earned from non-agriculture efforts (Y_{np}), divided by expenses for agriculture efforts (E_p) plus expenses for non-agriculture efforts (E_{np}) as performed in Equation 3.

$$EVIF = \frac{[Y_p + Y_{np}]}{[E_p + E_{np}]} \quad \text{.....(3)}$$

The decision criteria are as follows: if the EVIF value was greater than one, it would imply that the welfare level of households belonged to a prosperous category. Conversely, if the EVIF value less than one, it would indicate that the household welfare was still not regarded as prosperous category (Yulian et al.,

2016). Furthermore, t-test was implemented to evaluate the difference on annual total consumption between the HKm farmers and the POF farmers. The analysis was performed using the software package SPSS 13.0.

III. RESULT AND DISCUSSION

A. Expense for Consumption

The expense spent by households could reflect their consumption pattern and figured out their welfare level. The structure of expense by farmer households consisted of three types, covering expenses for food, non-food items (e.g. clothing, school fees, house repair, health) and fuels. The greatest amount of expense for food was for cereal consumption (especially rice), which in portion reached consecutively 53.62% (by the HKm farmers) and 36.83% (by the POF farmers). This indicated that the HKm farmers were still at the level of satisfying their basic needs for their life, while the rest of their expenses were used to meet consecutively the non-food and fuel consumptions. This situation was commensurated with the particular research conducted by Randy, Rudi, and Herwanti (2016) in Sumber Agung village which inferred that the necessity levels for food by farmers were greater than those for non-food items.

Income level of farmer households influenced the choice on food to be consumed (Sosa et al., 2015). The households with low income would rather consume food with more varying composition (Drewnowski & Specter, 2004; Zentková & Hošková, 2011a), while the households with middle-up income preferred to choose less varying food (Pusposari, 2012). It means that households with low income usually more tolerate in consuming any kind of junk food as well as tradisional food. Nonetheless, all those cases apparently did not apply to the research location, in this regard, although the income level of the HKm farmers was low, they preferred consuming rice. The main reason was, as the limiting factor, the natural condition did not allow the land to be cultivated with alternative-food crops. Consequently, no other choices but rice become their main food.

Tobacco consumed by the HKm farmers was the second biggest expense after rice, which in portion corresponded to 12.17%. However, for the POF farmers, the portion was smaller (10.36%). That expense closely related to the health awareness indicated by the portion of health expense was only 4.82% (for the HKm farmers). Tobacco smoking was not only an expensive behaviour but also lead to broader impact on the wellbeing of smokers with limited financial resources (Widome et al., 2015). However, the HKm farmers seemed did not consider those. However, such high tobacco consumption was not associated with lower level of happiness or higher level of depression as investigated by Churchill and Farrell (2017), but it was attributed to the preparation activities for the planting season. The cigarettes were needed to neutralize the cool air blowing during the activities for land cultivation.

The expense for health maintenance by the HKm household was very limited; it was IDR 177,600 per year or 4.82% of non-food items need. This expense was even less than half portion for health maintenance by the POF farmers which reached 10.73%. The HKm farmers preferred to take traditional medicines instead, that flourished abundantly in the nature. They would only visit the physician, if their sickness persisted and could no longer be cured by traditional medicines. It might relate to Srivastava and McGuire (2015) statement that low-income patients would experience access problems, raising important policy implications to improve access to health care and medicines.

The clothing necessities for the POF farmers were mostly provided by their relatives and their children. This made the expenditure for clothing of the POF farmers was relatively small. Conversely, the expenditure for children education was quite high as both farmer groups unexpected their children to experience the living situation like them.

Nearly all activities of the farmers were performed using gasoline-powered two-

Table 1. Average amount of expenses for the consumption of food, non-food, and fuel items by farmer household per year

Group of items as consumed	Farmers			
	HKm		POF	
	Amount (IDR)	(%)	Amount (IDR)	(%)
A. Kinds of food items as consumed				
1. Rice	3,780,000	53.62	4,310,000	36.83
2. Animal Protein	792,000	11.23	1,910,000	16.32
3. Vegetation protein	168,000	2.38	1,470,000	12.56
4. Vegetables + fruit	564,000	8.00	990,000	8.46
5. Oil + fat	300,000	4.26	445,000	3.80
6. Beverages	252,000	3.57	813,000	6.95
7. Spices	240,000	3.40	400,000	3.42
8. Ready-consumed food	96,000	1.36	152,000	1.30
9. Tobacco	858,000	12.17	1,213,000	10.36
Sub-total A	7,050,000	100.00	11,703,000	100.00
B. Kinds of non-food items as consumed				
1. Education	1,572,000	42.70	1,812,000	40.12
2. House repair	690,000	18.74	888,000	19.66
3. Clothing	396,000	10.76	288,000	6.38
4. Health	177,600	4.82	484,800	10.73
5. Others	846,000	22.98	1,044,000	23.11
Sub-total B	3,681,600	100.00	4,516,800	100.00
C. Kinds of fuels as consumed				
1. Gasoline	431,000	67.55	286,000	50.18
2. Kerosene	207,000	32.45	284,000	49.82
Sub-total C	638,000	100.00	570,000	100.00
Total (A+B+C)	11,369,600	100.00	16,789,800	100.00

cycle vehicles due to the absence of public transportations. The expenditure by the HKm farmers on gasoline was about double than kerosene, while that expenditure by the POF farmers was almost similar. This difference occurred since the total distance of farm land that should be controlled by the HKm farmers was more remote than the farm land belonged to the POF farmers. Besides that, fire woods at the HKm forest were more abundant so that they could replace partial consumption of the kerosene. Unlike the HKm farmers, the POF farmers were able to process coconut fruits into the frying oil for complying with their cooking needs, thereby not only allowing them to cut down expenses, but also earning higher additional incomes. According to Ningsih, Suandi, and Damayanti (2012), the greater the income level of a person, the greater as well would be the consumption level. Their statement was commensurate with the condition of farmers at the research location, although the portions of the type of food consumed were different. In this case, the greater income of a person, the more they would abandon in rice purchasing. Crawford, Laisney, and Preston (2003) argued that the higher welfare of a person, the lower they would consume food stuffs; but the greater they would expend on luxurious and high-technology items).

Total expense of the HKm farmer household for consumption was smaller than that of the

POF farmer household. This condition was inline with Foss (2014) statement that HKm activities were often established in marginal or highly degraded areas and most of their incomes were for subsistence. Moreover, enforcement of implementation rules in HKm agreement i.e. designing plants composition and timber harvesting schedule tended to limit access to forest products harvesting. According to Hkm agreement, the composition of 50% woody trees, 30% multipurpose tree species (MPTS) and 20% cash crops should be employed and farmers were not allowed to cut the trees before the harvesting time. Those all constraints have caused the incomes of HKm farmers remained low which lead to low expenditure as well.

B. Determinants of Consumption Behaviour

The following three factors i.e. household size (X_1), years of education (X_2), and the income (X_3) impacted almost equally on the household consumption expenditure (Y) both for HKm and POF farmers Table 2.

Based on the MLR analysis, the consumption by the HKm household (Y) of 67.08 % could be explained by household size ($X1$), years of education ($X2$), and annual income (X3); while the rest of it (32.92%) was due to unexplainable factors, which were regarded as errors. Likewise, the corresponding figures for the POF farmers were consecutively 70.39% (as explained by those three factors) and the rest of it (29.61%) were due to unexplainable factors).

The annual income became the most dominant factor affected farmer households consumption expenditure. Therefore, it was confirmed that relationship between the income and the consumption belonged to strong category, under the situation where the effect of household size and years of education were assumed to be constant. On the other hand, effect of years of education on household consumption seemed to be the weakest. Therefore, the relationship between years of education and consumption for both farmer groups belonged to very weak category.

Similarly, the effect of household size on the consumption for the POF farmers was far weaker than for the HKm farmers despite both revealing a positive relationship. This weak effect was due to the good items which should be compensated by household especially food consisted of shared items as also reported by Jacobson et al., (2010). However, the way of how the household size affected the equally consumption for the HKm farmers appeared to be rather different from the way for the POF farmers.

Based on the regression model, supposed that farmers had no responsibility to their household members, or acting as household head only ($X_1 = 1$); uneducated ($X2 = 0$); and no income ($X_3 = 0$), then the consumption of HKm farmers was far greater than the consumption of the POF farmers, i.e. IDR 2,552,080/year and IDR 1,085,574/year respectively or with the ratio of 2.35: 1.00. These figures asserted more strongly that limitation in access to natural resources provoked HKm farmers to meet their living needs by spending expenses as much as twice greater than that of POF farmers. The

Table 2. The summary of multiple linear regression analysis regarding households' consumption

No.	Farmer Group	Regression	R^2 (%)
1.	HKm	$Y = 1{,}638.256 + 868.823.7X_1 + 126.489X_2 + 0.705X_3$	67.08
		Significant Level (0.19) (0.23) (0.00)	
2.	POF	$Y = 288{,}044 + 797.529X_1 + 255.420X_2 + 0.631X_3$	70.39
		Significant Level (0.04) (0.06) (0.00)	

Remarks:
Y= Consumption by farmer households/(IDR per year); X_1= Household size (persons); X_2 = The years of education (years); X_3 = Incomes (IDR); ry.123 = Correlation coefficient

ratio also indicated that such limitation for the HKm farmers was more severe than for the POF farmers. Such condition, therefore, it should overcome by providing HKm farmers with opportunities to develop alternative agriculture cultivation for their daily needs, or by introducing apiculture (honeybees on calliandra calothyrsus) to increase their incomes. This is by considering that calliandra trees can grow fast in almost any types of soils and at wide range of climate, including at the research location; and moreover, the market for bees honey was already available widely. Alternatively, government could encourage farmers to decrease their expenses for rice and tobacco by subsidising them with rain fed paddy and tobacco seeds which were suitable for local condition. The Virginia tobacco has been introduced in West Nusa Tenggara and these varieties have high yield and quality, less cost productions, uniform colour of mature leaf, and are able to grow well at extinction area (Suwarso et al., 2009).

Other potential commodity was cashew trees that grew widely, almost at any block on the research locations. However, the economic value of the abundance of cashew nut has not been utilized optimally. The farmers harvest only the nuts, and left the flesh of fruit. The flesh of fruit can actually be processed to become other valuable products such as chips or wine. Learning from this condition, provision of practical training related to food processing could be more profitable for the farmers. However, to make the economic value of the product works properly, the availability of market has to be facilitated by government. Agriculture sector could be a potential source of income to support expenditure for majority of persons (48.4%) such as occurred in Zimbabwe (Zimbabwe National Statistics Agency, 2011).

Since consumption was viewed as a production activity and the household as a small firm, years of education could not significantly improve the productivity in this small firm (Juster, 1975). It was due to limited resources availability and lack of access to technology.

C. Welfare Level of Farmer Households

Welfare level of the farmers are necessarily assessed in order to obtain a figure of whether or not the development program set forth by the government was already accomplished evenly and enjoyed by the farmers. To examine the welfare indicators, this assessment used quantitative criteria, i.e. the so-called exchange value for the income earned by farmer households (EVIF). The EVIF value which was figured out from the earned incomes, expenses for consumption, and expenses for input production costs (on-farm and off-farm costs) could provide description about the welfare level which could be achieved by households (Table 3).

The values of EVIF which were calculated against the total expense for both farmer groups, each of them revealed the figure less than one (EVIF = 0.74 - 0.99), indicating that all farmer groups at the research location still could not be categorized as prosperous in satisfying their subsistence needs. There was no difference on annual total consumption between the HKm farmers and the POF farmers, as shown in t-test in Table 4. This condition was also supported by Sajogyo (1997) who stated that poverty line was indicated by income per capita equivalent to exchange value of 320 kg rice/capita/year. As the price of rice per kg in research location was IDR 8,000 per kg and the size of households averagely 4 persons, the poverty line would fall on IDR 10,240,000 per year. Although the income of POF farmers were much higher than the HKm farmers, however their total expense were also high. The average of land size managed by POF farmer was 1.75 ha which was higher than land size managed by HKm farmers (1.01 ha). According to Vidiawan and Tisnawati (2015), the welfare level could serve as one of the indicators associated with the development of poverty condition, in which the more decreasing the poverty level implied the more increasing the welfare of community would be.

Production costs expended by two farmer groups were low, and they considered that plant

Table 3. Exchange value for the income earned by a farmer household per year at Labuhan Badas village

Descriptions	Farmers	
	HKm (IDR)	POF (IDR)
A. Incomes (I+II)	9,961,500	19,625,000
I. Agriculture incomes	3,531,500	8,247,000
1. Agriculture Endeavours	2,622,500	6,800,000
2. Farming labour wage	909,000	1,447,000
II. Non-agriculture incomes	6,430,000	11,378,000
1. Non-agriculture endeavour	6,430,000	11,378,000
2. Non-agriculture labouring	-	-
B. Production costs	2,021,000	3,105,000
1. Agriculture	215,000	1,100,000
2. Non-agriculture	1,806,000	2,005,000
C. Consumptions	11,369,600	16,789,800
1. Food	7,050,000	11,703,000
2. Non-food items	4,319,600	5,086,800
D. Total expenses, Summation : B + C	13,390,600	19,894,800
E. Exchange value for incomes		
1. Against the total expenses	0.74	0.99
2. Against the production cost	4.93	6.32
3. Against food consumption	1.41	1.68
4. Against non-food consumption	2.31	3.86
5. Against the total consumption	0.88	1.17

Remarks: *) Figures at aspects A, B, C, and D in equivalent value to IDR

maintenance was still very limited. Moreover, they used seedlings taken from their own land; and the labours were taken from their own family, thereby rendering the production costs to be almost none. It was different from the consumption needs which should be available every day, therefore this induced farmers to make vigorous efforts to earn incomes, to meet their needs for food and non-food consumptions.

The expense by household could become a reliable measurement of their incomes, whereby the greater amount of expense for non-food items indicated that the more welfare of the living condition of those farmer household would be (Prasetyoningrum, Rahayu, & Marwanti, 2016). Based on the EVIF analysis, the amount of income earned by the HKm farmers was still unable to meet their consumption necessities. Current attempts done by those farmers to cope with their consumption needs were periodically migrating to Lombok to search additional incomes or borrowing money or items from the small shops or neighbours. If farmers borrowed money from the shops, they would pay back when their harvest came or the money was available. However, if they borrowed items (kitchen ingredients, rice, and other kinds of food) from their neighbours, they would seldom return it. This was because for HKm farmers, their neighbours were already regarded as closest relatives to share both difficulties and pleasures. This situation was in accordance with the statement from Zhao (2014) who said that rural household choose income diversification pattern by referring to the surrounding neighbourhood; when most farm families depended on off-farm activities to boost their

Table 4. The result of t- test on annual total consumption between HKm farmer and POF farmer in Labuhan Badas village, Sumbawa.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	17,183	,000	1,851	66	,069	13408300,00000	7242982,61872	-1052781,38361	27869381,38362
	Equal variances not assumed			1,851	36,970	,072	13408300,00000	7242982,61872	-1267781,46479	28084381,46479

income, the individual household was more likely to follow the surrounding households by participating in the off-farm.

Such brotherhood sense presumably caused the HKm farmers to become more capable to solve their living difficulties. In addition, policy to provide incentives to the HKm farmers would seem to be easier to realize, because there is already a strong network, where their characters were more homogenous than the POF farmers. More importantly, the HKm as well as the POF farmers were potentially organized to contribute to the national food security programme by developing agroforestry system.

IV. CONCLUSION

Findings of the research revealed that value of income strongly influenced the consumption of farmers living in the state production forest area (the community-based forest/the HKm) and the private owned forest (the POF) in rural Sumbawa. Size of household and years of education indicated the weaker affect to farmer consumption. The community-based forest farmers (HKm) earned lower annual income than that of the private owned forest farmers. This condition combined with limited access to natural resources made the community-based forest farmers were unable to consume more varied food, and prefer to consume rice. It was due to rice that has been the only easiest carbohydrate sources to find in the state forest area either by cash or by borrowing from others.

To improve the welfare level of the two farmer types, there are two strategies that could be taken simultaneously by the farmers i.e. pressing the expenditure as well as improving the incomes. Both strategies were designed by prioritizing utilization of resources abundance of in their vicinity.

The expenditure of farmers could be decreased by reducing the amount spent for rice and for tobacco consumption. Government could support the farmer efforts by subsidizing them with rain fed paddy seeds and tobacco seeds of Virginia Hybrid varieties which are not only suitable for the West Nusa Tenggara climate but also produce high yield to meet high demand of cigarette industries. Meanwhile, income of the farmers could be increased by cultivating calliandra (*Calliandra* spp.) trees for developing apiculture and also utilize calliandra wood for wood charcoal or wood palled materials, which already has established market. Furthermore, the government has to facilitate training for the farmers on how to process the flesh of cashew fruit into products with higher economic value such as wine and chips. More importantly, the government should also develop further and generate new market to facilitate and simplify product marketing from the farmers.

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GUIDELINE FOR AUTHORS

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In Text Citation :

Water is a necessary part of every reasons's diet and of all the nutrient a body needs to function, it requires more water each daya than any other nutrients a body needs to function, it requires more water each day than any other nutrient (Whitney & Rolfes, 2011)

Or

Whitney and Rolfes (2011) state the body requires many nutrients to function but highlight that water is of greater importance than any other nutrient.

IJFR TEMPLATE

TITLE SHOULD BE CONCISE, INFORMATIVE, AND CLEARLY REFLECT THE CONTENT OF THE MANUSCRIPT

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TITLE SHOULD BE CONCISE, INFORMATIVE, AND CLEARLY REFLECT THE CONTENT OF THE MANUSCRIPT. The abstract should not exceed 250 words. The abstracts should be self-explanatory. It must include the reason for conducting the study, objectives, methods used, results and conclusion. Objective should briefly state the problem or issue addressed, in language accessible to a general scientific audience. Technology or Method must concisely summarize the technological innovation or method used to address the problem. Results should bring a brief summary of the results and findings. Conclusions should provide brief concluding remarks on your outcomes.

Keywords: Four to six keywords should be provided for indexing and abstracting. The word or term overviews the issues discussed, written in alphabetical order, separated by commas

JUDUL HARUS RINGKAS, INFORMATIF DAN SECARA JELAS MEREFLEKSIKAN ISI MANUSKRIP. Tuliskan terjemahan abstrak dalam bahasa Indonesia. Abstrak tidak lebih dari 250 kata. Abstrak menjelaskan keseluruhan isi artikel. Abstrak meliputi maksud, tujuan penelitian, metodologi yang digunakan, hasil dan kesimpulan. Maksud penelitian harus menjelaskan secara ringkas permasalahan yang diteliti menggunakan bahasa ilmiah umum yang mudah dimengerti oleh pembaca. Teknologi atau metodologi yang digunakan untuk pemecahan permasalahan penelitian harus dicantumkan secara lengkap dan ringkas dalam abstrak. Ringkasan hasil penelitian dan temuannya ditampilkan dalam ringkasan singkat. Kesimpulan harus menyatakan outcome yang dicapai dalam kegiatan penelitian.

Kata kunci: Empat sampai enam kata kunci untuk keperluan indeksasi dan abstraksi. Setiap kata mencakup isu yang dibahas dan diurutkan secara alphabet dipisahkan oleh tanda koma

Note:
- There should no nonstandard abbreviations, acknowledgements of support, references or footnotes in the abstract.
- In case of authors from one institution, footnote numbering is not necessary.

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I. INTRODUCTION

State the objectives of the work and provide an adequate background of the research objectives, avoiding a detailed literature survey or summary of the results. To prepare your manuscript, a template can be downloaded from: http://ejournal.forda-mof.org/ejournal-litbang/files/IJFR_Template.docx

Do not change the font sizes or line spacing to squeeze more text into a limited number of pages. Use italics for emphasis; do not underline. To insert images in Word, position the cursor at the insertion point and either use Insert | Picture | From File or copy the image to the Windows clipboard and then Edit | Paste Special | Picture (with "float over text" unchecked). IJFR will do the final formatting of your paper.

II. THEORY/CALCULATION (if any)

This chapter of theory/calculation is noncompulsory or optional. A theory or detailed calculation should be extended, not repeated, in the introduction. The theory of calculation (if any) mentioned should lay the foundation of the work.

III. MATERIAL AND METHOD

Provide sufficient detail of the research work to allow method to be reproduced. The material and method chapter can be divided into several sub-chapters.

A. Your Study Site/Location and/or materials

Describe the time and location of the study, materials and tools used as well as research method.

B. Your Methods

Methods already published should be indicated by a reference. Specific location should include the geographical information system. Only relevant modification to the method should be described clearly.

C. Your Analysis

Write the process of inspecting, cleaning, transforming and modeling data with the goal of discovering useful information, suggesting conclusions and supporting decision-making.

IV. RESULT AND DISCUSSION

Results should be presented clearly and concisely. Discussion should explore the significance of the results work to the current condition or other research result, but not repeating the result. References must be used to support the research findings and expected to be written at least in the last five years.

V. CONCLUSION

A brief summary of the possible clinical implications of your work is required in the conclusion section. Conclusion contains the main points of the article. It should not replicate the abstract, but might elaborate the significant results, possible applications and extensions of the work.

ACKNOWLEDGEMENT

Acknowledgement is a must for persons or organizations who that have already helped the authors in many ways. Sponsor and financial support acknowledgements may also be placed in this section. Use the singular heading even if you have many acknowledgements.

REFERENCES

At least 10 references are listed according to American Psycological Association (APA) referencing style, 6th edition. References must be listed in alphabetical order by another name. Eighty percent of references should be cited from primary sources and published in the last five years. To properly credit the information sources, please use citation tools such as Mendeley or EndNote to create a bibliography, references and in-text citations. Mendeley is a free reference manager that can be downloaded at https://www.mendeley.com/download-mendeley-desktop/.

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