ISSN 2355-7079
E-ISSN 2406-8195
No. 754/AU3/P2MI-LIPI/08/2016
No: 21/E/KPT2018

Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

Ministry of Environment and Forestry
Research, Development and Innovation Agency
Indonesia

Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

ANNALS OF THE INDONESIAN JOURNAL OF FORESTRY RESEARCH

Indonesian Journal of Forestry Research (IJFR) was first published as Journal of Forestry Research (JFR) on November 2004 (ISSN 0216-0919). The last issue of JFR was Volume 10 Number 2 published on December 2013. The Journal of Forestry Research has been accredited by the Indonesian Institute of Sciences since 2008. The last accreditation from Indonesian Institute of Sciences was on June 2016 (accreditation number: 754/AU3/P2MI-LIPI/08/2016) which will be valid until June 2021. IJFR also has obtained acreditation from Ministry of Research, Technology and Higher Education on 2018 (accreditation number: 21/E/KPT/2018) which will be valid until October 2020. IJFR will be issued in one volume every year including two issues which will be delivered every April and October.

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IMPRINT

IJFR is published by Research, Development and Innovation Agency (FOERDIA), Ministry of Environment and Forestry, formerly known as Forestry Research and Development Agency, the Ministry of Forestry Republic of Indonesia.
ISSN print: 2355-7079
ISSN electronics: 2406-8195
Electronic edition is available at:
http://ejournal.forda-mof.org/ejournal-litbang/index.php/IJFR

All published article are embedded with DOI number affiliated with Crossref DOI prefix
http://dx.doi.org/10.20886/ijfr

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Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

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Vol. 6 No. 2, October 2019

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Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

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Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

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Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

Acknowledgement

The Indonesian Journal of Forestry Research expresses sincere appreciation to all reviewers for selflessly contributing their expertise and time to the reviewing process, which is crucial to ensurethe quality and substantive impact of the journal. The journal's editors and authors are grateful for the reviewers' efforts in evaluating and assessing the articles submitted for of publication, regardless of the outcome (acceptance or rejection).

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Indonesian Journal of Forestry Research

Vol. 6 No. 2, October 2019

Contents

Indonesian Journal of Forestry Research

ABSTRACTS

ISSN 2355-7079 Vol. 6 No. 2, October 2019

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UDC/ODC 630*449:636.084

R Garsetiasih, Ragil Irianto, and Vivin S Sihombing

THE UTILIZATION OF *Merremia peltata* FOR LIVESTOCK FEED TO CONTROL AN INVASIVE ALIEN PLANT SPECIES IN BUKIT BARISAN SELATAN NATIONAL PARK

(*PEMANFAATAN* Merremia peltata *SEBAGAI PAKAN TERNAK UNTUK PENGENDALIAN SPESIES ASING INVASIF DI TAMAN NASIONAL BUKIT BARISAN SELATAN*)

Mantangan (Merremia peltata) adalah jenis tanaman yang menginvasi habitat satwa herbivora diantaranya gajah dan badak di Taman Nasional Bukit Barisan Selatan (TNBBS) Sumatera, Indonesia. Salah satu upaya pengendalian dilakukan dengan cara memanfaatkan mantangan sebagai pakan ternak. Tujuan penelitian ini untuk mengetahui potensi tanaman invasif mantangan sebagai pakan kambing. Penelitian dilakukan di Desa Tampang Tua yang merupakan zona penyangga TNBBS dimana sebagian masyarakatnya peternak. Penelitian dan perlakuan diberikan pada empat ekor kambing kacang umur 6-7 bulan dengan berat awal 7-8 kg. Pengumpulan data pemanfaatan jenis tanaman invasif mantangan sebagai hijauan pakan tambahan untuk kambing dilakukan selama tiga bulan mulai bulan Maret sampai Juni 2014. Penelitian menggunakan rancangan bujur sangkar latin dengan empat perlakuan dan empat ulangan. Perlakuan yang diberikan terdiri dari empat formulasi yaitu, perlakuan A (rumput lapangan), B (rumput lapangan + 200 g mantangan), C (rumput lapangan + 400 g mantangan), dan D (rumput lapangan + 600 g mantangan). Rumput lapangan tersedia secara terus menerus (ad-libitum). Hasil penelitian menunjukkan bahwa perlakuan berpengaruh nyata (P <0,05) terhadap tingkat konsumsi pakan namun tidak berpengaruh nyata (P> 0,05) terhadap berat badan, dengan kata lain mantangan berpotensi sebagai pakan ternak. Penelitian ini dilakukan sebagai salah satu upaya untuk mengelola tanaman invasif dengan memanfaatkan mantangan sebagai pakan untuk ternak.

Kata kunci: Invasif, mantangan, pakan ternak, TN Bukit Barisan Selatan

UDC/ODC 630*861.19:628.4.042

Siti Wahyuningsih

BIODEGRADATION OF PULP SLUDGE BY *Phanerochaete chrysosporium, Penicillium oxalicum AND Penicillium citrinum* AFTER SIX MONTHS INCUBATION

(*BIODEGRADASI PULP SLUDGE DENGAN* Phanerochaete chrysosporium, Penicillium oxalicum *DAN* Penicillium citrinum *SETELAH MASA INKUBASI ENAM BULAN*)

Meningkatnya produksi pulp dan kertas sebagai imbas kenaikan permintaan pasar akan menghasilkan komoditas dan juga hasil sampingan. Hasil sampingan seperti limbah pulp memiliki nilai ekonomi yang rendah dengan konsekuensi lingkungan yang tinggi, oleh karenanya, diperlukan teknologi untuk menambah nilai limbah pulp. Penelitian ini bertujuan untuk mengetahui kemampuan P. chrysosporium, kombinasi Penicillium oxalicum dan P. citrinum dan kombinasi ketiga jamur tersebut dalam mendekomposisi limbah pulp. Limbah pulp yang digunakan berasal dari perusahaan pulp di Sumatera Utara yang mendapat perlakuan pendahuluan sebelum pengomposan. Pengomposan dilakukan dengan menginokulasi jamur P. chrysosporium, kombinasi P. oxalicum dan P. citrinum dan kombinasi dari ketiga jamur tersebut dengan kerapatan 107 (spora/ml) ke dalam 15 kg limbah yang telah mendapat perlakuan awal. Kemudian, limbah yang telah diinokulasi tersebut diinkubasi selama satu dan enam bulan. Analisis dilakukan terhadap limbah yang tidak diinokulasi dan yang diinokulasi, terdiri dari analisa pH, cation exchange capacity (CEC) (me/100 g), hara makro (N, P, K, Ca and Mg)(%), hara miro (S, Zn) (ppm) and logam berat (Pb, Cd)(ppm). Setelah satu bulan inkubasi, P. chrysosporium dapat meningkatkan hara makro dan mikro dari limbah pulp. Namun, setelah enam bulan inkubasi, kombinasi dari P. oxalicum dan P. citrinum mampu meningkatkan kadar P, K, CEC dan mengurangi kadar timbal dari limbah pulp. Sedangkan, kombinasi dari ketiga jamur P. oxalicum, P. citrinum and P. chrysosporium memberikan kadar N dan Mg tertinggi.

Kata kunci: Limbah pulp, dekomposisi, P. chrysosporium, P. oxalicum, P. citrinumi

UDC/ODC 630*233:582.34

Safinah S. Hakim, Wawan Halwany and Dony Rachmanadi

FUNGI AND SOIL MACROFAUNA COMMUNITY IN REVEGETATED POST-FIRE PEATLAND IN CENTRAL KALIMANTAN

(*KOMUNITAS JAMUR DAN MAKROFAUNA PADA LAHAN GAMBUT BEKAS TERBAKAR DI KALIMANTAN TENGAH*)

Tanah gambut yang memiliki karakter fisika dan kimia yang unik merupakan habitat bagi berbagai macam mikroba dan fauna. Di tanah gambut, adanya mikroba dan makrofauna dipengaruhi oleh beberapa parameter lingkungan. Penelitian ini dilakukan dengan tujuan untuk mengetahui informasi tentang komunitas jamur dan makrofauna di lahan gambut bekas terbakar dengan berfokus pada dua hal yakni: Kelimpahan jamur tanah dan makrofauna tanah dan (ii) hubungan parameter lingkungan dengan komunitas mikroba yang ada. Pengenceran tanah dan metode perangkap sumuran digunakan untu mendapatkan sampel jamur dan makrofauna pada plot yang telah ditentukan yakni: lahan gambut bekas terbakar yang belum direvegatasi (A), lahan gambut bekas terbakar yang sudah direvegetasi 12 bulan (B), lahan gambut bekas terbakar yang sudah direvegetasi 21 bulan (C), dan lahan gambut bekas terbakar yang sudah direvegetasi 24 bulan (D). Kelimpahan jamur tanah yang didapatkan selama penelitian ini adalah 4×105 cfu/ml hingga 11×105 cfu/ml dan kelimpahan makrofauna adalah 353-1038 individu/m^2. Kelimpahan jamur dan makrofauna dipengaruhi oleh persentase penutupan tumbuhan bawah yang berhubungan dengan aktivitas revegetasi. Semakin tinggi persentase penutupan tumbuhan bawah, maka semakin tinggi pula kelimpahan jamur dan makrofauna tanah.

Kata kunci: Kelimpahan, kebakaran hutan, makrofauna, mikroba, gambut

UDC/ODC 630*911:347.236.1

Tuti Herawati, Esther Mwangi and Nining Liswanti

IMPLEMENTING FOREST TENURE REFORMS: PERSPECTIVES FROM INDONESIA'S FORESTRY AGENCIES

(*IMPLEMENTASI REFORMASI TENURIAL KEHUTANAN: PERSPEKTIF DARI BIROKRAT PELAKSANA PROGRAM*)

Program reformasi pengelolan hutan melibatkan banyak pihak dengan masing-masing peran dan kepentingannya, terutama birokrat pemerintah. Penelitian tentang peran birokrasi di dalam reformasi tenurial masih sangat terbatas. Studi ini mengkaji pelaksanaan program reformasi tenurial dari perspektif individu pelaksana di tingkat nasional dan sub-nasional di Indonesia. Penelitian dilakukan melalui wawancara

responden yang dipilih dari birokrat di tingkat pemerintah pusat dan daerah. Data dianalisis secara deskriptif kualitatif untuk mendalami aspek internal faktor birokrat pelaksana, penilaian mereka terhadap pelaksanaan program dan faktor penghambat serta pendukungnya. Sebagian responden menyatakan bahwa program reformasi tenurial hutan secara umum ditujukan untuk melestarikan atau memulihkan hutan yang rusak meningkatkan penghidupan masyarakat, dan menjamin hak akses masyarakat yang bergantung pada sumber daya hutan. Pelaksanaan program dinilai telah efektif dalam melindungi hak-hak masyarakat untuk mengakses, menggunakan, mengelola, dan mengambil manfaat dari hutan. Responden juga menunjukkan bahwa mereka telah memberikan perhatian khusus kepada kelompok berpenghasilan rendah tetapi hanya sedikit yang memberikan perhatian khusus pada kelompok perempuan. Kendala utama untuk pelaksanaan program terdiri dari: 1) keterbatasan anggaran; 2) kurangnya tenaga pelaksana; 3) prioritas yang berbeda antara nasional dan sub-nasional; dan 4) personil birokrat yang cepat berubah posisi. Secara keseluruhan, responden menyatakan bahwa sebagian (51–70%) program reformasi tenurial hutan di Indonesia telah berhasil diimplementasikan. Upaya penyelesaian konflik sebagai persoalan dasar dalam program reformasi tenurial dapat ditingkatkan melalui koordinasi dan kolaborasi diantara para pelaku program termasuk antar sektor di pemerintahan dan mitra pembangunan.

Kata kunci: Analisis birokrasi, tenurial hutan, implementasi, kendala, gender

UDC/ODC 630*839.813

Gunjan Patil

THE POSSIBILITY STUDY OF BRIQUETTING AGRICULTURAL WASTES FOR ALTERNATIVE ENERGY

(*STUDI PEMANFAATAN BRIKET LIMBAH PERTANIAN SEBAGAI ENERGI ALTERNATIF*)

Krisis energi global dikenal sebagai masalah terbesar di era baru. Penggunaan limbah pertanian dalam bentuk briket adalah pilihan alternatif terbaik dari sumber energi terbarukan. Tulisan ini mempelajari kemungkinan pemanfaatan limbah pertanian menjadi produksi briket dengan nilai kalor tinggi. Limbah utama yaitu ampas tebu, sekam kopi, jerami gandum, kulit kacang, sekam padi, jerami padi, tangkai jagung, tangkai bunga matahari, kulit kedelai, sabut kelapa, tongkat rami, kulit biji kastor, tangkai mustard, batang kapas dan limbah tembakau untuk energi dalam bentuk biomassa briket. Pengamatan dilakukan pada berbagai bahan baku dan briket bahan baku tersebut di Departemen Bioenergi, Universitas Pertanian Tamil Nadu, Coimbatore (Tamil Nadu), India. Penelitian menunjukkan adanya hasil yang sangat memuaskan setelah evaluasi perbedaan antara nilai kalor bahan baku dan briket bahan baku tersebut. Bahan baku limbah pertanian dan sisa limbah hutan berkisar 1.200-3.000 Kkal/Kg. Setelah dilakukan evaluasi, hasil pengamatan menunjukkan perbedaan siginifikan antara nilai kalor briket dan nilai kalor bahan baku. Bahan baku sekam padi menghasilkan 3000 Kkal/Kg dan briket sekam padi menghasilkan 3.200 Kkal/Kg. Demikian juga perbedaan diamati pada semua jenis limbah pertanian. Rasio output input diamati sebagai biaya efektif dan menguntungkan di semua parameter untuk petani. Produksi briket adalah teknologi yang muncul, ramah lingkungan, hemat biaya, dan menguntungkan untuk penggunaan residu pertanian. Pemanfaaan briket limbah pertanian dapat membantu petani untuk meningkatkan status sosial ekonomi dan penggunaan kembali limbah pertanian dengan tepat.

Kata kunci : Briket, penggunaan kembali, limbah pertanian, biomas, nilai kalori

UDC/ODC 630*714:594

Sri Lestari and Bambang Tejo Premono

INSTITUTIONAL AND MARKETING EFFICIENCIES OF DRAGON'S BLOOD MANAGEMENT IN BENGKULU PROVINCE, INDONESIA

(*EFISIENSI KELEMBAGAAN DAN PEMASARAN ROTAN JERNANG DI PROVINSI BENGKULU, INDONESIA*)

Rotan jernang adalah salah satu hasil hutan bukan kayu (HHBK) dimana jumlah pasokannya tergantung pada ketersediaan di alam dan permintaannya tidak dapat ditentukan. Penelitian ini bertujuan untuk mengetahui bagaimana kelembagaan, rantai nilai, dan efisiensi pemasaran rotan jernang. Data yang dikumpulkan adalah data primer dan sekunder yang dikumpulkan dengan metode snowball sampling dan wawancara. Selanjutnya, data dianalisis dengan metode deskriptif kuantitatif. Pendekatan ekonomi digunakan untuk mengetahui kelembagaan dari sistem pemasaran rotan jernang. Hasil penelitian menunjukkan bahwa hubungan dan perilaku pelaku pemasaran rotan jernang akan membentuk kelembagaan pemasaran dengan sistem patron-client, karena adanya ketidakseimbangan posisi dalam hal ekonomi, akses, dan informasi. Ada empat saluran pemasaran yang ada di wilayah penelitian. Keempatnya dapat dikategorikan efisien dimana nilai efisiensi pemasaran rata-ratanya adalah 17,86%. Rantai pemasaran yang paling efisien adalah saluran tiga dengan nilai efisiensi pemasaran terkecil yaitu 12,86% dan nilai farmer's share yang tinggi (62,86%), yaitu penjernang – pedagang tingkat desa – pedagang tingkat kabupaten – pedagang tingkat provinsi – eksportir. Hasil ini menunjukkan bahwa saluran pemasaran yang paling efisien adalah saluran yang menjual jernang dalam bentuk resin.

Kata kunci : Efisiensi pemasaran, kelembagaan lokal, Provinsi Bengkulu, rotan jernang

THE UTILIZATION OF *Merremia peltata* FOR LIVESTOCK FEED TO CONTROL AN INVASIVE ALIEN PLANT SPECIES IN BUKIT BARISAN SELATAN NATIONAL PARK

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Received: 14 November 2017, Revised: 2 September 2019, Accepted: 28 October 2019

THE UTILIZATION OF *Merremia peltata* FOR LIVESTOCK FEED TO CONTROL AN INVASIVE ALIEN PLANT SPECIES IN BUKIT BARISAN SELATAN NATIONAL PARK. Mantangan (*Merremia peltata*) is a plant species which invades the habitat of herbivorous animals such as elephants and rhinos in Bukit Barisan Selatan National Park (BBSNP) Sumatera, Indonesia. One possible way to overcome the problem is by providing *M. peltata* as livestock feed. This paper observes potential use of mantangan for goat feed. The study was conducted at Tampang Tua Village, a buffer zone of BBSNP where most of communities are farmers. The study and treatment were given to 6–7 months old goat breeders with an initial weight of 7–8 kg. Additional forage feed data were collected during March to June 2014. The research was designed as Latin Square Design with four treatments and four replications. The treatments consisted of four formulations: treatment A (field grass), B (field grass + 200 g mantangan), C (field grass + 400 g mantangan), and D (field grass + 600 g mantangan). Field grass is available continuously (ad-libitum). Result shows that the treatments significantly affect feed consumption level ($P < 0.05$), but it did not have significant effect to body weight ($P > 0.05$). In other words, mantangan is potential for animal feed. This research was conducted as an effort to manage invasive alien plant species by utilizing mantangan as feed for livestock.

Keywords: Invasive, morning glory, feed livestock, Bukit Berisan Selatan National Park

PEMANFAATAN Merremia peltata *SEBAGAI PAKAN TERNAK UNTUK PENGENDALIAN SPESIES ASING INVASIF DI TAMAN NASIONAL BUKIT BARISAN SELATAN. Mantangan (*Merremia peltata*) adalah jenis tanaman yang menginvasi habitat satwa herbivora diantaranya gajah dan badak di Taman Nasional Bukit Barisan Selatan (TNBBS) Sumatera, Indonesia. Salah satu upaya pengendalian dilakukan dengan cara memanfaatkan mantangan sebagai pakan ternak. Tujuan penelitian ini untuk mengetahui potensi tanaman invasif mantangan dengan menggunakannya sebagai pakan kambing. Penelitian dilakukan di Desa Tampang Tua yang merupakan zona penyangga TNBBS dimana sebagian masyarakatnya peternak. Penelitian dan perlakuan diberikan pada empat ekor kambing kacang umur 6–7 bulan dengan berat awal 7–8 kg. Pengumpulan data pemanfaatan jenis tanaman invasif mantangan sebagai hijauan pakan tambahan untuk kambing dilakukan selama tiga bulan mulai bulan Maret sampai Juni 2014. Penelitian menggunakan rancangan bujur sangkar latin dengan empat perlakuan dan empat ulangan. Perlakuan yang diberikan terdiri dari empat formulasi yaitu, perlakuan A (rumput lapangan), B (rumput lapangan + 200 g mantangan), C (rumput lapangan + 400 g mantangan), dan D (rumput lapangan + 600 g mantangan). Rumput lapangan tersedia secara terus menerus (ad-libitum). Hasil penelitian menunjukkan bahwa perlakuan berpengaruh nyata ($P < 0,05$) terhadap tingkat konsumsi pakan namun tidak berpengaruh nyata ($P > 0,05$) terhadap berat badan, dengan kata lain mantangan berpotensi sebagai pakan ternak. Penelitian ini dilakukan sebagai salah satu upaya untuk mengelola tanaman invasif dengan memanfaatkan mantangan sebagai pakan untuk ternak.*

Kata kunci: Invasif, mantangan, pakan ternak, TN Bukit Barisan Selatan

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 doi:10.20886/ijfr.2019.6.2.85-93

I. INTRODUCTION

Bukit Barisan Selatan National Park (BBSNP) is located in the south of Sumatera Island, between Lampung and Bengkulu Provinces, Indonesia. It covers about 365,000 hectares since it was established in 1982 by the Ministry of Agriculture. BBSNP conserves habitat for wild fauna including sumatran tiger, elephant and rhino. Mantangan infestation in this area is considered as one of the causes of animal migrations to rural areas in the north, such as tiger, elephant and sumatran rhino (Irianto & Tjitrosoedirdjo, 2010). Currently, it was reported that BBSNP had lost more than 20% of its original forest area and it has been facing serious threats of deforestation (Suyadi, 2011). This valuable remaining forest will become highly fragmented into isolated patches if current deforestation and encroachment rates continue.

The invading species has destroyed the local ecosystem and particularly farmers' plantations and grazing areas that also provided fodder for wild herbivores (deer, elephant, and rhinoceros). Such invasive action could result in a reduction in the available living and grazing space for these herbivores. Invasive Alien Species (IAS) is an alien species that have the ability to grow quickly on a massive scale and capable to alter the previous ecosystem (Pyŝek et al., 2015). It could surpass native species in fitness, size, and growth rate, thus reducing the living and grazing space for local herbivores (van Kleunen, Weber, & Fischer, 2010)

At present, biodiversity in Indonesia tend to decline and unless corrective management practices are adopted, about 20–70% of the original habitat will disappear (Bappenas, 2013). This situation also resulted in the destruction of habitat due to land conversion and an excessive exploitation and the occurrence of invader species, both native (local) and exotic. One overarching character of an invasive species is that it has no enemies that are naturally capable of controlling its population (Irianto & Tjitrosoedirdjo, 2010). *Merremia peltata* or locally know as mantangan is an invasive species that grown in conservation areas. *Merremia peltata* invaded the vegetation of Bukit Barisan Selatan National Park (BBSNP) in Lampung Province, Indonesia. In this site, the invasion has reached more than 7000 hectares (Mardiyati, 2018); this species grows very quickly in the open area and forest edges (Master et al., 2010; Yansen, 2015). The number of scientific papers about the growing threat of invasive alien species to native flora and fauna have been increasing in the last two decades (Thomaz et al., 2015).

In their new territories, alien species could expand their populations either regarding the geographical area and/or in terms of increasing frequency and density (Kolada & Sebastian, 2016). The destruction of habitat in BBSNP caused by invader species needs to be addressed immediately by providing best practice management and controlling mantangan. As part of the efforts to control mantangan it is also important to investigate the potential of this species as animal fodder. Mantangan is similar to Ipomoea generas (so-called kangkung locally), which is utilized as green fodder. In India, areas that have been invaded by mantangan are usually used by cows for grazing, and this provides one method of control in estates areas (Paynter, Harman & Waipara, 2006).

Controlling mantangan in BBSNP by using it as goat feedstuffs is important because this species can change the characteristic of the BBNSP's ecosystem, decrease the quality and quantity of wildlife habitat and this further will affect the pattern of wildlife behavior. Principally, this research used fresh mantangan's leave to determine effect of mantangan to body weight and level of goat's feed consumption. Research trials are needed on its use as fodder for herbivores, especially goats. The goat is one ruminant whose main food source is green field grasses (Kolada & Sebastian, 2016). Such field grasses are usually low in protein content, which is not sufficient for either domesticated or wild ruminant. This paper explores the

effect of mantangan to body weight and level of goat's feed consumption. This research was carried out using the domestic ruminant "bean goat" that has characteristics similar to deer both physically and biologically; Thus, if the goat is able to consume mantangan, then deer will do. The "bean goat" is an indigenous goat in Indonesia and has been widely domesticated elsewhere because it can easily adapt to new environments (Jaelani, Rostini, Zakir & Jonathan, 2014). Mantangan is an alternative livestock feed, other than field grass, to increase the nutrition content of feed.

II. MATERIAL AND METHOD

A. Study Site

The study was conducted in Tampang Tua Village, Kota Agung, Tanggamus District, Lampung Province, Indonesia (Figure 1). Research locations were determined by the distance between the village and Bukit Barisan Selatan National Park, and the majority of the people's livelihoods as a farmer.

B. Materials

The materials used in this research are field grass (such as buffalo grass (*Paspalum conjugatum*) and torpedo grass (*Panicum repens*)), libitum, mantangan's twig and leave, and goats. Four female bean goats aged six to seven months having a previous weight range estimated from 7 to 9 kg and have never been reproduced (Ismoyo & Widiyaningrum, 2008). They were housed in four separate cage enclosure panels (1.5 m x 1 m) with the walls and floor made from bamboo materials. Goats were fed with field grasses as their main green fodder with *M. peltata* (mantangan) as an added green supplement. Salt and fresh water were also made available to each goat. Other equipment consisted of an individual goat cage with a length of 110 cm, width 50 cm, height 80 cm, camera, digital scale with a weighing capacity of 2 kg, ordinary hanging scale with 50 kg capacity, and measurements recording on log book, and writing implements to record measurements.

C. Research Design

The experiment was conducted using latin square design with four replications and four treatments (Mattjik et al., 2002). The four treatments were: A: control (field grass ad libitum); B: field grass ad libitum + 200 g mantangan; C: field grass ad libitum + 400 g mantangan; and D: field grass ad libitum + 600 g mantangan.

Figure 1. Research location at Tampang Tua village, Southern Sumatera, Indonesia

The green foliar mantangan was fed at 7:00 am at the level according to each treatment. After the mantangan had been eaten by each goat, at 9:00 am field grass was made available. For each feeding of grass, the amount remaining was weighed and recorded and the new amount offered was weighed and recorded. All goats were initially weigthed prior to the experiment.

D. Data Analysis

The parameters measured were: (i) the consumption of fodder provided by subtracting the amount refused from the original amount offered at each feeding time plus any foliar mantangan according to the treatment used; and (ii) the body weight increment every 12 days were determined by weighing each animal using the 50 kg scales and substracting the previous weight. Data were analyzed quantitatively using the Minitab version 17 software package.

The mathematical model used was:

$$Yijk = \mu + \alpha i + yk + \sum ijk \quad \text{..... (1)}$$

where:

Yijk = value of measurements of treatment k at row i and column j
μ = mean value
αi = effect of goat i; I–Y
βj = effect of period j; I–Y
y.k = effect of treatment k; I–Y
$\sum eijk$ = base error

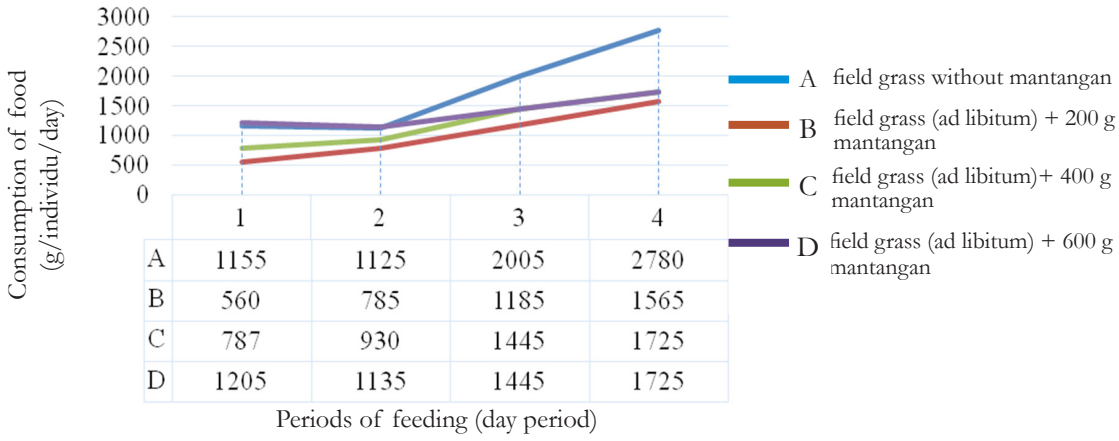
Treatments were tested for significance using convergence analysis (Tukey's method) according to Sall et al. (2005). The nutrient contents of the added green fodder (mantangan) were determined using proximate analysis or Weende analysis (Alikodra, 2010).

III. RESULT AND DISCUSSION

A. Average Food Consumption

The average consumption of each goat for each treatment is based on the total measurements for each 12 day period as shown in Figure 2. Figure 2 shows that the daily green fodder consumption trend was highest only with the field grass control treatment followed by treatment D (field grass + 600 g mantangan). In D treatment, the amount of field grass consumed was smaller than in any other treatment suggesting that 600 g mantangan was sufficient to compensate for any desire to eat more grass (available ad libitum) The green fodder requirement of herbivores is commonly 10% of the body weight (Tillman, Day, Soedomo, Suharto, & Soekanto, 1984). While the average daily consumption for the goat in this research was more than 10% of the body weight.

The statistical testing showed that there was a significant difference in body weight among treatments at a confidence level of $P<0.05$ (Table 3). The highest food consumption was achieved in treatment A (grass without mantangan), possibly because the main fodder of domestic goats is grass usually given daily so that the goats were fed according to custom



	1	2	3	4
A	1155	1125	2005	2780
B	560	785	1185	1565
C	787	930	1445	1725
D	1205	1135	1445	1725

Figure 2. Trend level of food consumption

Table 1. Average consumption of food per individual goats in each period of treatments (g/goat/day)

Goat	12 Day period				Total	Average
	I	II	III	IV		
1	A 1155	B 785	C 1 445	D 1975	5360	1340
2	B 560	A 1125	D 1645	C 1725	5055	1263.75
3	C 787	D 1135	A 2005	B 1565	5492	1373
4	D 1205	C 930	B 1185	A 2780	6100	1525
Total (g/individual/period/day)	3707	3975	6280	8045	22007	
Average	926.75	993.75	1570	2011.25		5501.75

Remarks: A: field grass without mantangan, B: field grass (ad libitum) + 200 g mantangan, C: field grass (ad libitum) + 400 g mantangan, D: field grass (ad libitum) + 600 g mantangan

Table 2. ANOVA food consumption

SC	DF	SS	MS	F-value	P-value	
					$\alpha = 0.01$	$\alpha = 0.05$
Periods	3	3156472	1052157	31.04	0.000	0.000^{n}
Goats	3	144419	48140	1.42	0.326	0.326^{tn}
Treatments	3	1252652	417551	12.32	0.006	0.006^{n}
Error	6	203373	33896			
Total	15	4756916				

Remarks: ^{n} = significant ; ^{tn} = not significant; SC = Source of convergence; DF: Degrees of Freedom; SS = Sum of squares; MS = Mean squares

in treatment A. Goats receiving a high-level of grass compared to goats receiving a high-level of grass mixed with legumes showed no significant difference with regard to the fodder consumed (Ngitung, Hasan, Sonjaya & Pakiding, 2013). This may have been because of the legume being fed was refused by the goats. Consumption will be greater for preferred fodder if it is fed continuously to ruminants as there is an increase in microbial activity and the rates of fermentation and digestibility, and the amount of consumption will increase (Aryanto, Suwignyo, & Panjono, 2013).

Treatments involving the addition of different amounts of green mantangan indicated that the amount of consumed food was smaller. This may have been caused by that mantangan was consumed before the grass being sufficient to satisfy the needs of the goats and so the subsequent amount of grass consumed was not as high. Mantangan has a high protein content (9.7%) compared to field grasses, which was only 2.78% (Garsetiasih, 2007). The total amount of grass consumed was high for the controlled treatments possibly because field grasses are the fodder the goats prefer and these are what are ordinarily eaten when there is no other choice of fodder. When small ruminants graze and browse under extensive conditions, goats have a habit of selecting their feed carefully when eating and are considered to be browsers, and utilise a wide range of native range plants, including foliage from trees and shrubs, forbs and grasses throughout the year (Sanon et al., 2007; Ngwa et al., 2000). Goats given the green mantangan may need more time to adapt, so that they eat it by preference. Goats fed on added mantangan fodder consumed less food compared to ones that only received green grass (Table 2). Based

on the statistical analyses (Table 3), the periods of feeding treatments and the levels of feeding (A, B, C, D) were significantly different in every period of goat treatment.

The levels of treatments affected the amount of food consumed. For example, the amount of food consumed in treatment B (grass + 200 g mantangan) was significantly different to treatment A (the control) and treatment D, (grass + 600 g mantangan). Treatment C (grass + 400 g mantangan) was significantly different to treatment A, but was not significantly different to treatment D. This was possible because the mantangan was sufficient in both quantity and quality for the goats and so it replaced their need for grass and they consequently consumed less grass. Besides it's high protein content, mantangan also has a high amount of raw fiber (39.85%) which was satisfied the goats need for roughage. The higher the raw fiber content in fodder, the less digestion occurs of the food consumed, so consumption decreases (Mulyaningsih, 2006). Mantangan was able to be used as green fodder for the livestock. Goats in the young growth state weighing less than 10 kg in addition to being fed grass, can be fed to 600 g of green matangan. The rate of mantangan provided can be increased appropriately as the growth state and body weight of the goat increases.

B. Incremental Body Weight of Goats

The average weight increment of the goats in each period fluctuated with the treatment, being 0.325 kg when fed grass + 200 g mantangan (treatment B) and 0.675 kg for the only grass control (treatment A), as shown in Table 3. Based on the statistical analyses, the level of mantangan feeding did not significantly affect body weight increment, but qualitatively there were differences in body weight increment among treatments, with treatment B having a smaller body weight increment, followed by treatments C and D, respectively.

Treatment A (only grass without mantangan) produced a higher body weight increment (675 g per periods) with this treatment also having the highest consumption of fodder. This was consistent with the results reported by Kartadisastra (1997) who found that the body weight of livestock increased directly with the level of fodder consumption. Ismoyo and Widiyaningrum (2008) stated that there was a relationship between the sum of food consumed and its digestibility, with the greater the amount of food consumed, the greater the body weight increase. The body weight increment was not much different for treatment D (grass + 600 g mantangan), namely, 575 g. Thus, to utilize the mantangan that had invaded the area, it is suggested that mantangan be fed at 600 g per individual goat per day while the goat is still in the growth stage.

C. Nutritional Content of *M. peltata*

Mantangan (*M. peltata*) is green foliage species that has potential to be used as fodder in the National Park, where mantangan is eaten by deer and other wild herbivores as a source of green food. The proximate analysis measured

Table 3. Body weight increment of goat in each treatment (kg/individual/day)

Period	Treatment			
	A	B	C	D
I	0.2	-0.5	0.2	0.8
II	1.5	0.3	0.7	0.8
III	0.5	0.5	0.5	0.5
IV	0.5	1	0.5	0.2
Total	2.7	1.3	1.9	2.3
Average	0.675	0.325	0.475	0.575

Remarks: A: field grass without mantangan, B: field grass (ad libitum) + 200 g mantangan, C: field grass (ad libitum) + 400 g mantangan, D: field grass (ad libitum) + 600 g mantangan

Table 4. Nutrient content of mantangan (*M. peltata*)

Location	Mantangan nutrient content (%)								
	DM	Ash	CP	CF	CE	Nfe	Ca	P	GE (kal/g)
Tamling BBSNP	89.30	6.56	9.70	39.85	3.29	29.90	1.26	0.30	4087

Remarks: DM = Dry matter; CP = Crude protein; CF = Crude fiber; CE = Crude ether; NFE = Nitrogen-free extract; Ca = Calcium; P = Phosphorus; GE = Gross energy (cal/g)

the levels of some nutrients to determine their suitability for livestock or wild herbivores as the main food source. The results are presented in Table 4.

The contents of fat, calcium, and phosphorus of mantangan exceeded those of lamuran grass, further adding to the potential of using mantangan as fodder for livestock. Wild herbivores or livestock need nutritional elements for their growth and mantangan has not only quality potential but also quantity since it is abundant and widespread in the buffer zone of BBSNP and within the National Park.

Treatments consisting of green field grass with the addition of some mantangan foliage statistically did not have any effect on body weight, but treatment A (only grass) and treatment D (grass + 600 g mantangan) resulted in higher increments in body weight than the other treatments (adding 200 g or 400 g mantangan). Mantangan showed potential as a green fodder source for livestock, especially goats, because of its high nutritional content compared to field grasses, and in particular, with regard to protein, fat, calcium and phosphorus. Feeding IAS to large-bodied herbivores, such as cows, sheep, and goats, could be effective in suppressing dominant (IAS) plants and support local economics by generating valuable goods, such as meat, milk, and leather (Esselink et al., 2002). In the past century, the appearance of IAS and their impact on ecosystem has become apparent. The spreading of species beyond their natural habitat has been contributed by the development of transportation and international trade (Hussner et al., 2010; Lenda et al., 2014).

IV. CONCLUSION

Mantangan is relatively high with a protein content of 9.70% and an energy content of 4087 calories. The protein content was higher than in field grass *Paspalum conjugatum* (8.85%), *Panicum repens* (7.54%) that are usually grazed by goats in Lampung Province. The protein and energy contents have a substantial effect on body weight increment. The acceleration in weight growth depends on the quality of the food being consumed, with higher protein content in the fodder the consumption of dry matter increasing that is used for growth.

The results of this study have implications for the management of the area including, *Merremia peltata* as an alternative animal feed, and rehabilitation to restore the authenticity of species and increase ecological functions. In addition, management that includes ecological, economic and social aspects needs to be improved through the selection of appropriate native species for plant enrichment, and control during the succession process.

ACKNOWLEDGEMENT

The writer is grateful to the head officer of the BBSNP, the head of Kampung Tampang Tua village in Tanggamus District, the Forest Rangers of Tampang Muda Resorts, the two technicians, Carlan and Najmullah, and local community leaders who contributed to research activities. For his much-valued assistance, we would like to thank Dr. Andrew John Warner.

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BIODEGRADATION OF PULP SLUDGE BY *Phanerochaete chrysosporium, Penicillium oxalicum* AND *Penicillium citrinum* AFTER SIX MONTHS INCUBATION

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Received: 24 October 2018, Revised: 23 August 20019, Accepted: 28 October 2019

BIODEGRADATION OF PULP SLUDGE BY *Phanerochaete chrysosporium, Penicillium oxalicum* and *Penicillium citrinum* AFTER SIX MONTHS INCUBATION. The rise of pulp and paper production due to market's demand will increase both main and secondary products of pulp. Secondary products such as pulp sludge have low economic value, but high environmental cost. Therefore, improved technology is needed to raise its value. This study aims to evaluate the ability of *Phanerochaete chrysosporium*, a combination of *Penicillium citrinum* and *P. oxalicum* and a mixture of those three fungal species in decomposing pulp sludge after one and six months incubation. The pulp sludge was collected from pulp company in North Sumatera, Indonesia and it was pre-treated prior to composting. The composting was conducted by inoculating *P. chrysosporium*, a combination of *P. oxalicum* and *P. citrinum* or a mixture of those fungal species with a density of 107 spores/ml into 15 kg treated sludge. The inoculated sludge was then incubated for one and six months. Analysis was held for the non-inoculated and inoculated sludge regarding pH, cation exchange capacity (CEC) (me/100 g), macronutrients (N, P, K, Ca and Mg) (%), micronutrients (S, Zn) (ppm) and heavy metals (Pb, Cd) (ppm). After one month incubation, *P. chrysosporium* was leading in enhancing sludge's macro and micronutrients. After six months incubation, a combination of *P. oxalicum* and *P. citrinum* generated higher P, K, CEC and reduced lead content of the sludge. Meanwhile, a mixture of the three fungus species produced the highest N and Mg.

Keywords: Pulp sludge, decomposition, *P. chrysosporium*, *P. oxalicum*, *P. citrinum*

BIODEGRADASI PULP SLUDGE DENGAN Phanerochaete chrysosporium, Penicillium oxalicum *DAN* Penicillium citrinum *SETELAH MASA INKUBASI ENAM BULAN. Meningkatnya produksi pulp dan kertas sebagai imbas kenaikan permintaan pasar akan menghasilkan komoditas dan juga hasil sampingan. Hasil sampingan berupa limbah pulp yang memiliki nilai ekonomi rendah dengan nilai konsekuensi lingkungan yang tinggi. Oleh karenanya, diperlukan teknologi untuk menambah nilai limbah pulp. Penelitian ini bertujuan untuk mengetahui kemampuan* P. chrysosporium, *kombinasi* Penicillium oxalicum *dan* P. citrinum *dan kombinasi ketiga jamur tersebut dalam mendekomposisi limbah pulp. Limbah pulp yang digunakan berasal dari perusahaan pulp di Sumatera Utara dengan perlakuan pendahuluan sebelum pengomposan. Pengomposan dilakukan dengan menginokulasi jamur* P. chrysosporium, *kombinasi* P. oxalicum *dan* P. citrinum *dan kombinasi dari ketiga jamur tersebut dengan kerapatan 107 (spora/ml) ke dalam 15 kg limbah yang telah mendapat perlakuan awal. Kemudian, limbah yang telah diinokulasi tersebut diinkubasi selama satu dan enam bulan. Analisis dilakukan terhadap limbah yang tidak diinokulasi dan yang diinokulasi, terdiri dari analisa pH, cation exchange capacity (CEC) (me/100 g), hara makro (N, P, K, Ca and Mg)(%), hara miro (S, Zn) (ppm) and logam berat (Pb, Cd)(ppm). Setelah satu bulan inkubasi,* P. chrysosporium *dapat meningkatkan hara makro dan mikro dari limbah pulp. Namun, setelah enam bulan inkubasi, kombinasi dari* P. oxalicum *dan* P. citrinum *mampu meningkatkan kadar P, K, CEC dan mengurangi kadar timbal dari limbah pulp. Sedangkan, kombinasi dari ketiga jamur* P. oxalicum, P. citrinum *and* P. chrysosporium *memberikan kadar N dan Mg tertinggi.*

Kata kunci: Limbah pulp, dekomposisi, P. chrysosporium, P. oxalicum, P. citrinum

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 doi:10.20886/ijfr.2019.6.2.95-105

I. INTRODUCTION

Currently, pulp and paper industries in Indonesia rank among the top 20 producers in the world, ranks as tenth for pulp and sixth for paper (APKI, 2016). Meanwhile, world's demand for the products increases 2–3% every year which drives Indonesia's pulp and paper industries to increase capacity from 7.93 million tons per year to 10.53 million tons (Setyawati, 2017). The increasing capacity will also generate secondary products in a large quantity such as wastewater sludge, wood yard wastes, causticizing wastes, and ashes (Simao, Hotza, Raupp-Pereira, Labrincha, & Montedo, 2018). It is estimated that one tonne paper production generates 40 to 50 tonne sludge (dry), consisting of 70% primary sludge and 30% secondary sludge (Bajpai, 2015). The sludge contains 59–72% (dry basis) cellulose, 6–16% lignin, 7–10 % hemicellulose, 10–70% ash, and inorganic contents such as kaolin clay, calcium carbonate, titanium dioxide (Das, Tollner, & Tornabene, 1998).

Many studies on composting pulp and paper's sludge were undertaken to give an added value to the disposal (Gopinathan & Thirumurthy, 2012; Hazarika & Khwairakpam, 2018; Rodriguez, de Castro Andrade, Bellote, & Tomazello-Filho, 2018). However, its high C/N ratio, low nutrients characteristic, and heavy metal content need to be addressed to use it as a soil amendment. Pulp and paper sludge decomposition can be raised by adding N fertilizer (N'Dayegamiye, Nyiraneza, Giroux, Grenier, & Drapeau, 2013), manure (Hazarika & Khwairakpam, 2018) or decomposer (Hong, Dashtban, Chen, Song, & Qin, 2015). In 2005, it was reported that 25 mills in the US recycled their wastewater treatment's sludge and deinking residual as compost by using windrow method (Bird & Talberth, 2008). However, in the composting process by those mills was not mentioned the use of decomposers.

Some fungi species can produce cellulose degrading enzyme (Morgenstern & Powlowski, 2014). Among many fungi species, white rot fungi is a well-known lignocellulosic degrading fungus by producing LiP, MnP and Lcc (Rajwar, Joshi, & Rai, 2016). *Phanerochaete chrysosporium*, a white rot basidiomycete generates LiP and MnPs, enzymes for lignin degradation (Bak et al., 2009). Those lignin-degrading enzymes are produced under limited nutrient, particularly nitrogen (Tien & Kirk, 1988). The MnP is the main enzyme for lignin degradation that using H_2O_2 to oxidize Mn^{2+} to Mn^{3+} (Wang, Yao, & Su, 2018). Stimulation of MnP activity triggered by oxalic acid which the oxidation of glyoxylate and oxalate produce H_2O_2 (Kersten & Cullen, 2007). *P. chrysosporium* also has a capability to degrade cellulose by producing cellulose-degrading enzymes: endoglucanase, cellobiohydrolases and exocellulases (Dashtban, Schraft, & Qin, 2009). Those enzymes work synergistically to release cellobiose which by B-glucosidases will be converted to glucose (Horn, Vaaje-kolstad, Westereng, & Eijsink, 2012).

Penicillium oxalicum and *Penicillium citrinum* have also been known to have generated b-glucanase (Doughari, 2011). However, *P. oxalicum* will generate more lignocellulose enzymes in complex substrates such as agricultural waste than in a pure cellulose medium (Liao, Li, Wei, Shen, & Xu, 2014). This phenomenon indicates *P. oxalicum* potential as cellulose producer for industrial purposes. Meanwhile, substrate alkali pre-treatment can induce CM Case production of *P. oxalicum* (Shah, Kalia, & Patel, 2015), and lignin presence does not interrupt saccharification of lignocellulose materials. On the other hand, *P. citrinum* secretes LiP (Yadav, Yadav, & Yadav, 2009) can generate thermophilic and acidophilic B-glucosidases in solid state fermentation of rice bran (Ng et al., 2010). However, cellulose generation of *P. citrinum* will be higher if no nitrogen source is added (Ghoshal, Banerjee, & Shivhare, 2013). Utilization of *P. citrinum* in rice husks fermentation resulted in cellulose yields of 37 units/g in 12 days and the cellulose degraded more than 70% (Kuhad & Singh, 1993).

Pulp sludge used in this study had a high CN ratio, about 62.7. Application of the sludge directly to the soil can cause N immobilisation. A common sludge composting method was mixing the sludge with manure or other rich nitrogen materials to lower the CN ratio (Gopinathan & Thirumurthy, 2012; Quaye, Volk, & Leopold, 2011). Microbes are usually applied to mill's wastewater for lignin decolourisation or detoxification (Hossain & Ismail, 2015; Madan, Sachan, & Singh, 2018). However, in a conventional composting, the use of decomposers has been widely practiced. This paper examines the ability of *P. chrysosporium*, a combination of *P. oxalicum* and *P. citrinum* and a mixture of those three fungal species in enhancing decomposition of pulp sludge generated from a pulp company located in North Sumatera, Indonesia.

II. MATERIALS AND METHOD

A. Study Site

The research was conducted at the Research and Development Institute of Fiber Technology of Forest Plant, Kampar, Riau. Decomposers isolation, multiplication and density counting were held in microbiology laboratory. Whereas the composting was performed in the technology laboratory.

B. Methods

Fresh pulp sludge was collected from a pulp company located in North Sumatera Province, Indonesia. The company employs kraft cycle for pulping wood chips. Chemicals for bleaching process was ClO_2, H_2O_2, CaO, oxygen, HCl, S, NaOH 10%, Na_2SO_4, and SO_2 (Simangunsong, 2014). The study showed that the pH of the pulp sludge was neutral (7.2). Sludge material sampling for study was taken from the top, middle and bottom of a pile. The sludge characteristics were wet, black, lumpy, and stinky and contained fibres and residues of the pulping process. Prior to composting, the sludge was pre-treated through dewatering. The sludge was air-dried to 60–70% moisture content for high composting-ability (Malinska & Zabochnicka-Swiatek, 2013). For composting, the dewatered sludge was not sterilized, weighed 15 kg, put in a plastic bucket and placed in a composting site.

A medium for decomposers multiplication was potato dextrose agar (PDA). The medium was made by diluting 39 g commercial potato dextrose agar (Oxoid) in 1000 ml sterile water. The agar medium sterilization was held using autoclave at 121°C, 15 psi for 15 minutes. Meanwhile, for sterilization of laboratory instruments using autoclave was held for 30 minutes. Spores of decomposer were inoculated from a test tube into the sterilized PDA medium in an incubator. The inoculated medium was incubated in the dark at room temperature for a week.

P. oxalicum and *P. citrinum* were collected from a former study (Wahyuningsih, 2014). However, in the former study, the fungi had not yet been identified. The fungi identification was then held in the Indonesian Institute of Science, Bogor, Indonesia. The fungi were isolated from a rhizosphere of *Acacia mangium* and sludge of pulp and paper mill located in Riau Province, Indonesia. Soil samples of *A. mangium's* rhizosphere were collected from 10–20 cm soil depth. Various serial dilutions of soil samples and pulp and paper sludge were plated on Potato Dextrose Agar and incubated at room temperature for 6 days. The fungal isolates were tested for their ability to degrade cellulose and lignin in CMC and Bavendam lignin 1% medium. Meanwhile, the isolate of *P. chrysosporium* American Type Culture Collection (ATCC) 34541 was obtained from Biotechnology Centre, Gadjah Mada University, Yogyakarta, Indonesia. Each fungus species was maintained in test tubes containing potato dextrose agar and stored at ±40°C.

For composting, spores of *P. chrysosporium*, *P. oxalicum* and *P. citrinum* single inoculant were harvested from the agar medium surfaces. The spores, either single fungus species or a mixture of two or three species were diluted in 150 ml sterile water and counted with a haemocytometer to reach inoculum density at

10^7 (spora ml^{-1}). The density was determined based on a former study that compared to the density of *P. oxalicum*, *P. citrinum* and a mixture of both fungi at 107, 10^8 and 10^9 (spora ml^{-1}) as pulp and paper sludge's decomposers. The result showed pulp and paper's sludge inoculated with a mixture of *P. oxalicum* and *P. citrinum* at a density of 107 (spora ml^{-1}) had the highest cation exchange capacity.

The composting was held by inoculating decomposers consisting of; *P. chrysosporium*, a combination of *P. citrinum* and *P. oxalicum*, and a mixture of *P. chrysosporium*, *P. citrinum* and *P. oxalicum* into the sludge. For control, the sludge was not inoculated with any decomposers. Sterile water (150 ml) contained inoculums was poured into 15 kg dewatered pulp sludge placed in a bucket. Each treatment was replicated three times. The top of the bucket was covered by a clear plastic sheet to avoid flies. During composting, sterile water was sprayed to the incubated sludge to maintain the moisture. Laboratory analysis was held after one and six month's incubation. The analysis was undertaken for composite samples of each treatment. The composite samples were analysed for its macronutrients (N, P, K, Ca, Mg), micronutrients (S, Zn) and heavy metals (Pb, Cd, As, Hg). The first and sixth months sampling aim to know the inoculums ability in degrading organic matter of the sludge through time.

C. Analysis

Laboratory analysis was undertaken based on organic fertilizer analysis ((Evianti & Sulaeman, 2009). The analysis was to determine the pH, CEC (me/100 g), organic C (%), macronutrients (N, P, K, Ca, Mg) (%), micronutrients (S, Zn) (ppm) and heavy metals (Pb, Cd) (ppm) content of the non-inoculated and inoculated sludge. Sample preparation was prepared by grinding and sieving the sludge using 2 mm sieve before analysis. pH measurement was conducted by diluting 10 g prepared sludge in 50 ml sterile water in a test tube and centrifuging for 30 minutes. The sludge suspension was measured for pH and CEC (me/100 g). The organic C (%) was determined using the Walkley and Black method. The total N (%) was determined by using the Kjeldahl method. P_2O_5 (%) and S (%) were determined using a spectrophotometer. Determination of K_2O_5 (%), Ca (%), Mg (%), Zn (ppm), Pb (ppm) and Cd (ppm) were determined using atomic absorption spectrophotometer. These parameters were analysed to know the ability of *P. citrinum*, *P. oxalicum*, and *P. chrysosporium* to increase sludge's macro and micronutrients. Moreover, pulp sludge does not only contain organic waste, but also calcium carbonate, kaolinite and talc (Abdullah, Ishak, Kadir, & Bakar, 2015). The decomposers inoculated to the pulp sludge were expected to raise the macro and micronutrients and reduce the heavy metal contents.

III. RESULT AND DISCUSSION

Pulp sludge inoculated with the fungi contained higher macro and micronutrients and lower heavy metals than the non-inoculated pulp sludge. In one month incubation, macronutrients (N, P, and Mg) of the inoculated sludge have increased (Table 1). However, CEC of the non-inoculated sludge was higher than the inoculated, particularly because of the high percentage of calcium and potassium. The high calcium and potassium content of the sludge is related to metal removal process during pulping to prevent operating problems (Maples & Ambady, 1991).

Those metals are originating from the wood supply. However, during pulping, calcium oxide (CaO) are also added in a re-causticizing step to increase NaOH level (Simangunsong, 2014), which can increase the calcium level of the sludge. In one month incubation, sludge was inoculated with a combination of *P. citrinum* and *P. oxalicum* had the lowest CN ratio. However, the sludge's macronutrients (P, K, Ca and Mg) increased when the sludge was inoculated with *P. chrysosporium*. Further, a study by Zhang et al. (2018) showed *P. chrysosporium* decreased 30% of the total organic matter of sewage

Table 1. Chemical and macronutrients analysis of pulp sludge after incubated for a month

Inoculum	pH	Org C (%)	Total N (%)	C/N ratio	P_2O_5 (%)	K_2O (%)	Ca (%)	Mg (%)	CEC me/100 g
Without inoculum	7.2	39.52	0.63	62.7	0.26	1.62	0.39	0.21	47.33
P. chrysosporium	6.8	46.27	1.04	44.5	1.13	1.13	0.31	0.31	46.28
P. oxalicum + *P. citrinum*	6.7	43.85	1.09	40.2	1.08	1.08	0.26	0.29	46.81
P. chrysosporium + *P. oxalicum* + *P. citrinum*	6.9	46.58	1.11	42	1.05	1.05	0.28	0.28	47.14

Table 2. Micronutrients and heavy metals content of pulp sludge after incubated for a month

Inoculum	Micronutrients		Heavy metals	
	S ppm	Zinc ppm	Pb ppm	Cd ppm
Without inoculum	137.4	26.3	4.8	2.6
P. chrysosporium	164.1	388.2	1.4	1
P. oxalicum + *P. citrinum*	162.8	360.4	1.1	0.9
P. chrysosporium + *P. oxalicum* + *P. citrinum*	155.9	349.6	1.3	1.1

sludge after 60 days incubation. According to Jeffries et al. (1981), a ligninolytic activity of *P. chrysosporium* depends on the availability of carbohydrate, nitrogen and sulphur. Further more, it was mentioned that to produce one mg of mycelial weight (dry) of *P. chrysosporium* requires 2.2 mg carbohydrate, 5.4 µg nitrogen and 0.5 µg sulphur. Pulp sludge used in this study provided those nutrients sufficiently. On the other hand, Choudary et al. (2016) found that *P. oxalicum* decomposed 18% of 10 g/l of a mixture of rice and wheat straw in a Mendel and Weber medium after 10 days incubation. While, Islam and Borthakur (2016) reported *P. citrinum* degraded 23.27% of rice stubble after 60 days incubation. A lower nutrients content of the sludge inoculated with *Penicillium* sp. in this study could be caused by the fungi consumption.

Meanwhile, the zinc content of the inoculated pulp sludge and incubated for a month increased about 13 times than the non-inoculated (Table 2). Zinc in the pulp sludge can be sourced from wood and chemicals during the bleaching. Zinc content of Eucalyptus wood was reportedly linear with the zinc content in soil (Assareh, Shariat, & Ghamari–Zare, 2008). Also, a mix of zinc dust and sulphuric acid are added during the bleaching process of mechanical pulp (Mall, 2014). On the other hand, production of metal chelator by fungus, namely oxalate, increases the immobilization of zinc of the pulp sludge. The accumulation of zinc in fungus biomass raised zinc content of the pulp sludge when the biomass was also extracted during micronutrients analysis. Among three inoculums used in this study, inoculation of *P. chrysosporium* enhanced zinc content of the sludge. The ability of *P. chrysosporium* to accumulate zinc is also shown in a study by Zhang et al. (2018). Except *P. chrysosporium* generates oxalate (Huang et al., 2015), it also has a high biosorption ability for Zn (II) and Pb (II) in which the uptake and yield are in an opposite position (Marandi, Ardejani, & Afshar, 2010).

In a month's incubation, the inoculated sludge also showed lower level of lead and cadmium than the non-inoculated (Table 2). A combination of *P. citrinum* and *P. oxalicum* can

reduce sludge's lead and cadmium content by about 77% and 65%, respectively.

According to Mahish et al. (2018), lead biosorption of *P. oxalicum* in the lead-contaminated soil after nine days incubation was 56.35%. Meanwhile, the dead biomass can absorb lead by 2.65 mg g^{-1} biomass. Tian et al. (2018) reported *P. oxalicum* can reduce lead up to 98% cation when innoculated to a media containing 1700 mg/l lead and fluoro apatite. *P. citrinum* also has an ability to absorb lead as an insoluble lead in the matrix fungal mycelia which the process initiated through surface binding (Wahab, Adeyemi, Awang, Azham, & Tay, 2017). For cadmium, *P. oxalicum* was reported resistant up to a concentration of 250 ppm (Bahobil, Bayoumi, & Atta, 2017). While at pH 6, *P. citrinum* can absorb cadmium of 0.25g/50 ml through free biomass and 0.1g/50 ml through immobilization (Suhag, 2011). A reduction of heavy metals content of material by a fungus is related to the production of organic acids such as citric and gluconate through precipitation or leaching (Gholami, Borghei, & Mousavi, 2011; Xu, Ramanathan, & Ting, 2014).

In comparison to pulp sludge that was inoculated and incubated for a month, the six months incubation resulted in higher macro and micronutrients (Table 3 and 4). The pH was also higher than that of one month incubation, probably it is related to a decreasing fungus activity. When less organic acids were produced by the fungus, the environment tends to have a higher pH. The changes also occurred in *P. chrysosporium* performance. Although at one-month incubation *P. chrysosporium* generated higher phosphor and potassium contents of the sludge than other inoculums, after six months incubation, a combination of *P. citrinum* and *P. oxalicum* resulted in the highest values. It indicates that *P. chrysosporium* has a more rapid initial growth than another inoculum which also showed by a pH drop. Urek and Pazarlioglu (2007) found that the MnP activity of *P. chrysosporium* in a growing medium enriched with $(NH_4)_2SO_4$ was optimum when a concentration of nitrogen was 20 mM or equal to 0.07 %. In this study, the sludge content of total nitrogen ($(NH_4)_2SO_4$) and nitrogen was about 0.63% and 0.13%, respectively. However, the abundance of sludge's nitrogen content can inhibit ligninolytic production of *P. chrysosporium* which also limits oxalic acid's secretion. Thus, along with incubation time, the increasing availability of nitrogen probably decreased LiP and MnP production.

A combination of *P. citrinum* and *P. oxalicum* showed rapid sludge decomposition in the six months incubation. A study by Waing et al. (2015) showed among 22 cellulolytic fungal species isolated from leaf litter, *P. citrinum* generated the largest clear zone in a CMC agar. While, in the same medium, *P. oxalicum* produced a smaller diameter of the clear zone. The clear zone in a CMC medium showed the ability of fungal species to decompose cellulosic materials. The sludge inoculated with these fungus combinations also resulted in higher phosphorous and potassium contents which the latter contributes to the increasing CEC.

Table 3. Chemical and macronutrients analysis of pulp sludge after incubated for six months

Inoculum	pH	Org C (%)	Total N (%)	C/N ratio	P_2O_5 (%)	K_2O (%)	Ca (%)	Mg (%)	CEC me/100 g
Without inoculum	7.2	39.52	0.63	62.7	0.26	1.62	0.39	0.21	47.33
P. chrysosporium	7.2	31.16	1.24	25.1	1.84	1.84	0.34	0.33	48.36
P. oxalicum + *P. citrinum*	7.1	29.84	1.22	24.5	2.03	2.03	0.31	0.32	51.24
P. chrysosporium + *P. oxalicum* + *P. citrinum*	7.3	30.77	1.27	24.2	1.76	1.76	0.34	0.34	49.72

Table 4. Micronutrients and heavy metals content of pulp sludge after incubated for six months

Inoculum	Micronutrients		Heavy metals	
	S (ppm)	Zinc (ppm)	Pb (ppm)	Cd (ppm)
Without inoculum	137	26.3	4.8	2.6
P. chrysosporium	173	391.2	1.3	0.9
P. oxalicum + *P. citrinum*	158	376.6	0.8	0.9
P. chrysosporium + *P. oxalicum* + *P. citrinum*	170	384.5	1	1

A combination of *P. oxalicum* and *P. citrinum* also reduced the lead content from 1.1 ppm to 0.8 ppm after six months incubation. Wahab et al. (2017) found *P. citrinum* was optimum in absorbing lead when the concentration reached 400 ppm. According to this study, a longer incubation time probably can significantly reduce the sludge's lead content because the initial concentration was below 400 ppm. The study by Wahab et al. (2017) also reported that the older biomass age had lower metals biosorption capacity than the younger. During first-month incubation, a combination of *P. citrinum* and *P. oxalicum* showed slow lead biosorption activity which was probably the result of each species was adapting to another. Previous study shows, inoculation of *P. citrinum* alone or *P. oxalicum* alone did not significantly reduced heavy metals content (Pb and Cd) of the sludge. However, *P. oxalicum* performed better in generating macro and micronutrients of the sludge than *P. citrinum*. Meanwhile, a combination of these *Penicillium* sp. increased macronutrients and decreased the heavy metals content (Pb and Cd).

The ability of *P. oxalicum* and *P. citrinum* in producing organic acids, especially oxalic and citric acids can reduce heavy metals through mycelial binding (Abdel-ghany & Abdel-mongy, 2009). However, production of oxalic acid by *P. citrinum* is occurred at the last stage of growth and was suppressed in a media containing ammonium but increased by the presence of zinc (Sazanova et al., 2014). The pulp sludge that contains both ammonium and zinc can be suppressed and trigger the oxalic production of *P. citrinum*. However, as the oxalic acid is produced by *P. citrinum* at the last stage, a concentration of ammonium in the sludge will be reduced through consumption before the acid production.

In contrast to a combination of *Penicillium* sp., a mixture of *Penicillium* sp. with *P. chrysosporium* produced the highest nitrogen and magnesium content after six months incubation. High production of N and Mg could be mostly the contribution of *P. chrysosporium*. This study showed sludge inoculated with P. chrysosporium alone produced higher N and Mg than a combination of *P. citrinum* and *P. oxalicum* after six months incubation. Ligninolytic fungus, *P. chrysosprium* produces lignin degrading enzyme in a nitrogen-limited medium. Thus, to gain nitrogen, a ligninolytic fungus degrades C organic and lignin in a poor nitrogen environment (Rinkes et al., 2016). Meanwhile, lead and cadmium content of the sludge after inoculation with a mixture of three fungi was remained higher than of Penicillium's combination. According to Akamatsu et al. (1990), oxidation of veratryl alcohol, an enzyme produced by *P. chrysosporium*, deteriorates oxalate to carbon dioxide but oxalate hinders the veratryl alcohol oxidation. Thus, a ligninolytic activity of *P. chrysosporium* could be inhibited by oxalate production from the fungi mixture. Also, metals removals of the sludge by the oxalic acid could be inhibited by the oxidation of vertaryl alcohol.

According to this study, the fungal isolates inoculated to the sludge can significantly decompose pulp sludge after six months of

incubation. However, the CN ratio was still above 20. The increasing macronutrients after inoculation and incubation showed a better opportunity for the fungus as sludge decomposers. A reduction of heavy metal contents such as lead and cadmium after composting will also benefit to the environment. On the other hand, *P. citrinum* has been known to be able to chelate Al and Fe the application of which to acid soil or iron ore can raise phosphorous availability for plants (Rea, McSweeney, Dwyer, & Bruckard, 2015). However, the use of decomposer for sludge composting in commercial scales are rarely found. The mills prefer to apply mechanical rather than biological composting (Bird & Talberth, 2008). Mechanical composting by using a modern composting machine is commonly undertaken by adding nitrogen fertilizer, cow dung or other organic materials to raise compost quality. However, the Composting Council of Canada (2010) explained that mechanical composting by using in-vessel aerobic technology with a capacity 50,000 of tonne/year costs 300–500$/tonne. Meanwhile, conventional composting using windrow technology at the same capacity costs 40–60$/tonne.

IV. CONCLUSION

A combination of *P. citrinum* and *P. oxalicum* is promising as decomposers for pulp sludge. They were better in generating nutrients and reducing the lead of the sludge after six months incubation. However, a longer incubation could be required to achieve CN ratio 20. A combination of *P. citrinum* and *P. oxalicum* can be applied to sludge composting either in a mechanical or conventional composting. However, cost implication should be considered. The small sample size for chemical analysis was a limitation in this study. In the future, a study about the application of the non-inoculated and inoculated sludge to plants as soil amendment should be undertaken and a larger scale replication should be carried out to gain a statistically consistent result.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to the Ministry of Environment and Forestry for granted funding for the research. My sincere gratitude is also to Ramiduk Nainggolan, Minal Aminin, and Edi Nurrohman for their help during the research.

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FUNGI AND SOIL MACROFAUNA COMMUNITY IN REVEGETATED POST-FIRE PEATLAND IN CENTRAL KALIMANTAN

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Received: 27 August 2018, Revised: 17 September 2019, Accepted: 6 October 2019

FUNGI AND MACROFAUNA COMMUNITY IN POST-FIRE PEATLAND IN CENTRAL KALIMANTAN. Peat soil with its unique physical and chemical character is host to various microbe and fauna. In the peat, the existence of microbe and macrofauna influenced by several environmental parameters. This paper investigates the fungi and macrofauna community in the post fire degraded peat swamp soil with emphasize on two points: the abundance of soil fungi and soil macrofauna and to describe the environmental parameters (e.g. understory and chemical properties) on the existence of fungi and macrofauna community. Soil dilution and pitfall trap methods were used to collect soil fungi and macrofauna in four different plots based on the revegetation time which are: no revegetation (A), 12 months after revegetation (revegetated in December 2016) (B), 21 months after revegetation (revegetated in April 2016) (C), and 24 months after revegetation (revegetated in December 2015) (D). Result showed that abundance of soil fungi obtained during this study is 4×105 to 11×105 cfu/ml. While the macrofauna abundance is 353–1038 ind/m^2. Soil fungi and macrofauna community in peatland affected by understory cover which was related with revegetation activity. There is a trend of increasing the abundance of soil fungi and macrofauna on the post-fire peatland along with the increase of the percentage of understory cover.

Keywords: Abundance, forest fire, macrofauna, microbe, peat

KOMUNITAS JAMUR DAN MAKROFAUNA PADA LAHAN GAMBUT BEKAS TERBAKAR DI KALIMANTAN TENGAH. Tanah gambut yang memiliki karakter fisika dan kimia yang unik merupakan habitat bagi berbagai macam mikroba dan fauna. Di tanah gambut, adanya mikroba dan makrofauna dipengaruhi oleh beberapa parameter lingkungan. Penelitian ini dilakukan dengan tujuan untuk mengetahui informasi tentang komunitas jamur dan makrofauna di lahan gambut bekas terbakar dengan berfokus pada dua hal yakni: kelimpahan jamur tanah dan makrofauna tanah dan hubungan parameter lingkungan dengan komunitas mikroba yang ada. Pengenceran tanah dan metode perangkap sumuran digunakan untu mendapatkan sampel jamur dan makrofauna pada plot yang telah ditentukan yakni: lahan gambut bekas terbakar yang belum di revegatasi (A), lahan gambut bekas terbakar yang sudah direvegetasi 12 bulan (B), lahan gambut bekas terbakar yang sudah di revegetasi 21 bulan (C), dan lahan gambut bekas terbakar yang sudah direvegetasi 24 bulan (D). Kelimpahan jamur tanah yang didapatkan selama penelitian ini adalah 4×105 cfu/ml hingga 11×105 cfu/ml dan kelimpahan makrofauna adalah 353–1038 individu/m^2. Kelimpahan jamur dan makrofauna dipengaruhi oleh persentase penutupan tumbuhan bawah yang berhubungan dengan aktivitas re-vegetasi. Semakin tinggi persentase penutupan tumbuhan bawah, maka semakin tinggi pula kelimpahan jamur dan makrofauna tanah.

Kata kunci: Kelimpahan, kebakaran hutan, makrofauna, mikroba, gambut

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 doi:10.20886/ijfr.2019.6.2.107-116

I. INTRODUCTION

Soil fungi and macrofauna play a big role in soil ecosystem, such as influencing soil property, hydrology, aeration and gaseous composition which important in soil productivity and plant that grow above it (Brussaard, 1997). Most of named and studied fungi (±80,000 species) are mostly grown in soil habitat (Bridge & Spooner, 2001), including in peat soil. Peat soil with its unique physical and chemical character is host to various microbe including bacteria, saprobe, endophyte fungi (Hakim, Yuwati, & Nurulita, 2017), Mycorrhizal Arbuscular fungi (Tawaraya et al., 2003), Ectomycorrhiza (Turjaman et al., 2005). Microbe in peatland has important roles in the decomposition of organic matter (M.N. Thormann & Rice, 2007; Thormann, Rice, & Beilman, 2007; Bridge & Spooner, 2001). As well as microbe, macrofauna in peatland also has an important roles in soil ecosystem such as influences soil turnover, mineralization, soil physic and chemistry, soil nutrient content, and water availability (Bottinelli et al., 2015; Lal, 1988).

Tumbang Nusa Research Forest (KHDTK Tumbang Nusa) experienced several forest fire in 1997, 2003, 2006 and 2015. Repeatedly forest fire in Tumbang Nusa, Central Kalimantan lead by several caused, i.e extreme dry season (El Nino), land clearing, land conflict, and lack of law enforcement. Durinf the last forest fire incident in 2015, KHDTK Tumbang nusa has lost approximately 2,700 Ha or 54% to its total area. It is estimated about 500 m^3 biomass/ ha were burned that caused great loss of biodiversity, research data and plots (Santosa & Qirom, 2016). Several activities were carried out in KHDTK Tumbang Nusa to restore the ecosystem including microorganism, macrofauna, wildlife, and also the vegetation. Several revegetation activities were done to restore degraded post-fire peat land in Tumbang Nusa, ie. in December 2015, in April 2016 and December 2016.

Forest fire affected many aspects on the ecosystem, such as economic, social, and ecology including loss of plant biodiversity, soil microbes, and also soil macrofauna (Meador, Springer, Huffman, Bowker, & Crouse, 2017; Koster et al., 2015; Wang, Wang, Wang, Hu, & Luo, 2015). Fire affected microorganism in the organic horizons and in the top 1–2 cm of soil layer, the location where the burning and heating effect could reach moderate to critical severity. Fire will change soil environment that affects the function of fungi soil and macrofauna community (Meador et al., 2017; Gongalsky & Persson, 2013a; Neary, Klopatek, Debano, & Folliott, 1999).

In general habitat, revegetation is one of the solution to alter ecosystem after fire. Revegetation will give the reciprocal effect to the soil that directly support the plant growth. The success of revegetation activities can be seen from several parameters such as plant growth and also the re-existence of living creature including microbe (An, Cheng, Huang, & Liu, 2013; An, Huang, & Zheng, 2009; Rolda, 2005) and also macrofauna (Gupta, Gorai, & Sighn, 2007; Ruiz-jaen & Aide, 2005). However, the baseline information about the fungal and macrofauna community in revegetated post-fire peat land is still limited. Therefore, this study would like to obtain the information about fungi and macrofauna in the post-fire degraded peat swamp soil after revegetation activity with emphasize on two points which are (i) abundance of soil fungi and soil macrofauna, and (ii) to describe the environmental parameters (e.g. understory cover and chemical properties) on the existence of fungi and macrofauna community.

II. MATERIAL AND METHOD

A. Study Site

The study was carried out in September to December 2017 in Tumbang Nusa Research Forest (KHDTK Tumbang Nusa), Tumbang Nusa village, Pulang Pisau, Central Kalimantan (02°18'34"S and 114°02' 48"E) and in Microbiology Laboratory of Banjarbaru Environment and Forestry Research and

Development Institute, Banjarbaru, South Kalimantan. KHDTK Tumbang Nusa covered with peatland with elevated area about 0–5 m above sea level. Annual rainfall is about 2000-3000 mm/year with minimum temperature is 21°C and maximum temperature is 36°C. KHDTK Tumbang Nusa dominated by hemic peat with low bulk density (0.04-0.16) with soil acidity (pH) less than 4. Sampling points were located in four different plots based on the revegetation time which are: no revegetation (A), 12 months after revegetation (revegetated in December 2016) (B), 21 months after revegetation (revegetated in April 2016) (C), and 24 months after revegetation (revegetated in December 2015). Observation were done to the fungi and macrofauna community in several parameters which are species, abundance, understory cover, and soil chemical properties.

B. Method

1. Soil Sample Collection and Fungal Isolation

Soil sample from 0–30 cm soil surface were collected from four sampling point at post -burn peat land. In each point sampling location, we took one sample about 500 gr soil. Soil dilution technique to measure fungal abundance was done according to Kruger, Sharma, and Ajit (2009). Ten gram's of soil sample was mixed with 90 ml of sterile distilled water (10-1 dilution), then shook for 30 minutes (100 rpm). This initial dilution was done to 10-4 dilution. Fungal abundance determined with following formula:

$$TPC = \Sigma \text{colony} \times \frac{1}{\text{suspension}} \times \frac{1}{fp} \quad \text{.....(1)}$$

Where:
TPC = Total Plate Count; fp = total dilution factor.

Fungal morphospecies was obtained by incubated fungi which grow in Potato Dextrose Agar and isolated until we obtain single culture fungi. Fungal morphospecies were determined according to cultural characteristic: colony colour, texture, habit, and growth rate on petri dish containing PDA.

2. Soil Macrofauna Observation

Soil macrofauna was observed using pitfall trap method which refers to Suhardjono, Deharveng, and Bedos (2012) and Maftuah, Alwi, and Willis (2005) One small plastic container (d=7 cm, h= 10 cm) filled with insect preservatives (70% alcohol) was placed in the soil targeted plot. In addition, the plastic container rims were placed at the same level with soil surfaces. To protect the container from rain, a small cover was made above the trap. Samples were taken 2x24 hours after the trap was installed. Macrofauna that trapped inside the plastic container were put into vials bottle to identify. Identifications were conducted according to Borror, Triplehorn, and Johnson (1992). Furthermore, Shannon and Wiener index was used to calculate the diversity of soil macrofauna (Krebs, 1978).

3. Understory Cover

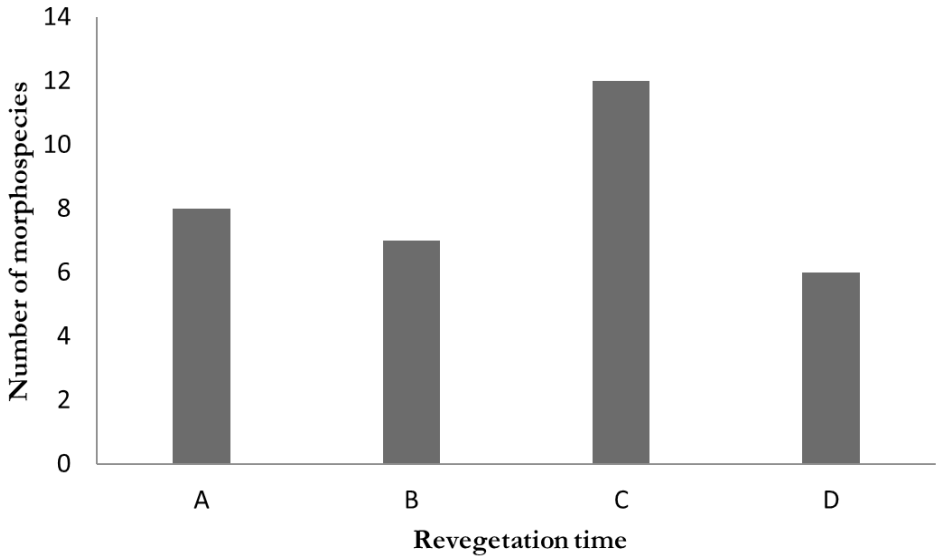
Understory cover data were collected by using 1 x 1 m plot which photographed from above ground using digital camera. Can-eye software was used to determine the land cover percentage that dominated by understory plant. In each sampling point, the analysis was performed in triplicate.

4. Soil Analysis

Soil sample from the upper soil horizon (0-30 cm) of each point sampling were taken to soil laboratory of Indonesian Swampland Agriculture Research Institute, Banjarbaru, South Kalimantan. Chemical and physical parameter were measured which are pH H_2O, Electrical Conductivity (EC)(mS/cm), N(%), Kdd (cmol(+)/kg), CEC (cmol(+)/kg), P Bray1(ppm P), P potential (mg/100 gr), K potential (mg/100 gr), ash (%) and water content (%).

III. RESULT AND DISCUSSION

Peat soils with all its limitations: acidic soil, low nutrient levels, and also post-burn soil are habitats for various fungi, bacteria as well as macrofauna. This is proven by the



Remarks: (A), 12 months after revegetation (B), 21 months after revegetation post-fire peat-land revegetated in April 2016 (C), and 24 months after revegetation (D)

Figure 1. Number of fungal morphospecies isolated from four post-fire peatland plots: no revegetation

Table 1. Number of fungal colonies, macrofauna genus, diversity index and vegetation cover in four sampling points

Revegetation time	Number of fungal colonies (cfu/ml)	Number of macrofauna genus	Macrofauna diversity index	Understory cover (%)
A (no revegetation)	$5x10^5$	7	1.29	6.83
B (12 months)	4×10^5	6	1.38	12.61
C (21 months)	$10x\ 10^5$	8	0.83	14.32
D (24 months)	11×10^5	10	1.55	31.93

successfull isolation of fungi and the discovery of macrofauna in our sampling plot, which are burnt peat soil. The result obtained in our study indicate that fungal abundance in the area with 24 months old revegetation plants has the highest abundance compare to others location (Table 1). In the location that revegetated in April 2016 (21 months old revegetation plants), the number of fungi morphospecies was found at most (12), with the lowest number of morphospecies found in site d (6) (Figure 1). The high amount of colony or fungal abundance not followed by the number of morphospecies.

In general, post degraded peatland or cutover peatland tend to have lower microbial biomass due to affected by many environmental factors such as moisture content, temperature (Trinder, Johnson, & Artz, 2008). In peat soil, soil fungal abundance categorized as low level, about 1/3 to 1/30 compare to non-peat land soil such as evergreen forest and cultivated soil (Yabuki, Duncan, & Okuda, 2013). Result revealed that the abundance of fungi increases along the increament of understory cover. Denser cover reduces temperature and increases relative humidity that provide better habitat for fungal growth (Shuhada, Salim, Nobilly, Zubaid, & Azhar, 2017). In addition, the abundance of fungi did not follow by number of morphospecies. However, in comparison with those of peatland in other areas, such as in Japan, fungal abundance in tropical peatland in Central Kalimantan tends to have higher abundance (5x105 to 11 x 105), while in peat soil japan, fungal abundance was 3.3 x 103 and 3.0 x 103. The higher diversity of vegetation

in tropical peat, which has role as fungal host, compared to peat in temperate region, which has lower vegetation diversity, could affect the fungal abundance (Arnold, 2007).

No fungal identification activity were done during this research, but according to Thormann and Rice (2007), there were some common fungi documented in Canada peat soil are Basidiomycetes, Zygomycetes, Chytridiomycetes. In addition, the most common genus found in Canada peat soil are Penicillum, Galerina, and Mortiella species. There is a possibility that the abundance of fungi in peatland is higher than the result that we obtained during this study. According to Kirk et al. (2004), fast growth rate of microbes and microbes that produce a huge number of spore is causing difficulties in the observation, and also could lead growth inhibition and colony spreading. In addition, only culturable fungi can be grown with agar media. These facts supporting the theory that only 17% fungi can be cultured (Bridge & Spooner, 2001).

Instead of having a high number of morphospecies, Plot D also known to have highest fungal abundance, macrofauna abundance, macrofauna diversity index and also highest vegetation cover (Table 1 and 2). The result also showed that the abundance of microbe and microfauna tend to increased along with the increment of understory cover percentage.

There was a unique pattern in macrofauna abundance found during this research. In the non-revegetation area, the number of macrofauna is higher compared to the revegetation plot. However, in the revegetation area, there are improvement of macrofauna availability along with the increament of understory cover. Furthermore, Orthoptera dan Hymenoptera (Table 2) were two dominant insects order obtained by the pitfall trap of macrofauna in this study. Analysis showed no differences of soil chemical composition in four different samples. However, the water content tends to increase along the duration of revegetation activity.

Effect of fire on macrofauna activities depends on several factor which are fire intensity and the macrofauna species itself (Coyle et al., 2017). The fire will impact the diversity of macrofauna. According to Istomo and Pradiastoro (2011) there is three categories of diversity index: low (<2), moderate (2–3) and high (>3). Previous study in peat area shown that macrofauna diversity index in peat area is in low to moderate category. In addition, Halwany, Andriany, and Manaon (2014) in his research mentioned that the diversity index in several peat areas is categorized in low to moderate (0.33–1.33). While, in this study, all of our sampling points have diversity index about 0.38–0.55, which categorized as low biodiversity compare to others plot near to our sampling points. As well as the fungal community, the macrofauna community also has the same trend as microbe community that has higher abundance in the area which has higher understory cover. However, there is a unique pattern in macrofauna community which different compare to microbe community. In the non-revegetation area, macrofauna abundance

Table 2. Soil macrofauna abundance in four sampling points

Order	A (no revegetation)				B (12 months)				C (21 months)				D (24 months)			
	j	∑ i	F	RD	j	∑ i	F	RD	j	∑ i	F	RD	j	∑ i	F	RD
Orthoptera	1	354	90	56	1	196	30	56	1	496	85	81	1	527	85	51
Hymenoptera	4	212	65	33	2	102	50	29	4	102	45	17	3	307	60	30
Coleoptera	1	15	10	3	1	39	15	11	2	16	5	1	4	173	35	16
Araneae	1	6	20	8	0	0	0	0	1	8	5	1	1	31	15	3
Diptera	0	47	0	0	1	16	10	4	0	0	0	0	0	0	0	0
Total	7	634			5	353			8	622			9	1038		

Remarks: j : species number; ∑ I : individual number/m^2; F: frequency (%); RD: relative density (%)

is higher compare to the revegetation area. Less predator in open area (non-revegetated) caused by higher colony of some macrofauna compare to revegetated area (Gongalsky & Persson, 2013a). This result supporting theory from Carpenter et al., (2012) that macrofauna is less diverse in the area with dense canopy cover and less diverse in open area. Therefore, it could be assumed that canopy cover affected the diversity of macrofauna.

Ant, which is classified in the family of Formicidae, is the most common macrofauna found in this study. According to Carpenter et al. (2012), Formicidae is commonly found in open area of forest. For example, Wawan Halwany, (2011) and Harun (2011) also found many Formicidae species in agroforestry area in Kelampangan, Tumbang Nusa which are peat area. Furthermore, Halwany et al. (2014) also found many of formicidae in peat area central Kalimantan and followed by other common insect families which are Glossoscolicidae, Formicidae, and Chillapoda. In the soil, ant play important roles in soil amandement. According to Frouz and Jilkova (2008) ants (formicidae) could mediated chemical change, increasing nutrient content in the soil by its nest occurrence in soil. In addition, ants also affect the soil physical condition and also increasing microbial activities.

The existence of Formicidae and the other insect in post-fire habitat occur by these two assumptions: (a) macrofauna that migrate from unburnt area into post-fire, (b) macrofauna that survive in the deep soil layer or in the unburnt location (Gongalsky & Persson, 2013b). Burning affected the soil macrofauna abundance and biomass but not so significantly affect the species richness (Gongalsky et al., 2012). In contrast, Malmstrom et al. (2009) in their research mentioned that fire decreased soil macrofauna species richness. In addition, Malmstrom, Persson, Ahlstro, and Malmstro (2009) stated that forest fire greatly affect to several insect order of soil macrofauna, including order that easy and have good ability to migrate and disperse such as Diptera, Coleptera and Aranea. Five years after fire incident, these species still absent and difficult to find in the post-burning area.

Many theories mention that environmental factor plays an important role with bacteria, fungi, and soil macrofauna abundance in several habitats. Biological community in the soil will respond to the habitat disturbance or degradation (Mandal & Sathyaseelan, 2012). In the soil, the fungal community and distribution have positive correlation with pH, soil temperature and humidity. While, altitude and soil moisture content have negative correlation with fungal distribution in the soil (Devi, Khaund, Nongkhlaw, & Joshi, 2012). Based on the analysis result (Table 2), plot D that have the highest percentage of land cover show highest fungal abundance and macrofauna. It is assumed, vegetation cover affected soil humidity and soil temperature that support the life of microbe and macrofauna.

On the contrary with the theories, soil analysis result (Table 3) on four sampling location showed no differences in several parameters. However, there are increasing of water content percentage along with the age of the revegetation tree. Based on these results, it can be assumed that 24 month after revegetation activity have not change or alter the chemical composition of the peat soil It is assumed that during 24 months, there are slow change in peat chemical properties. This result linear with the study of Too, Keller, Sickel, Lee, & Yule (2018) that mentioned that environmental variables (pH, nutrient availability, and C/N ratio) does not significantly impact in peat with different vegetation due to the waterlogging and regular flooding that lead the nutrients redistributed to forest soil.

No understory cover identification were done during this research but we assumed the litter of understory plant could affect the microbes and macrofauna community. According to Trinder et al. (2008), fungal community in peat was dominantly determined by litter type because litter type changes the turnover stats of C, N, and P in the soil.

Table 3. Chemical content of soil in four sampling points

Chemical properties	A (no revegetation)	B (12 months)	C (21 months)	D (24 months)
pH H_2O	3.64±0.27[a]	3.24±0.12[a]	3.41±0.11[a]	3.65±0.26[a]
EC (ms/cm)	0.12±0.07[a]	0.22± 0.12[a]	0.14±0.02[a]	0.12±0.07[a]
N total (%)	0.81±0.19[a]	0.84±0.09[a]	0.77±0.11[a]	0.81±0.13[a]
K-exc (cmol(+)/kg)	0.57±0.23[a]	0.90±0.26[a]	0.79±0.29[a]	0.73±0.19[a]
CEC (cmol(+)/kg)	182.28±43.96[a]	182.30±5.27[a]	172.01±11.13[a]	189.67±38.37[a]
P Bray1 (ppm P)	16.88±14.91[a]	24.27±13.32[a]	12.84±1.91[a]	19.64±9.35[a]
P potential (mg/100 g)	2.18±0.53[a]	3.5915±1.38[a]	2.09075±0.41[a]	3.27±1.06[a]
K potential (mg/100 g)	19.19±8.38[a]	30.97±10.61[a]	22.25±5.19[a]	23.79±6.03[a]
Ash content (%)	6.42±2.89[a]	9.58±4.56[a]	12.84±4.56[a]	10.14±5.71[a]
Water content (%)	28.83±4.98[a]	41.26±10.86[a]	58.71±11.52[a]	55.11±27.35[a]

Remarks: *Means with different letter show significant differences at 95% of confidence by the Tukey's test

In general, revegetation activities are playing an important role in restoring degraded peat land. In areas with high vegetation cover, moisture will increase and the environment conditions will support the growth of culturable soil fungi and macrofauna. The existence of these microorganisms and macrofauna ultimately gives advantages to the plant and the whole ecosystem through plant-insect and microbes interaction. This study result showed that revegetation activity playing an important role in restoring degraded peat land.revegetation will increase moisture and humidity and alter micro-climate that support the growth of soil fungi and macrofauna. the existence of these microorganisms and macrofauna ultimately gives the plant and the whole ecosystem through the insect plant and microbes interaction.

The results of the study certainly illustrate that in revegetation activities, plant growth parameters are not the only indicator of success, but biological communities such as microbes and macrofauna are also important indicators and play a role in determining the success of revegetation. Hence, technology inputs are needed to succeed of revegetation activities such as by utilizing the active charcoal (Gusmailina, 2010), utilizing soil amandment (Dariah, Sutono, Nurida, & Hartatik, 2015), application of soil microbes (Turjaman et al., 2008; Turjaman et al., 2008), and the use of surfactants to increase the binding capacity of peat soils (Utami, Maas, & Radjagukguk, 2009). Further research that involve molecular identification of soil microbe is needed in order to see the information about the species and community dynamic along the revegetation process.

IV. CONCLUSION

Post-fire peat soil were habitat for soil fungi and macrofauna. Based on the result, revegetation activities affect the soil fungi and macrofauna community. On the revegetated peat land, Soil chemical composition does not affect fungal soil and macrofauna community. The presence of fungi and macrofauna on post-fire peat soil is affected by the understory cover. The denser understory cover, the abundance of soil fungi and macrofauna will increase.

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IMPLEMENTING FOREST TENURE REFORMS: PERSPECTIVES FROM INDONESIA'S FORESTRY AGENCIES

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Received: 16 November 2018, Revised: 15 Septembr 2019, Accepted: 28 October 2019

IMPLEMENTING FOREST TENURE REFORMS: PERSPECTIVES FROM INDONESIA'S FORESTRY AGENCIES. Forest Tenure Reform implementation involves diverse actors with multiple roles and interests, more importantly government officials. Few studies have attempted to systematically document the conditions faced by government agency implementers in their efforts to implement forest tenure reforms. This study attempts to identify factors that enhance or hamper reform implementation from the perspective of individual implementers both at national and sub-national levels in Indonesia. The study was conducted through analysing data resulted from interviewing bureaucrats who were purposively selected at Central and Local Governments. Most interviewees indicated that forest tenure reforms have three interrelated objectives, i.e.: to conserve forests and restore degraded forests, to improve community livelihoods and ensure benefits are equitably distributed; and to secure the rights of access to locals, forest-adjacent or forest-dwelling communities. Reform implementation has been effective or somewhat effective in protecting community rights to access, use, manage and benefit from forests. Close to half of the respondents indicated that their activities gave special consideration to low income groups but few paid special attention to women and women's rights. Main constraints in implementation are inadequate budgets and insufficient manpower to execute tenure-related activities. Divergent priorities between national and sub-national/local levels and changes in government that redistribute personnel are additional factors that hinder reform implementation. Overall, respondents agree that reforms are only partially implemented due to technical and institutional constraints, which in turn influence the extent to which collaboration/coordination among actors can be achieved and the extent to which community tenure needs such as conflict management and resolution can be addressed.

Keywords: Bureaucrat analysis, forest tenure, implementation, constraint, gender, conflict

IMPLEMENTASI REFORMASI TENURIAL KEHUTANAN: PERSPEKTIF DARI BIROKRAT PELAKSANA PROGRAM. Program reformasi pengelolan hutan melibatkan banyak pihak dengan masing-masing peran dan kepentingannya, terutama birokrat pemerintah. Penelitian tentang peran birokrasi di dalam reformasi tenurial masih sangat terbatas. Studi ini mengkaji pelaksanaan program reformasi tenurial dari perspektif individu pelaksana di tingkat nasional dan sub-nasional di Indonesia. Penelitian dilakukan melalui wawancara responden yang dipilih dari birokrat di tingkat Pemerintah Pusat dan Daerah. Data dianalisis secara deskriptif kualitatif untuk mendalami aspek internal faktor birokrat pelaksana, penilaian mereka terhadap pelaksanaan program dan faktor penghambat serta pendukungnya. Sebagian responden menyatakan bahwa program reformasi tenurial hutan secara umum ditujukan untuk melestarikan atau memulihkan hutan yang rusak meningkatkan penghidupan masyarakat, dan menjamin hak akses masyarakat yang bergantung pada sumber daya hutan. Pelaksanaan program dinilai telah efektif dalam melindungi hak-hak masyarakat untuk mengakses, menggunakan, mengelola, dan mengambil manfaat dari hutan. Responden juga menunjukkan bahwa mereka telah memberikan perhatian khusus kepada kelompok berpenghasilan rendah tetapi hanya sedikit yang memberikan perhatian khusus pada kelompok perempuan. Kendala utama untuk pelaksanaan program terdiri dari; 1) keterbatasan anggaran; 2) kurangnya tenaga pelaksana; 3) prioritas yang berbeda antara nasional dan sub-nasional; dan 4) personil birokrat yang cepat berubah posisi. Secara keseluruhan, responden menyatakan bahwa sebagian (51–70%) program reformasi

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 doi:10.20886/ijfr.2019.6.2.117-132

tenurial hutan di Indonesia telah berhasil diimplementasikan. Upaya penyelesaian konflik sebagai persoalan dasar dalam program reformasi tenurial dapat ditingkatkan melalui koordinasi dan kolaborasi diantara para pelaku program termasuk antar sektor di pemerintahan dan mitra pembangunan.

Kata kunci: Analisis birokrasi, tenurial hutan, implementasi, kendala, gender

I. INTRODUCTION

Indonesia's forest area covers around 121 million ha (MoEF, 2016) or about 63% of Indonesia's total land area, which is 190 million ha (FAO, 2015). Over the past three decades, the forestry sector has been a key part of the economic development agenda of Indonesia. Based on the 1967 Foreign and Domestic Investment Act (No. 1/1967) and Forestry Act (No. 5/1967), the Ministry of Environment and Forestry (MoEF) allocated about 60 million ha of available state forests for timber production, either through concessions for logging (Hak Pengelolaan Hutan/ HPH) or industrial timber plantation (Hutan Tanaman Industri/HTI).

Based on Global Forest Resource Assessment/FRA (FAO, 2010, 2015), Indonesia was reported having the second highest rate of deforestation among tropical countries. The level of deforestation has been verified periodically since 1990 with the highest level of deforestation rates recorded during the period of 1996 to 2000, at 3.51 million hectares per year (MoEF, 2018). Several factors have contributed to deforestation, including excessive logging (Hidayat et al., 2018); infrastructure development (Sloan et al., 2018); development of oil palm plantations and forest fires (MoEF, 2018). Beyond that, the underlying factors are the corruption of the political and economic system (FWI, 2015); the weakness of forest governance (FWI, 2015); and inadequate mechanisms and resources for law enforcement (Hidayat, 2016) mainly on tenurial conflicts (Hall, 2013; Herawati, Hubert, Rohadi, Banjade, & Fay, 2017; Siscawati et al., 2017).

Therefore, an adaptive governance, adaptive management, and participatory learning are strategic approaches in governance reform to achieve sustainable forest management (Larson & Dahal, 2012; Nugroho, van der Veen, Skidmore, & Hussin, 2017). Forest policy in Indonesia has increasingly shifted from a more centralized, state-based management to more community-based forest management. This shift has gradually devolved forest management to local and customary communities (Siscawati et al., 2017). Recently this devolution has shown sign of accelerating, as the national policy of government of Indonesia supports improved implementation of both agrarian and forest tenure reforms.

This forest tenure reform, well known as social forestry program refers to the latest legislation i.e. Minister of Environment and Forestry Regulation No.83 of 2016 (result of revision and integration of various former social forestry rules). The Minister of Environment and Forestry takes the lead in implementing forest tenure reform. At the sub-national level, the ministry's implementing unit agency works collaboratively with the Forestry services under the authority of the local government in each province (Herawati, Liswanti, Banjade, & Mwangi, 2017). In more detail, Forest Management Unit, under the Forestry Office, plays a significant role as the main parent in the implementation of the Social Forestry program in Indonesia.

The first momentum of Indonesia's forest tenure reform is still debatable. Some of the key players in the forestry community consider that reform started in 1999 with enaction of the Forestry Law No. 41. The 1999 Forestry Law is very different from the previous one (Law No.5/1976), by providing more rooms for community participations in forestry governance (Colfer & Resosudarmo, 2012). The current legal and regulatory framework of forest governance provides considerable

opportunity for advancing forest tenure reform implementation by allocating 12.7 M ha of forest land for social forestry (De Royer, Van Noordwijk, & Roshetko, 2018; MoEF, 2018). There are five schemes in the social forestry program i.e. community forest (*Hutan Kemasyarakatan*), village forest (*Hutan Desa*), community-based timber plantation (*Hutan Tanaman Rakyat*), partnership (*Kemitraan*) and customary forest (*Hutan Adat*) (Banjade, Herawati, Liswanti, & Mwangi, 2016; Herawati, Liswanti, et al., 2017; Siscawati et al., 2017).

Forest tenure reform involves diverse actors with multiple roles and interests, including government officials (Blanc et al., 2018; Zhang & Putzel, 2016). Over the past 30 years, numerous studies in Indonesia have examined these reforms from diverse angles e.g. community participation (Djamhuri, 2008; Kusumanto & Sirait, 2012; Suharti, 2001); community livelihood (Barr et al., 2006; Maryudi et al., 2012); social capital in supporting community forestry (Lee, Rianti, & Park, 2017; Wulandari & Inoue, 2018); and sustainable forest management (Mendoza, 2000; Purnomo, Mendoza, & Prabhu, 2005; Santika et al., 2017; Tiani & Charancle, 2007). At the global level a number of studies indicating forest tenure reforms play a critical role in resource management, as evidenced by for example, granting of forest rights in Nepal (Devkota & Mustalahti, 2018; Fox, 2018; Maharjan, 2005), implementing land formalization policy in Africa (Boone, 2019) and in Malagasy (Boué & Colin, 2018); provision of certificate of ownership in Mexico (De Janvry, Emerick, Gonzalez-Navarro, & Sadoulet, 1993; Sellars & Alix-Garcia, 2018). Similarly, household land distribution in China is convincing as an effective forest and land resource management (Tan, Wang, & Heerink, 2018; Zinda & Zhang, 2018). However, few studies have attempted to systematically document the conditions faced by government agency implementers in multiple settings in their efforts to reform forest tenure.

Many previous studies point to a role of government in reforms, but also identify its weaknesses in capacity. Some of these studies often fail to dig deeper to parse out root causes or to explore the set of positive and negative stimuli and incentives faced by government agencies and implementers charged with such a sensitive and highly contentious mandate. Because of this incomplete analysis the range of possible solutions is limited and mostly inadequate. This study aimed to generate insights into the underlying processes and factors that influence implementation of tenure reforms. Specifically, it identifies factors that enhance or constrain reforms from the perspective of individual implementers in government agencies at national and sub-national levels.

II. MATERIAL AND METHOD

A. Study Site

This study was conducted at the national and sub-national levels. The central government officials were selected purposively within the Ministry of Environment and Forestry who are responsible for forest tenure reform. At the sub-national level, the respondents were selected from provincial and district Government. As part of the Global Comparative Study on Tenure (GCS-Tenure) project, the study was conducted in Lampung, Moluccas and South Sulawesi Province. Lampung Province and South Sulawesi were selected as sample sites that have conducted forest tenure reform programs with considerable progress. Moluccas was chosen as an example of a site where forest tenure reform programs are still at early stages.

B. Methods

A purposive method was used in selecting respondents, targeting those who have legal mandate in implementing forest tenure reform in the relevant organization. This survey was mainly targeted to mid and high position government officials, with a minimum level as head of division. The total respondents were 28 whom were interviewed personally from November 2016 to February 2017. The 75% of the interviewees were male and 25% were female and majority of the interviewees were

Figure 1. Study site of implementation of forest tenure reforms in four Provinces (Jakarta, Lampung, South Sulawesi, and Moluccas)

from subnational (64%) compared to national (36%) level. Potential respondents were identified through series of discussion during the project consultations with key informants from Ministry of Environment and Forestry. The interviews were mostly conducted at respondent's office during working hour. The interviewer used paper-based questioner and electronic tools for data input. The discussions were also recorded by permission from the interviewee. The shortest time for an interview process was 2 hours, but sometimes longer, up to 4 hours depending on the situation and additional information provided by respondents.

The survey inquired multiple reforms or implemented laws that are related such as forest tenure reform, land tenure or agrarian reform, regional autonomy and decentralization. While it targeted key individuals responsible for implementing a specific law, the individuals were also asked for their views on other laws to the extent that they are implicating implementation of their primary reform or law.

The interviews which used a structured questioner aimed to understand roles and responsibilities of government implementing agencies, the challenges faced during reform implementation, and their priorities, aspirations, expectations, and capabilities. The study also examined institutional arrangements to implement the reforms including extent of coordination and collaboration between relevant actors. In addition, the study also analysed gender aspect such as who are the target beneficiaries of the program, whether they give special consideration for woman group and gender norm in social aspect that may facilitate or hinder. The interviewees were asked also to provide a self-assessment of the extent to which reform has been implemented and what needs to be done to improve implementation. A full guideline including set of questioner is available online https://data.cifor.org/file. xhtml?fileId=1766&version =RELEASED&version=.0) in the "Securing Tenure Rights for Forest-Dependent Communities: Implementing agency surveys in Peru, Uganda, Nepal and Indonesia" (Herawati & Mwangi, 2017).

The survey was designed for Open Data Kit and deployed for data collection through mobile applications using ONA platform1.

[1] ONA is a social enterprise that builds the data infrastructure to drive change. Using mapping and data technologies from its namesake mobile survey platform, ONA also builds mobile apps such as OpenSRP, which helps frontline health workers deliver services more effectively to rural families. The mapping work, referenced in TIME, is, an innovative approach to support precision service delivery

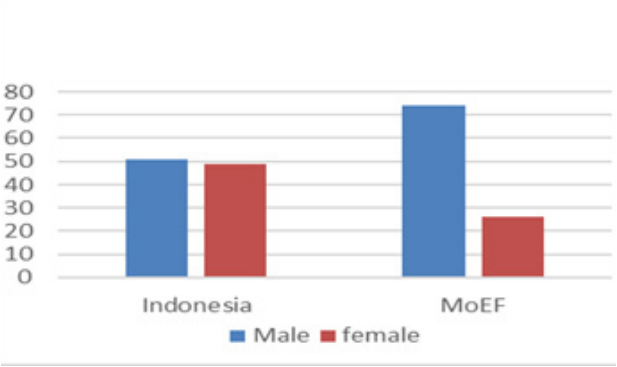

Figure 2. Gender composition on Government officials overall in Indonesia and in MoEF
Source: MoEF (2016)and BPS (2017)

An Android-based tablet version of a complex interview was developed and successfully validated. Use of tablets may be costlier than paper for small samples and less costly for large studies (Giduthuri et al., 2014). Beside for collecting interview data surveys, this technology was proven valid to be applied for community-based forest monitoring (Devries, Pratihast, Verbesselt, Kooistra, & Herold, 2016; Pratihast et al., 2014).

C. Analysis

Once the survey was completed, data was downloaded from ONA server for analysis. The data from ONA was pre-processed in R program using ONA R-package. All the data were analyzed using descriptive statistics mainly by calculating its percentage through Exploratory Data Analysis (EDA) approach. Open-ended and closed-ended questions were both coded. Closed-ended variables that had many questions were re-coded into broader groups using a transformation tool in SPSS software. Coding was done for open ended questions and closed ended questions that had many options.

Exploratory Data Analysis (EDA) is the general descriptive analysis statistics done on the entire dataset but most importantly, to the variables that directly answer our research questions. The exploratory analysis covered three aspects of the data which are; background information of implementing agency comprising gender composition, skill and knowledge; general information related to forest tenure reform, and assessment of forest tenure reform and its constraints. The techniques used in EDA consisted of cross tabulation summaries, scatterplots, bar graphs and histograms. This was done to maximize insight into a data set, uncover underlying data structure, extract important variables and detect outliers or anomalies and to test underlying assumptions.

III. RESULT AND DISCUSSION

A. Gender, Knowledge, Skills and Capacity of Implementing Agency Officials

Three-quarters of the respondents were male, even though women have similar tasks and responsibilities in implementing the program. This finding is unsurprising as the forestry sector is commonly perceived as a male dominated sector (Elias et al., 2018; Gurung & Lama, 2003). Although data on the overall gender composition of Indonesia's government officials shows a fairly good balance between women and men, the MoEF is highly skewed with 74% men and 26% women (Figure 2). Table 1 shows the dominance of male in mid to highest level of government officials career (BPS, 2017).

B. Reform Types, Objective and Target Beneficiaries

The forest tenure reform in Indonesia under social forestry has introduced five

Tabel 1. Composition of male and female staff on the mid to high position levels

No	Position	Male (person)	Female (person)
1.	Echelon V	10.206	4.908
2.	Echelon IV	220.193	148.304
3.	Echelon III	66.845	51.507
4.	Echelon II	14.002	10.928
5.	Echelon I	610	382

Source: BPS. (2017)

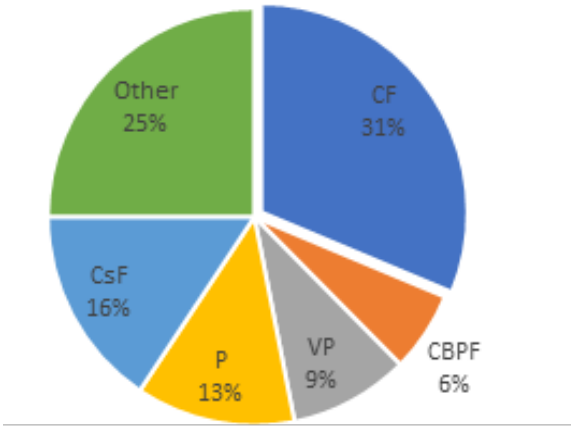

Figure 3. Proportion of respondents based on implementing forest tenure reform

schemes, i.e. community forest (*Hutan Kemasyarakatan*/HKM), village forest (*Hutan Desa*/HD), community based plantation forest (*Hutan Tanaman Rakyat*/HTR), partnership (Kemitraan) and customary forest (*Hutan Adat*/HA) (Figure 3).

Study shows that most respondent (75%) directly implement all types of forest tenure reforms on the ground. Specifically, 31% implements on community forestry (HKM); 6% community-based plantation forest, 9% village forestry, 13% partnership and 16% customary forestry schemes. The remaining 25% support regional planning and forestry development as they are the main stakeholders with high level of power and influence for implementing forest tenure reform.

Respondents mentioned "Forest tenure and right" and "Community Forestry" as the main thematic areas in which they had worked during the previous year (Figure 4). No respondent mentioned gender mainstreaming aspect, which suggests forest tenure reform in Indonesia relatively has not yet focused on this issue.

The objectives of forest tenure reforms range from securing the tenure rights of communities and supporting community access to conserving the forest (including restoring degraded forests) and improving community livelihood. Twenty one percent (21%) of the respondents reported that reforms were crafted in response to secure tenure rights of community; 20% indicated that reforms sought to support community access, use and management of forest lands, 16% indicated that the reforms sought to conserve forest including restoring degraded forest, and 13% noted that they sought to improve livelihoods of local community and ensure that benefits from forest resources are equitably distributed among local communities (Figure 5).

The study found that the target beneficiaries were categorized as 41% for local communities, 22% for local government and 12% for

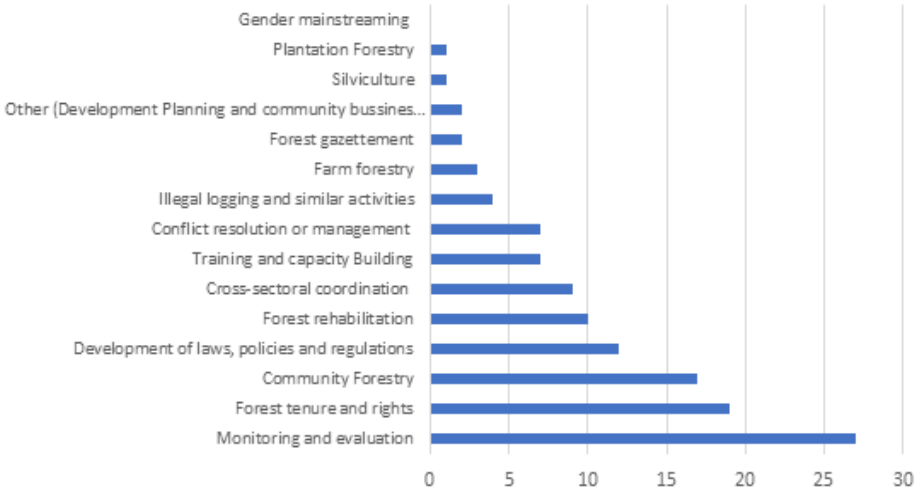

Figure 4. Thematic area of bureaucrats' activities

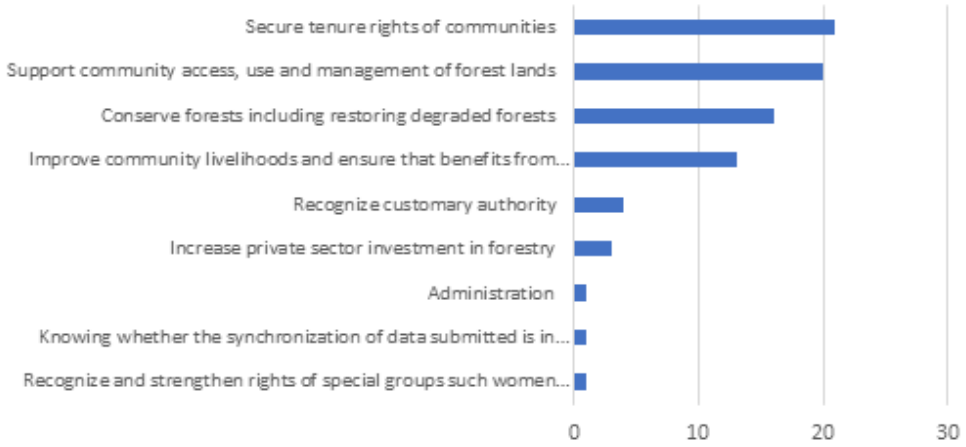

Figure 5. Objectives of forest tenure reforms

private sector (Figure 6). Only 9% and 7% of correspondents said that the reforms targeted non-governmental organizations (NGOs), the poor, and women respectively. This in turn indicated that most activities would very likely have targeted local communities in general. Most implementers targeted local communities but did not disaggregate them into constituent groups. Greater disaggregation is required as it helps to better address the needs and priorities of social groups, which are often different.

C. Assessment of Forest Tenure Reform Implementation

The implementers were asked about main tenure problems faced by community they serve. Figure 7 shows that government officials perceived illegal settlement or land invasion, land allocation to private companies and illegal cultivation in forests as the most widespread tenure problems faced by communities. The case of land allocated to private companies causing conflict between the local community and company in many places where logging

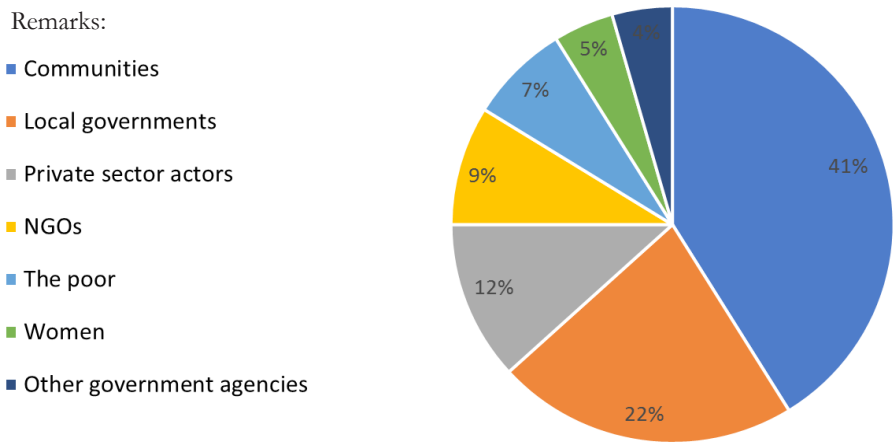

Figure 6. Target beneficiaries of forest tenure reforms

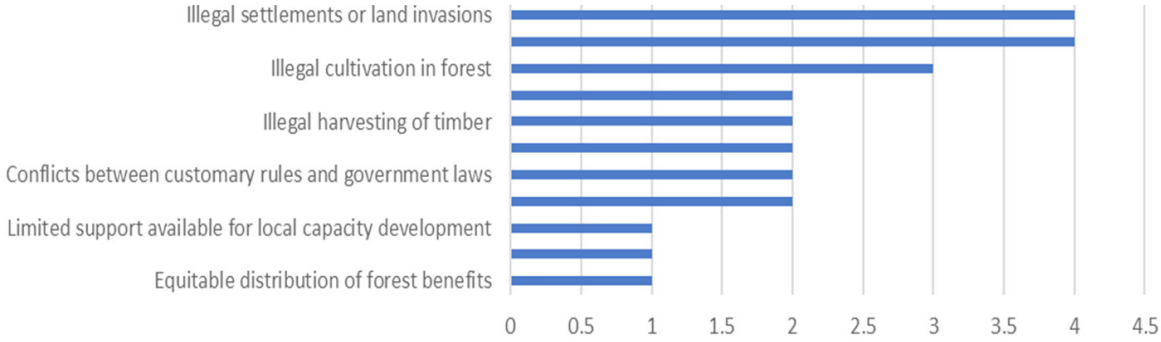

Figure 7. Tenure related needs and problems faced by community based on bureaucrat's perception (Notes the scale presenting score of priority)

companies and plantation concession operated. In Maluku province, the study found the most common problem in the community was inconsistent boundary demarcation between state forest and customary territory. In addition in Maluku, overlapping individual claims within a customary territory leads to conflicts over boundaries within community. Several studies (Liswanti, 2007; Siscawati, 2017) indicate that overlapping boundaries among customary territories and incompatibility/ mismatch between maps used as a reference in determining the object of forest tenure reform with real situation in the field has become an inhibiting factor for the acceleration of forest tenure reform in Indonesia.

Implementers have taken several measures to safeguard community rights (Figure 8). They educate or inform communities on their rights under the law to overcome illegal activities. They also clarify boundaries through consultation and mapping, and work closely with customary or traditional leaders, while coordinating with agriculture, lands, and other sectors to minimize threats and to anticipate potential tenure conflicts.

Figure 9 illustrates assessment of implementers for achievement of each objective. According to respondents, the objective of supporting communities' access, use and management of forest land were mostly achieved. Securing community tenure rights and conserving forest, including restoring degraded forests and improving community livelihood, were also mostly achieved. Ultimately, support for community access, use and forest was the

Figure 8. Measures to safeguard community rights

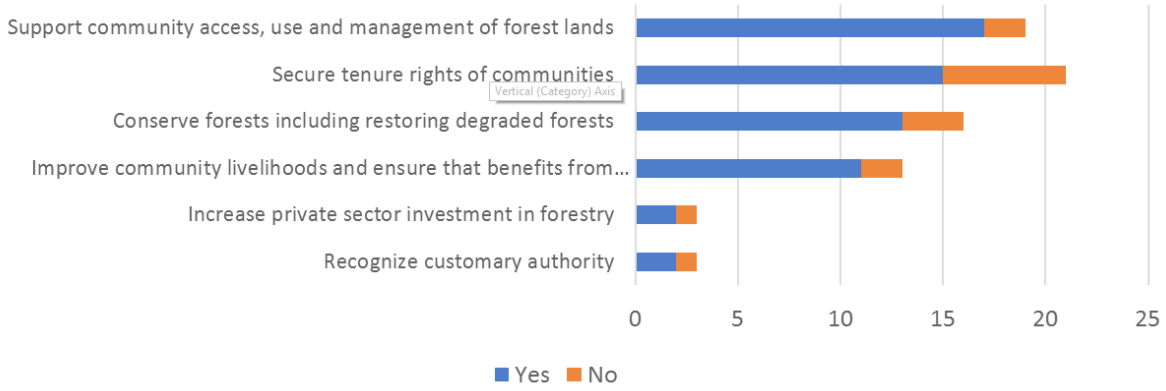

Figure 9. Implementers' assessment of objective of forest tenure reform achievement

greatest achievement, as many stakeholders including the President of the Republic Indonesia, support forest tenure reform as part of Nawacita- the current President's vision on Indonesia's development. This political view has led to increase in total area of forest that can be accessed and used by community.

More than half (53%) of government officials viewed activities to implement reforms as somewhat effective, while 29% and 11% said they were effective to very effective, and only 7% mentioned they were not effective (Figure 10). Figure 11 identifies how respondents perceive the effectiveness of activities (Figure 11).

Those who argue "very effective" achievement (91-100%) mention the strong legal foundation for community to secure their access and right.

"It can be considered very effective in providing community access, because there is no opportunity for other actors to manage that specific area. The farmers have strong basis for legality and are highly confident on their right of forest land. In addition to that, if we give them full right such as in customary forest, there is a risk that the community will face threat for land trading. The high risk for community on losing their livelihood resources is expressed." (pers.com, 2016).

The few who said that reform implementation was effective or very effective indicated that nearly all activities had been implemented as planned. Most cases of tenure conflict had been resolved. Those who said that implementation was somewhat effective, indicated about half

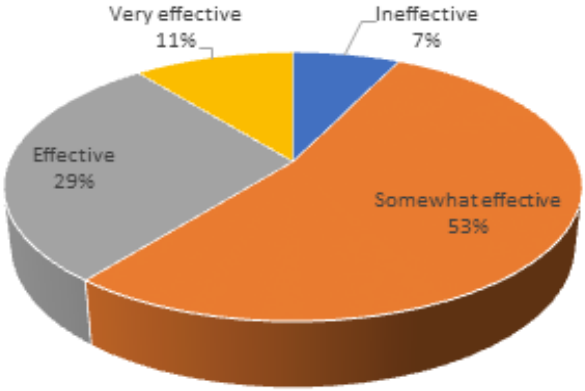

Figure 10. Effectiveness of tenure reform implementation activities

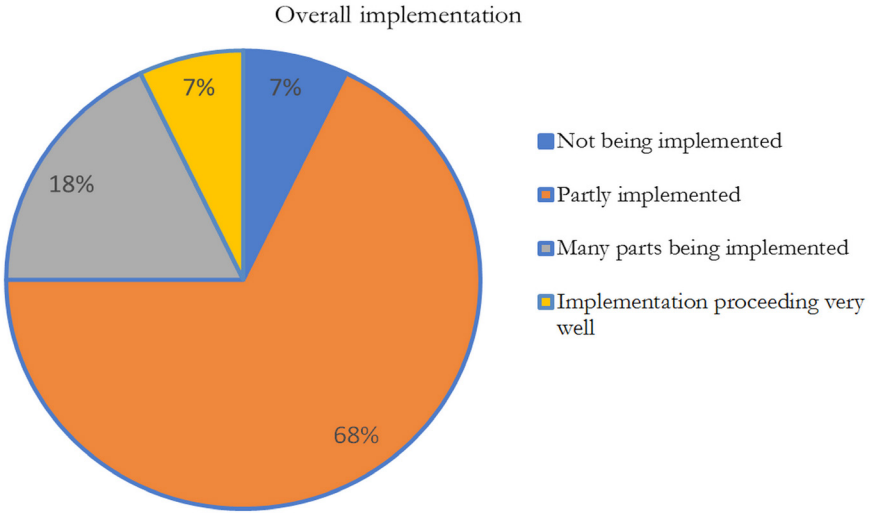

Figure 11. Overall implementation of forest tenure reform

of activities were completed. For example, in the case of HKm half of the previous year's allocation targets were licensed and thus achieved. Those who said that reforms were not effective worked primarily in divisions that had only been operating for two years.

In terms of the overall forest tenure reform implementation, most respondent (68%) stated it was partly implemented; 18% said many part being implemented; 7% said it was not being implemented and the rest, 7% saw implementation proceeding very well. Most respondents compare target against achievement. At national level, they refer to the target of last period (2001-2014) which planned to allocate 2.5 M ha of forest for the community but unfortunately only achieved less than 1 M ha (pers.com, 2016). Moreover, they do not feel confident of achieving the new national target of 12.7 M ha in 2019.

D. Forest Tenure Reform Constraints

The top four constraints to reform implementation were: lack of knowledge on rights and policies both at community level and at government officials supporting the implementation, in particular from other related sectors; an onerous process to obtain permits; inadequate budgets and lack of sufficient human resource to execute initiatives (Table 2). Banjade et al., (2015) also noted the registration process as an enormous constraint to implement reforms.

The respondents reported that economic, social and political factors affected the implementation of tenure reforms (Figure 12). Most importantly, economic factors negatively affected implementation of various activities. The bureaucrats dealt with the problem of inadequate budgets and poverty in the community. To address poverty at community level, tenure reform is intended to enhance household incomes. Some respondents mentioned that budget allocation is related to national economic priorities, which have recently more focused on infrastructure development. Conversely, MoEF rank, 17 out of 34 ministries or about 0.8–1.2% of state revenue and expenditure budget.

Customary practice, authority and ethnicity were reported to be the major social factors affecting reform implementation (Figure 13). Communities insist that forests belong to them and are agitating for full ownership. They feel that participating in social forestry program legitimise state authority on their land. All respondents reported that religious practice and gender norms are not constraining factors.

About a third of respondents both at national and sub national levels reported that politicians interfered much more than they supported reform implementation (Figure 14). According to respondents at sub national level, some politicians pressure bureaucrats to provide community members with right and access to land in order to buy votes. Change in government structure were also reported to influence the implementation of forest tenure reforms. This issue is related to positioning the right man/woman in the right position at the right time.

Table 2. Main constraints/obstacles in forest tenure reform in Indonesia

Rank	Main Constraints/ obstacles	Score
1	Lack of knowledge on rights and policies	1.61
2	Onerous process to obtain a permit that requires years to complete	1.25
3	Inadequate budgets	1.25
4	Lack of sufficient human resources to execute initiatives	1.25

Note: the scale was calculated based on its frequency and weighting system within the factor

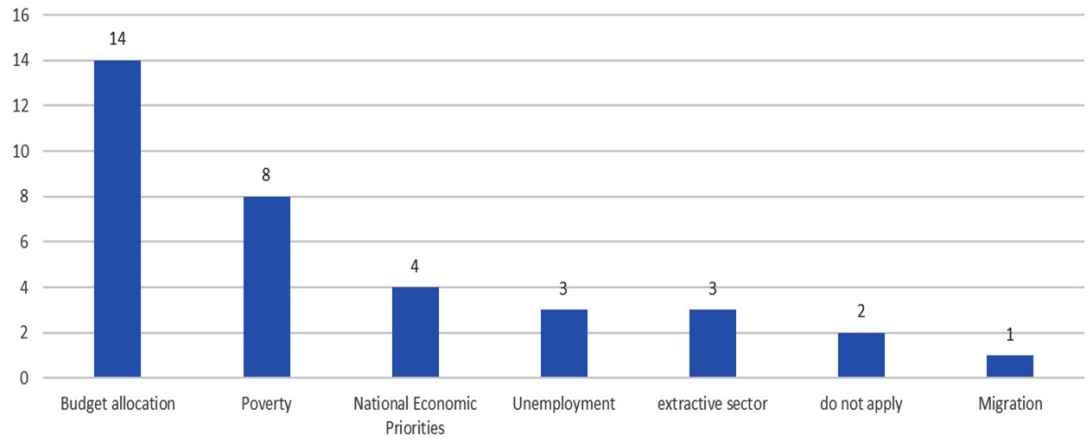

Figure 12. Economic factors that have affected implementation of forest tenure reforms

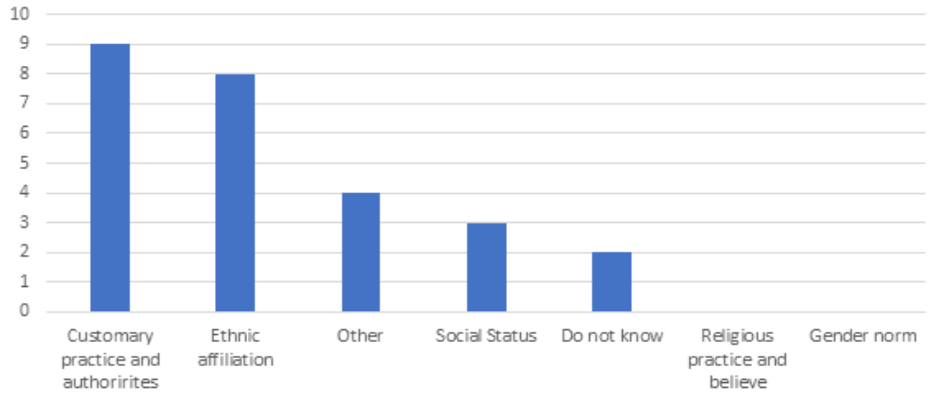

Figure 13. Social factors that constraint or hinder forest tenure reform implementation

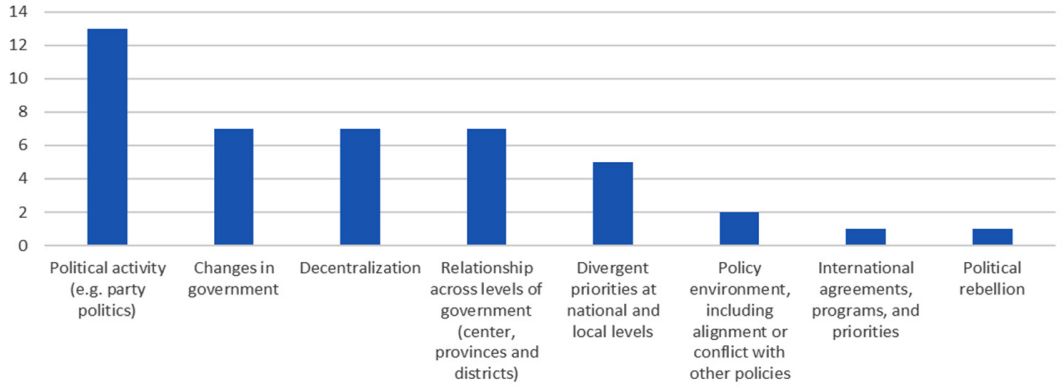

Figure 14. Political factor that constraint or hinder forest tenure reform implementation

IV. CONCLUSION

The study revealed that political, economic and social factors influencing bureaucrats in implementing forest tenure reforms. Some bureaucrats have a mandate to implement social forestry as they work for organizations that have long been in charge of this program. Other bureaucrats work for organizations established about two-three years ago after the revamping and restructuring due to merger of the Ministry of Forestry and Ministry of Environment in 2014. Even though their organizational structure is new, bureaucrats who implement forest tenure reforms at national level are knowledgeable or well informed about tenure issues. Although these organizations have just been established, it does not become a problem for them to continue the program. Individually, most bureaucrats clearly support community access on forest land to support livelihoods, while respecting the need to conserve and rehabilitate degraded forest. They are also clear on targeted beneficiaries, although attention to women and marginalized groups has not been particularly prominent.

Economic factors are the primary factors limiting allocation of development budgets and influencing the level of poverty at community level. Although social forestry is on the agenda of the current president to encourage land access and rights of the community, respondents reported that budget support for this activity is still insufficient. Forestry is not among the top ten of national priorities.

Indeed, budget allocation for MoEF ranked 17 out of 34 ministries.

Social factors are also reported as obstacles to implementation of forest tenure reforms when dealing with indigenous or customary communities. The strong claims of indigenous peoples over forest lands as ancestral heritage cause them to reject government claims on forest lands. Implementation is constrained by a lack of legitimacy and acceptance of the reforms by communities. They view themselves as full owners of the forests that they occupy and reject the partial rights offered by more longstanding social forestry schemes.

Most of the bureaucrats think that reform implementation is somewhat effective, having only partial implementation of reform activities and partial achievement of targets. This level of effectiveness can be linked to low availability of budgets. This, in turn, reflects the low priority of forestry in the development agenda at both national and sub-national levels compared to other sectors. Onerous processes for licensing and registration are another limiting factor. Lack of knowledge of policies and laws and lack of sufficient human resources to execute reforms may, however, limit the impact of these positive shifts.

Most implementers targeted local communities but did not disaggregate them into constituent groups. Greater disaggregation is required as it helps to better address the needs and priorities of social groups, which are often different. The customary rights of indigenous groups have gained currency in the past five years given the constitutional court rulings and a presidential decree. Gender differentiation needs similar attention to recognize the different needs of women and men. Although Indonesia has a Ministry of Woman's Empowerment and Child Protection and has signed several treaties on gender equality, forestry continues to be male-dominated.

ACKNOWLEDGEMENT

We are grateful to the European Commission, the Global Environment Facility, the International Fund for Agricultural Development and the UN Food and Agriculture Organization for supporting this work. Thanks, are also due to Mia Siscawati for invaluable input, Mani Ram Banjade for discussing during respondent determination and other CIFOR-GCS Tenure team in Peru, Nepal, and Uganda. We thank to Safia Agrawal and Mark Foss who provided valuable input on language editing.

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THE POSSIBILITY STUDY OF BRIQUETTING AGRICULTURAL WASTES FOR ALTERNATIVE ENERGY

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Received: 11 December 2018, Revised: 15 October 2019, Accepted: 28 October 2019

THE POSSIBILITY STUDY OF BRIQUETTING AGRICULTURAL WASTES FOR ALTERNATIVE ENERGY. Globally energy crisis is known as a new era's biggest problem. The use of agricultural wastes into the form of briquettes are the best alternative option of renewable energy sources. This paper studies the possibility of utilizing agricultural wastes into briquetting production with high calorific value. Major wastes were sugarcane bagasse, coffee husk, wheat straw, peanut shells, rice husks, paddy straw, corn stalks, sunflower stalk, soybean husk, coir pitch, jute sticks, caster seed shells, mustard stalks, cotton stalks and tobacco wastes for energy in the form of briquettes biomass. Observations were taken from Department of Bioenergy, Tamil Nadu Agriculture University, Coimbatore (Tamil Nadu), India of different raw materials and briquettes of those raw materials. Results show that there were very satisfactory results after evaluation. In general, calorific value briquettes is higher than those of raw materials. Raw materials of agricultural wastes and forest residual wastes ranged from 1,200-3,000 Kcal/Kg and its calorific values are significantly higher in briquettes than raw materials. Raw material of rice husk produces 3,000 Kcal/kg and briquettes of rice husk produces 3200 Kcal/kg. Likewise differences were observed in all types of agricultural wastes. The input and output ratio ware observed as cost-effective and profitable in all parameters for the farmers. Briquetting production is the emerging, ecofriendly, cost effective and profitable technology for the use of agricultural residues. It may help farmers to improve its socio-economic status and proper reuses of agricultural wastes.

Keywords: Briquetting, reuse, agricultural wastes, biomass, calorific value

STUDI PEMANFAATAN BRIKET LIMBAH PERTANIAN SEBAGAI ENERGI ALTERNATIF. Krisis energi global dikenal sebagai masalah terbesar di era baru. Penggunaan limbah pertanian dalam bentuk briket adalah pilihan alternatif terbaik dari sumber energi terbarukan. Tulisan ini mempelajari kemungkinan pemanfaatan limbah pertanian menjadi produksi briket dengan nilai kalor tinggi. Limbah utama yaitu ampas tebu, sekam kopi, jerami gandum, kulit kacang, sekam padi, jerami padi, tangkai jagung, tangkai bunga matahari, kulit kedelai, sabut kelapa, tongkat rami, kulit biji kastor, tangkai mustard, batang kapas dan limbah tembakau untuk energi dalam bentuk biomassa briket. Pengamatan dilakukan pada berbagai bahan baku dan briket bahan baku tersebut di Departemen Bioenergi, Universitas Pertanian Tamil Nadu, Coimbatore (Tamil Nadu), India. Penelitian menunjukkan adanya hasil yang sangat memuaskan setelah evaluasi perbedaan antara nilai kalor bahan baku dan briket bahan baku tersebut. Bahan baku limbah pertanian dan sisa limbah hutan berkisar 1.200-3.000 Kkal/Kg. Setelah dilakukan evaluasi, hasil pengamatan menunjukkan perbedaan siginifikan antara nilai kalor briket dan nilai kalor bahan baku. Bahan baku sekam padi menghasilkan 3000 Kkal/Kg dan briket sekam padi menghasilkan 3.200 Kkal/Kg. Demikian juga perbedaan diamati pada semua jenis limbah pertanian. Rasio output input diamati sebagai biaya efektif dan menguntungkan di semua parameter untuk petani. Produksi briket adalah teknologi yang muncul, ramah lingkungan, hemat biaya, dan menguntungkan untuk penggunaan residu pertanian. Pemanfaaan briket limbah pertanian dapat membantu petani untuk meningkatkan status sosial ekonomi dan penggunaan kembali limbah pertanian dengan tepat.

Kata kunci: Briket, penggunaan kembali, limbah pertanian, biomas, nilai kalor

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 doi:10.20886/ijfr.2019.6.2.133-139

I. INTRODUCTION

Economic growth, industrialization and growing population in the developing countries of Asia contribute to a rapidly growing demand for energy in the region while global environmental concerns call for limiting use of fossil fuels (Sainu et al., 2017). Production of biomass and biofuels are growing industries as interest in sustainable fuel sources is growing (Obi et al., 2013). In the present era facing the problems of price hike of liquid fuels, especially furnace oil are growing at steeper rate than solid fuel price, substitution of furnace oil to solid briquette is one of the alternative Renewable Energy Technologies.

Renewable Energy Technologies present a viable option of meeting the growing energy demand, especially in remote and rural areas (Patil et al., 2012). In the last decades, renewable energy sources are preferred, e.g. wind energy, water energy, solar energy and biomass energy. The effort results of more extensive utilization of the wind energy and solar energy are not conclusive in the conditions. But the utilization of the biomass energy appears as the perspective (Brozek et al., 2012). The process involves conversion of low density bio mass waste to high density bio mass fuel called briquettes. The more replicable, appropriate, cost effective, locally available, easy to make, environment friendly and culturally fitting a technology is for the briquetting of biomass, the higher its chance of success (Hood, 2010).

Briquettes have replaced the use of conventional and non-renewable fuels such as coal, wood, fossil fuel and others. This technology does not involve use of any kind of harmful chemical, which on burning emits poisonous gasses or smoke. Farmers are facing the problems related to proper disposal of agricultural wastes in to proper place. Most rural communities lack access to electricity and the cost of electricity is also unaffordable to the rural people. Energy usage by rural dwellers has been mainly for cooking or heating applications (Obi, 2014). Briquetting works on the natural phenomenon, which includes use of natural binder. Every bio mass contain a solid substance named lignin, which is when subjected to heavy pressure and heat gets converted into liquid, which binds the waste to produce high density bio mass fuel. A briquette is a block of flammable matter which is used as fuel to start and maintain a fire (Surajo & Mustapha, 2017)

Compaction of bulky combustible materials for fuel making purposes has been a technology widely used by many countries. There have been several researches carried out on production of fuel briquettes for both domestic cooking and industrial applications. One of the major driving forces behind these researches is the need to address the environmental consequences and health hazards associated with the use of solid fuels and also an effective means of managing agro wastes. Among the common types of briquettes widely used in some countries are biomass briquettes, coal briquettes and charcoal briquettes, etc. However, more recently, it has been shown that blending coal and biomass (agro wastes) gives rise to a briquette with better combustion properties and pollutant emission compare to the conventional coal briquette (Raju et al., 2014).

A number of companies in India have switched from furnace oil to briquettes to save costs on boiler fuels. The use of briquettes is predominant in the southern parts of India, where coal and furnace oil are being replaced by briquettes. A number of units in North India are also using biomass briquettes as boiler fuel. Use of biomass briquettes can earn Carbon Credits for reducing emissions in the atmosphere. Briquettes also provide more calorific value/ kg and save around 30-40% of boiler fuel costs (3e Savers India LLP). Billions of tons of agricultural residue are generated each year in the developing and developed countries.

This volume of biodegradable wastes can be converted to an enormous amount of energy and raw materials. Agricultural biomass waste converted to energy can substantially displace fossil fuel, reduce emissions of greenhouse gases and provide renewable energy to people in developing countries, which is still lack of

access to electricity. As raw materials, biomass wastes have attractive potentials for large-scale industries and community-level enterprises (Quartey, 2011). Most of the agricultural wastes are used in production of briquettes. Briquettes are eco-friendly renewable source of energy and avoid adding fossil carbon to the atmosphere. Objective of the study was to analyse the calorific value of briquettes, which may help to use of agricultural wastes in proper way. Biomass briquetting production may be the good alternate energy source in the future.

II. MATERIAL AND METHOD

A. Study Site and Raw Material

Study was carried out at Forest College and Research Institute, Mettupalayam, Tamil Nadu Agriculture University, India and College of Agriculture, Coimbatore, Tamil Nadu Agriculture University, India. A Briquetting unit was installed in FC and RI during 2009, which is running regularly. All type of forest and agricultural waste were the major raw materials used for the briquetting production. These were collected from industries around Mettupalayam to run the machinery. The process of compaction of residues into a product of higher density than the original raw material is known as densification or briquetting. Densification has aroused a great deal of interest in developing countries all over the world lately as a technique for upgrading of residues as energy sources. Following raw materials were used to production of briquettes (Table 1 and Figure 1) (Tripathy et al., 1998).

B. Method

Following steps were adopted to prepare briquettes at the department.

1. Drying: Drying is essential part of briquetting production as per used raw material. A moisture content of 8-12% is normally ideal for agricultural wastes and wood densification. The maximum allowance of moisture content in mechanical piston presses is 15%, whereas hydraulic systems can handle moisture contents up to 15-30 %, depending on design of machine. Used model was Random Piston Type model.
2. Comminuting (sizing raw material): The raw material used in production of briquettes must be of a suitable particle size before it enters the densification process. The particle size should not exceed 25 % of the diameter of the final product for most densification equipments (Bhattacharya, 1989). Forest

Table 1. Listed below are some of the materials used during formulating briquettes

Sugarcane bagasse	Coffee husk	Wheat straw	Peanut shells
Rice husks	Paddy straw	Corn stalks	Sunflower stalk
Groundnut shells	Rise husks	Castor husks	Coffee bean husks
Soybean husk	Coir pitch	Jute sticks	Caster seed shells
Mustard stalks	Cotton stalks	Tobacco waste	Corn waste
Agro-forestry wastes	Barks	Leafs	Saw dusts

Figure 1. Raw material used to prepare briquettes and briquetting machine

College & Research Institute has briquetting machine with the capacity to produce of 250 kg/hr briquettes and size of product is 30-40 mm and another capacity is 500 kg/hr, the size of product is 50- 60 mm.

3. Conditioning: To make the raw material softer and easier to work within the densification process, superheated steam added in the stage between comminuting and densification (Hirsmark, 2002). A softer raw material contributes to binding the material together and results in briquettes that do not fall apart easily.
4. Densification: There are a few different technologies for production of briquettes; mechanical- or hydraulic piston press densification, screw press densification and roll press densification units.
5. Cooling: To allow the briquette to cool off in an optimal way, most piston press systems need a cooling track where the material slowly can drop in temperature before they fall apart into desired lengths (3 metre).
6. Storing and transporting: After cooling, the briquettes are normally stored before combustion. Storing may take place outdoor under roof, indoor, in container or in other ways. The transport from production unit to combustion is by truck and tractor.
7. Combustion: Most of the combustion plants for solid fuels can utilize briquettes. Industrial boilers though are most suitable for and convenient with the task. In the cases where the briquettes are turned into powder after transport to the heating plant, combustion takes place. Used model for briquetting production was Random Piston Type model (Figure 1).
8. Calorific Value: The calorific value was determined by using Oxygen bomb calorimeter in accordance with Standard Method by the Bioenergy Department, Tamil Nadu Agricultural University, and Coimbatore (Tamil Nadu) India. Calorimetry is the science of measuring quantities of heat, as distinct from "temperature". The instruments used for such measurements are known as calorimeters. The calorific value (heat of combustion) of a sample may be broadly defined as the number of heat units liberated by a unit mass of a sample when burned with oxygen in an enclosure of constant volume. In this reaction the sample and the oxygen are initially at the same temperature and the products of combustion are cooled to within a few degrees of the initial temperature; also the water vapor formed by the combustion is condensed to the liquid state. The initial and final temperatures are not the same – differing by the amount of temperature rise in the calorimeter – but the effect of this difference is small and usually it is neglected. Thus the term calorific value (or heat of combustion) as measured in a bomb calorimeter denotes the heat liberated by the combustion of all carbon and hydrogen with oxygen to form carbon dioxide and water, including the heat liberated by the oxidation of other elements such as sulfur which may be present in the sample (Parr Instrument Company, 2013).

III. RESULT AND DISCUSSION

Manufacturing process of briquettes has been carried out at Forest College and Research Institute, Mettupalayam (Tamil Nadu). Study was focused on use of agricultural wastes in efficient manner. All Calorific value of different raw material and briquettes from it has been taken from the department of Bioenergy, Tamil Nadu Agriculture University, Coimbatore (Tamil Nadu).

Calorific value of briquettes showed significant difference from their raw materials. The differences of Calorific value of briquettes from coconut husks and raw were found highest 1460 kcal/kg followed by paddy straw 1070 kcal/kg, groundnut shell 530 kcal/kg and sugar cane bagasse 384 kcal/kg. The minimum differences were found in cotton husk 100 kcal/kg. Table

Table: 2. List of calorific value of raw agricultural waste and briquettes of it

No.	Raw material	Calorific value of raw material (kcal/kg)	Calorific value of briquettes (kcal/kg)	Calorific value Raw-Briquettes (kcal/kg)
1.	Rice husk	3000	3200	200
2.	Groundnut shell	4000	4530	530
3.	Cotton husks	4400	4500	100
4.	Coconut husks	3500	4960	1460
5.	Coir pitch	3975	4150	175
6.	Sunflower stalk	4180	4300	120
7.	Soya bean husk	3990	4170	180
8.	Sugarcane baggage	3996	4380	384
9.	Paddy straw	2400	3470	1070
10.	Tea waste	4020	4237	217

Figure 2. Processing of briquette into final product briquettes

2 showed very significant approach of use of agricultural wastes in briquetting production. Briquetting production may helps to increase the socio economic status of farmers.

Results were positive and good sign of use of agricultural wastes. Briquetting production is efficient technique for enhancement of livelihood of farmers (Patil et al., 2012). Briquettes were found higher calorific value than the raw material also observed by (Nurdin et al., 2018). Study was focused to recycle and reuse of wastes in ecofriendly manner. Wastes from different food based industries were used for fuel briquette production, which is a source of sustainable energy generation. It is environmentally friendly, cost effective and affordable compared to fossil fuel (Onukak et al., 2017). The calorific value of briquetted fuel shows that, the calorific value of combination 1 briquettes was found highest (5154.58 kcal/kg) and briquettes from combination 3 have least calorific value of 4188.64 kcal/kg (Sengar et al., 2012).

Agricultural waste covers a wide range of different species which show large variation in composition and fuel characteristics. However, the percentage composition of the combustible elements in the agricultural waste whether in loose form or briquette form are very low compare to fossil fuels. The calorific value is the energy released during combustion of unit mass of fuel. It forms the basis for determining the performance of energy system (Ioannis et al., 2016). Hence the low emissions of the oxides of the combustible elements. The composite rice husk and sawdust briquette has the highest theoretical Air- fuel ratio followed by composite groundnut shell and sawdust briquette (Nicholas, 2012). Manufacturing conditions such as temperature and pressure also

influences calorific value (Tumuru, 2010). The briquetting of biomass material leads to increase net calorific value per unit volume, reduces transportation cost, improves bulk density and also improves handling characteristics. Study has supported to the scenario of renewable energy, the effects of calorific value to increase the efficiency of power generation (Shukla & Vyas, 2015).

Briquetting of agricultural wastes/crop residues provides an excellent energy source and an environmental friendly combustible fuel. This actually prompted this present studies which is aimed at comparing the calorific values of briquettes produced from some available agricultural residues (Idah & Mopah, 2013). It was also observed that the higher the compaction pressure, the higher the density. From this result, it is evident that the briquetting process has been able to obtain increased density, which is a valuable factor in briquetting. Calorific values maximize with higher density and suitable for efficient transportation and safe storage. An increase in the maximum density was observed at all particle sizes, as pressure increased (Oladeji, & Enweremadu, 2012).

IV. CONCLUSION

The present study indicated that calorific values of all wastes were showed higher as compare to their respective raw material. The differences of calorific value of briquettes from coconut husks and raw were found highest 1460 kcal/kg followed by paddy straw 1070 kcal/kg, groundnut shell 530 kcal/kg and sugar cane bagasse 384 kcal/kg. The minimum differences were found in cotton husk 100 kcal/kg. Briquetting production is the best technique to use agricultural wastes.

ACKNOWLEDGEMENT

The author would like to thanks to Forest College and Research Institute, Mettupalayam (Tamil Nadu) and Bioenergy Department, College of Agriculture, Tamil Nadu Agriculture University (Tamil Nadu), Coimbatore, India for their support and appreciation for this work.

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INSTITUTIONAL AND MARKETING EFFICIENCIES OF DRAGON'S BLOOD MANAGEMENT IN BENGKULU PROVINCE, INDONESIA

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Received: 7 March 2018, Revised: 10 october 2019, Accepted: 31 October 2019

INSTITUTIONAL AND MARKETING EFFICIENCIES OF DRAGON'S BLOOD MANAGEMENT IN BENGKULU PROVINCE, INDONESIA. Dragon's blood is amongst non timber forest products in which its of supply depends on its natural availability and the demand of the commodity. This study discusses institutional market, value chains and marketing efficiency of dargon's blood. Primary and secondary data were collected by interview based on snowball sampling method. Data were analyzed descriptively and quantitatively. Institutional economics approach was used to determine institutional marketing of dragon's blood. Results show that the relations and behavior of marketing agents of dragon's blood will form an institutional marketing with patron-client system, because of unbalanced position in terms of economy, accessibility and information. There were four marketing channels that exist in the research area. All of these marketing channels of dragon's blood can be categorized as efficient marketing in which an average value of marketing efficiency were 17.86%. Channel 3 is the most efficient marketing channel with the smallest efficiency value of 12.86% and high farmer share (62.86%): penjernang – dragon's blood traders at the village level – urban merchants in the district level – wholesalers at the province level – exporter. This result indicates that the most efficient marketing channel was the channel where the collectors sell dragon's blood in the form of resin.

Keywords: Bengkulu Province, dragon's blood, local institutions, marketing efficiency

EFISIENSI KELEMBAGAAN DAN PEMASARAN ROTAN JERNANG DI PROVINSI BENGKULU, INDONESIA. Rotan jernang adalah salah satu hasil hutan bukan kayu (HHBK) dimana jumlah pasokannya tergantung pada ketersediaan alam dan permintaan pasar tidak dapat ditentukan. Penelitian ini bertujuan untuk mengetahui bagaimana kelembagaan, rantai nilai, dan efisiensi pemasaran rotan jernang. Data yang dikumpulkan adalah data primer dan sekunder yang dikumpulkan dengan metode snowball sampling dan wawancara. Selanjutnya, data dianalisis dengan metode deskriptif kuantitatif. Pendekatan ekonomi digunakan untuk mengetahui kelembagaan dari sistem pemasaran rotan jernang. Hasil penelitian menunjukkan bahwa hubungan dan perilaku pelaku pemasaran rotan jernang akan membentuk kelembagaan pemasaran dengan sistem patron-client, karena adanya ketidakseimbangan posisi dalam hal ekonomi, akses, dan informasi. Ada empat saluran pemasaran yang ada di wilayah penelitian. Keempatnya dapat dikategorikan efisien dimana nilai efisiensi pemasaran rata-ratanya adalah 17,86%. Rantai pemasaran yang paling efisien adalah saluran tiga dengan nilai efisiensi pemasaran terkecil yaitu 12,86% dan nilai farmer's share yang tinggi (62,86%), yaitu penjernang – pedagang tingkat desa – pedagang tingkat kabupaten – pedagang tingkat provinsi – eksportir. Hasil ini menunjukkan bahwa saluran pemasaran yang paling efisien adalah saluran yang menjual jernang dalam bentuk resin.

Kata kunci: Provinsi Bengkulu, rotan jernang, kelembagaan lokal, efisiensi pemasaran

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 doi:10.20886/ijfr.2019.6.2.141-154

I. INTRODUCTION

Non Timber Forest Products (NTFPs) vary widely in tropical forests and provide important contribution to the economy of surrounding forest community (Abtew et al., 2012; Mukul, 2011; Rahman et al., 2012;). Evidences show that the NTFPs have significant role in improving profitability of small-scale private forest managed by community (Pettenella, Secco, & Maso, 2007). Dragon's blood is a deep red color resin powder produced by *Daemonorops* spp. and has long been used as medicine in various cultures. Dragon's blood is high economic value due to its scarcity, and the price is determined mostly by its color depth and beneficial chemical contents (Edward, De Oliveira, & Quye, 2001).

Internationally, dragon's blood has been used for pharmaceutical materials, such as anti cancer (Rasul et al., 2012; Yu et al., 2013), cureing diarrhea (Winarni, Sumadiwangsa, & Setyawan, 2004) and wound (Gupta, Bleakley, & Gupta, 2007), as well as mix compound in toothpaste (Baja-Lapis, 2009). Dragon blood is also used for cosmetics, to reduce cancer pain, to cure stomachache and digestive problems (Rustiami, Setyowati, & Kartawinata, 2004). Dragon's blood has also been used for centuries as coloring material of high value art work (Baumer & Dietemann, 2010). The benefits of dragon's blood have been increasing its demands for this product. China and Singapore were the main export destination for Indonesian dragon's blood but Indonesian dragon's blood can only supply about 6.7 % of China's market demand (Gafar, 2010).

NTFPs have ecological functions similar to timber forest products, which are important in supporting the overall forest ecosystem as well as one of the most important parts of sustainable forest management (Gafar, 2010; Gaoue et al., 2016; SijiMol et al., 2016, Sukwika et al., 2016). Economically, NTFPs contribute significant source of income for the people (Harbi et al., 2018), although the contribution to regional and national economy remains low. To date, the NTFPs are only considered as byproducts or minor forest products and less considered by the government. Non-tax revenue (PNBP) from timber was 2,980.02 billion IDR (89.25%) whereas non timber forest product was 350.11 billion IDR (10.75%) (Article 33 Indonesia, 2014). Instead of its low contribution to PNBP, production activities of collecting and processing NTFPs have been able to absorb labor in sufficient quantities, hence it could provide job opportunities and improve livelihoods of surrounding forests people. Compared with timber products, utilization of NTFPs usually require less capital and more simple technology. Furthermore, NTFPs have a great opportunity to support better sustainable forest management, since it only utilizes part of plant materials such as fruit, stems, flowers or leaves.

Collection of dragon's blood from the nature needs to be well managed. The product usually grows in shared (common pool) resource and good management could prevent unsustainable harvest by the free riders. This common-property resource has two main characteristics that cause free rider behavior (Feeny, Berkes, McCay, Acheson, & James, 1990). The first is excludability, which means that it will be very costly or even impossible to limit the access of other parties to these resources. Second is subtractability (rivalry), meaning that each person's consumption or harvest of resources will reduce the chances of other people using those resources. In other words, the use of resources by one person will reduce the availability of the resources for other users.

These free riders will not pay attention to the negative impact caused or suffered by the other party. Behavior of "common-dilemma" arises because the effect of competition on the behavior of the harvest (Birjulin et al., 1993). Individual will exploit more natural resources when there are more competitors. Whereas, in some cases collective resources management not only aims to protect those resources, but also the livelihoods of forest communities

(Tieguhong, Ingram, Mala, Ndoye, & Grouwels, 2015; Wiersum, Ingram, & Ros-Tonen, 2014).

The market of forest products, including timber forest products is different from the agricultural and plantation commodities, which tend to have more perfectly competitive market. Supply and demand of agriculture and plantation products almost available in large quantities, while for the NTFPs, the number of goods that offered depends on the availability in the nature and the demand much more difficult to determine. Some NTFPs have limited use and are export oriented as there is no processing industry in the country. This condition causes the domestic demand for NTFPs become limited and most of them are still taken from the forest and not yet cultivated. For example patchouli (*Pogostemon cablin* Benth.), one among the potential NTFP products to be developed - its market is only for export needs and the demand and prices are controlled by exporters. Likewise agarwood, the demand is still unknown and the supply depends on natural production as the quality and quantity of cultivated agarwood are still low.

NTFPs governance including management of forest resources, NTFP policies and institutions plays an important role in ensuring ecological sustainability and NTFP resources, NTFP trade, and how people benefit from NTFPs. Weak supervision and implementation of policies related to NTFPs such as inventory of potential and availability of NTFPs as well as the flow of NTFP values and markets often become problems in the NTFP management (Laird, Wynberg, & Mclain, 2011). The main obstacles in the utilization and management of some NTFP are the absence of clear institutional authority, uncertain markets, limited public access to the markets and lack of capital resulting bargaining position of some NTFPs and profit margin earned by the producers are low. This condition could be occurred on dragon's blood since the policies for this product, especially relating to commercialization and market are still unclear. Deeper understanding of institutional market, value chains and the marketing efficiency of dragon's blood is important in order to improve public access to the markets and support the commercialization of this NTFP. This paper studies institutional market, value chains and marketing efficiency of dragon's blood.

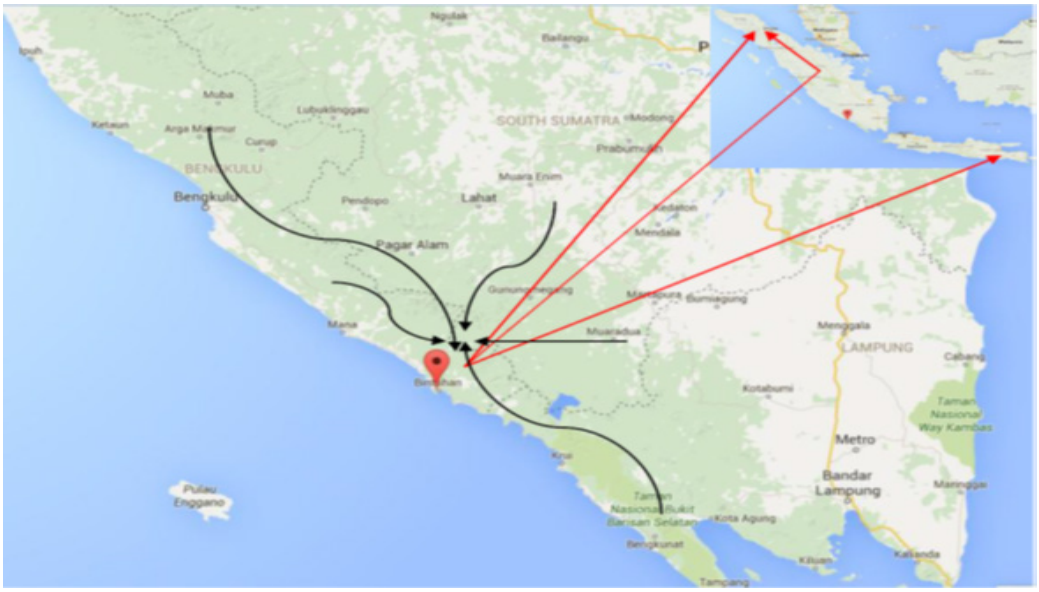

Figure 1. Map of the study area illustrating the marketing channels of dragon's bloods from Bengkulu to three main cities. i.e. Medan (a), Jambi (b) and Surabaya (c)

II. MATERIAL AND METHOD

A. Study Area

This study was conducted in South Bengkulu and Kaur Districts, Bengkulu Province, Indonesia. The research was conducted in October-November 2015. The research locations were chosen due to some considerations i.e. the districts are the center of commerce and processing of dragon's blood (flour/powder) in Bengkulu, especially in Southern Sumatera area. The community has already known well about dragon's blood and some of them become the traders of this product.

B. Analytical Approach and Data Collection

This study adopted value chain analysis to identify and mapping the marketing actors, identify the distribution of benefits of each actors, examine the value added and look at the role of governance in the value chain (Kaplinsky & Morris, 2001). Market performance was analyzed by economic institution approach (Schmid, 1987), i.e. through analyzing the structure of market channels and institution behavior. The structure of market is considered to determine the patterns of institution behavior. Additionally, patterns of institution behavior will affect the performance and will ultimately affect the market structure (Schmid, 1987). Marketing efficiency analysis was conducted using several indicators, such as marketing channels, market structure, marketing margin and the earnings of marketing actors.

Marketing margin consists of two components, namely marketing costs and benefits. Marketing margin of dragon's blood is marketing costs plus marketing profit. Marketing margin can be formulated by calculating the difference between the price at the consumer level with the prices at the producer level (Jumiati, Darwanto, Slamet, & Masyhuri, 2013). Anggraini, Hasyim, & Situmorang, (2013) revealed that the size of the marketing margin can be formulated by:

$$Mp = Pr - Pf \quad \text{..... (1)}$$

Where:
Mp = marketing margin
Pr = prices at the retail level
Pf = prices at the producer level

Furthermore, according to Hendarto and Wibowo (2005), the margins of the marketing chains are the amount of margin on every marketing chain, which is formulated by:

$$m_i = \sum_{i=1}^{n} M_i \quad \text{or} \quad m_i = \sum_{i=1}^{n} (P_i - P_{i-1}) \quad \text{..... (2)}$$

Where:

Mi = margins in the marketing chain at point i
Pi = price of the sale at the point of the marketing chain i
Pi-1 = price of the sale at the point of the marketing chain i-1
mi = total margin of the marketing chain

To specify the percentage of producer prices on consumer prices can be determined by calculating the farmer's share which can be defined by the formula:

$$FS = \frac{Pp}{Pc} \; x \; 100\% \quad \text{..... (3)}$$

Where:
Ps = Farmer's share
Pp = price at the producer level
Pc = price paid by the final consumer

The higher percentage values of farmer's share indicates more efficient marketing activities (Rosmawati, 2011). Farmer's share shows proportion received by farmers when they conduct marketing activities on commodity. Therefore, farmer's share have a negative correlation with the marketing margin, in which the higher marketing margins, the money that obtained by farmers will be lower (Setiorini, 2008). To calculate the marketing efficiency, the formula employed as follows:

$$Ep = \frac{Tb}{Tnp} \; x \; 100\% \quad \text{..... (4)}$$

Where:
EP = marketing efficiency

TB = total of marketing costs
TNP = total value of the product

Decision rules were implemented as shown in Table 1.

Tabel 1: Decision rules

Value	Description
0-33%	Efficient
34-67%	less efficient
68-100%	Inefficient

Source: Rosmawati (2011)

Data for inputs in the analysis was based on primary and secondary data. The primary data was collected by snowball interviews to selected respondents to identify actors that involved in marketing chains of the product, scope of actor activities, cost of each activities, prices at marketing points and the added value activities. Secondary data were obtained through literatures and other unpublished data. The number of respondents that have been interviewed can be seen in Table 2.

Table 2. Number of respondents for each marketing actors

No.	Category	Number of respondents (people)
1.	Penjernang (farmers)	15
2.	Village traders (gatherers and processors)	4
3.	Urban merchant at district level	4
4.	Wholeselers at province level	2
5.	Exportir	2

III. RESULT AND DISCUSSION

A. Marketing Chains and Actors Behaviours of Dragon's Blood

Dragon's blood as one of NTFPs has lots of benefits and its availability in the nature is limited. Until now, people just picked up dragon's blood from the forest and then sold to the collectors as source of additional income. So far, there are only a few of people who cultivate the dragon's blood. Institutional marketing activities of NTFPs have generally remained as traditional institutions and do not use written and clear rules. Moreover, relation among actors in marketing activity is usually very close in which they know each other and trust each other. The flow of goods (products) from producers to consumers raises the value chain in which activity can be separated and highly dependent on each other. Value chain of dragon's blood in the research sites involves multiple marketing actors. There are five actors that exist in the marketing of dragon's blood:

1. Collectors of Dragon's Blood from the Forest (*penjernang*)

Penjernang are people or farmers who collect dragon's blood from the forest. They collect this product from the forest and sell it to the buyer either in the form of fresh fruit or powder. *Penjernang* mostly comes from villages nearby the forest. *Penjernang* are producers of dragon's blood and transfer the products to village collectors and or processors.

2. Village Collectors and/or Processors (village traders)

Village traders collect dragon's blood from *penjernang*. They collect either fruits or powder. Some village traders only act as middlemen, i.e. buy and sell the dragon's blood without processing it. Some traders buy the fruits and proccess it to produce powder. There are more village traders with this second category as they will get more benefit from the added value process. Subsequently, village traders re-sell the products to urban merchants at district level.

3. District Collectors (urban merchants)

Urban merchants collect dragon's blood from village traders. They also process the resin to meet quality as specified by the exporters or final consumers. Urban merchants re-sell the products to wholesalers at province level. In some cases, urban merchants could also directly supply to exporters.

4. Province Collectors (wholesalers)

Wholesalers were exist at the province level. They collect dragon's blood from urban merchants within the districts.

5. Exporters

Exporters of dragon's blood are very limited and concentrated in Medan and Surabaya. They test the resin level and pack them to meet export quality standard. The exporters send the products to some destination countries, such as China and Singapore. Dragon's blood will be sent in the form of semi-finished goods. Resins that are exported to China will be inspected by the CFDA (China Food and Drug Administration), it will take approximately one week to be tested. After passing the test, the resin will enter the pharmaceutical company, and will be tested again before it is used. For exports, the minimum dracohodine content of jernang resin at least 1.5%, so that after the storage and testing, the draco content is still 1% or more. The standard demand from pharmaceutical companies in China is at least 1% of dracorhodin level.

Lack of capital; the presence of the parties who are in a better position of economy, information and access to other parties; inadequate ability and knowledge among *penjernang* as clients and village traders of dragon's blood at the village level, will lead to the institutional form of the patron-client system. Patron and client have an unbalanced bargaining position where the client as a subordinate has a lower bargaining position than the patron. Patron has the power of capital and information owned. Farmers as clients are usually given loans by collectors as patrons in the village to look for dragon's blood, hence the client has an obligation to sell their dragon's blood to patrons based on prices determined by the patron.

The pattern of this relation is intended to provide protection and security of subsistence to the client (Scott, 1976). Marketing actors will be interdependent with each other although the benefits received by each actor are not similar. The relation is not complementary but symbiotic (Stein, 1984). There are often imbalances positions among marketing actors. Information that is not balanced is theoretically considered as the cause of policy and market failures (Pindyck & Rubinfeld, 2001; Rahman, 2015). Moreover, imbalance information about dragon's blood market, less guidance from local government to increase and conserve dragon's blood business, and also dragon's blood price fluctuation due to some standard quality of dragon's blood that must be fulfill at farmers level become factors that cause low value added received by farmers as a client and give more benefit to the trader as a patron (Effendi & Rostiwati, 2014).

Patron client system could be mutually positive to both actors or exploitative. In the research location, the patron client relations were mostly exploitative. At the village level, village traders who have limited access to the capital and also to the exporters will act as the client while urban merchants and wholesalers who have big capital will act as a patron. *Penjernang* generally have low incomes, so that the village traders will offer some fund to *penjernang* with the obligation that *penjernang* must sell the results of dragon's blood to the village traders as the financiers. Hence, these village traders have a role as financiers and buyers for *penjernang*. On the other hand, Dragon's blood is increasingly limited, the distance to take it further into the forest, and the difficulty of its harvesting process in the forest causes the gatherers becomes important asset for village traders and processors of dragon's blood.

Village traders (gatherers and also processors of dragon's blood at the village level) and urban merchants at the district level are very limited. Consequently, *penjernang* do not have enough options to sell their product. Prices at the producer level often do not reflect the cost of production, hence the traders who always control the market price and determine the price (Neumann & Hirsch, 2000). There are negative consequences of this patron-client system due to the imbalance power among the actors and

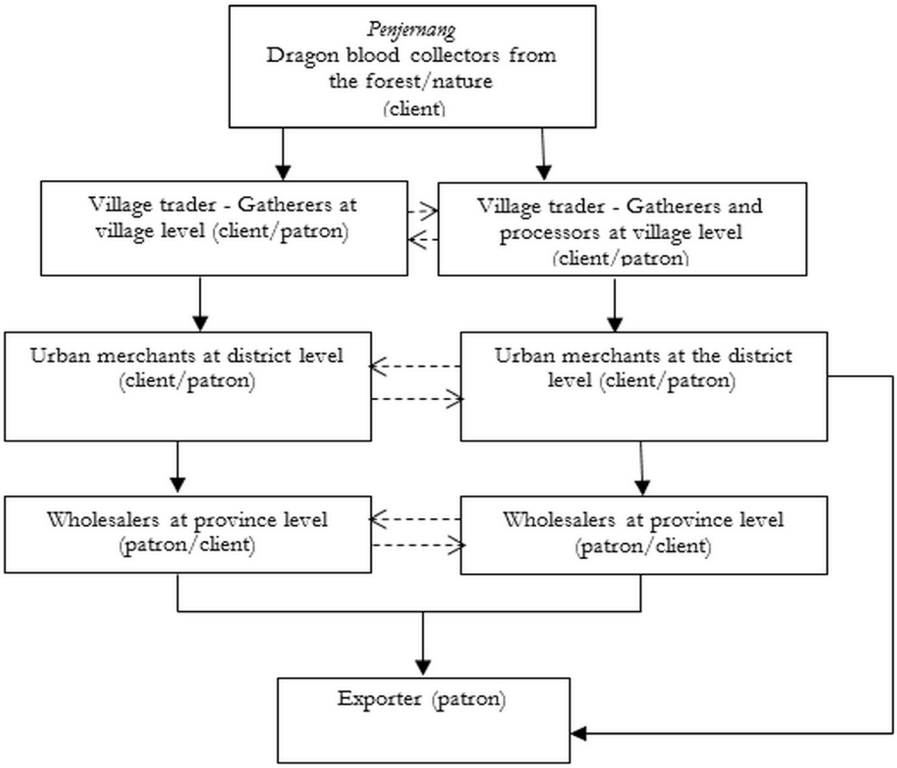

Figure 2. Performance of patron-client relation and value chain of dragon's blood marketing

the price taker behaviour of clients that may lead to exploitative marketing system and in the end will lead to unsustainable production system.

The final product traded in the value chain of dragon's blood is dragon's blood powder which is extracted from the fruit. The extraction technique done at the research location is dry method that uses special tool to spill the powder from the fruit. Dragon's blood powder quality is very diverse and already has the Indonesian National Standard (SNI) (Badan Standarisasi Nasional, 2010). To determine the quality of dragon's blood powder requires expertise and experience because it is quite difficult. The actors actually do not really know the precise quality of the resulting powder of dragon's blood. Only certain people could figure out how the quality of the dragon's blood powder.

Price and quality of dragon's blood were determined in the bid process by the sellers and buyers. There are several quality grades of the dragon blood and these grades determine the price. The grade is determined by simple and very subjective test, using fuel or methanol test, and usually done by the urban merchants and wholesalers. Strict tests were carried out on large size of the traded dragon's blood or if new village traders were enter the trade. This test was undertaken due to opportunistic behaviors of the village traders, where in some cases they mix the dragon blood resin of several grades to get the higher price. This cheating practice was intended to obtain bigger profit in the trade, but the risk the sellers could be put into a black list.

The position of patrons at district/province level (urban merchants and the wholesalers) was better than the clients (the village traders). The patrons have more freedom in determining the price and the intended profits. The patron-client relation of marketing actors in the value chain of dragon blood is illustrated in the Figure 2. The actors at the first level act as clients and the next higher level actor becomes patrons.

Figure 2 shows that patron-client relation exists between *penjernang* and village traders, village traders and urban merchants, urban merchants and wholesalers, and finally wholesalers and exporters. *Penjernang* has the position as a client of village traders or village trader becomes a patron of *penjernang*. This relation continuously goes on, up to the exporter level. Patron-client relation usually developed along continues transactions between the patron and clients that may involve long term credits and obligations, so that after certain time a personal bond may be formed between them (Kiss, 2014). Kiss (2014) revealed that the relations are mostly informal and never organized but typically infers long-term commitment of compulsory nature (Erbaugh et al., 2016). The higher the degree of compliance between client and patron the stronger the relation of them (Carney, 1989). *Penjernang* as clients of village traders will get some benefit from the patrons (village traders). The patrons share the information related to the product, buy the product, and sometimes give a loan to the clients. On the oher hand, the clients continuously supply the goods (dragon blood) to their patrons.

Penjernang picked fruit of dragon's blood in the forest around their dwelling or other areas that are the source of dragon's blood. Dragon's blood obtained will then be sold to the gatherers at the village level (village trader), either in the form of fruit or powder. Furthermore, they will resell to the larger gatherer that is urban merchants at the district level. Gatherer at the district level (urban merchants) will then sell the resin of dragon's blood to the wholeseler. In some cases urban merchant will directly sell it to the exporter in Medan and Surabaya, which is then exported to China.

Penjernang usually sells the products obtained to the gatherers or processors who were in the villages nearby and had been known (village traders), considering that they already trust in pricing and also have provided capital (loans). Some *penjernang* did not bring the results in the form of fruits. They processed this fruits in the forest into powder to facilitate the transportation process. The resulted powder is still slightly dirty due to the processing which only use a wire screen.

The number of gatherers and processors of dragon's blood that exist in the village level, urban merchant in the district level, and wholesaler in the province level were not many. These actors have their own way or different techniques to search for and collect their wares. Because the availability of dragon's blood in the forest is getting scarce, urban merchant have to order dragon's blood fruits or resin a few weeks earlier to the village trader. In general, one urban merchant will have several village trader as dragon's blood supplier. Furthermore, some urban merchants will supply dragon's blood to the same wholesaler. If it is possible and more profitable, urban merchants will sell their goods directly to the exporter. In some cases, each of these actors (village trader, urban merchant, and wholesaler) will trade with one another at the same level to sell and buy dragon's blood fruits/resin. Such exchanges occur because the stock of goods (inventory) that exist in every actor is very limited. Therefore, each of marketing actors at the same level will also supply each other as long as it is mutually beneficial to all parties involved.

This activity is only mutually helpful to meet the demands of their patrons or to sell dragon's blood that are too long settled in one of the market actors, specifically when they need cash income immediately. Interviews and observations during the research indicate that there was a difference in price of dragon's blood fruits and resin that exists between actors, because big traders (exporters) of each player were different and dragon's blood qualifications they need were also not similar. Each wholesaler in the province level require different grade (level) of powder, depending on the demand of exporters

The market structure illustrates how the market characteristics of dragon's blood affect marketing behaviours. The market structures of dragon's blood along the value chain are

dominated by monopsony system at village level and oligopsony sistem at the district and also provincial level. The existence of oligopoly/oligopsony market in district and provincial level is due to some barriers to enter the market for new players or new producers (Dahl & Hammond, 1977; Nava, 2015). These barriers are:

1. Access to the information that is likely covered by actors to maintain interdependence with each other (close market).
2. Relation is based on trust with each other, therefore it causes great difficulties to access the market directly.
3. Difficulty in determining the quality (grade) of dragon's blood due to the subjective test and variations in quality.
4. Limitations of the raw materials (dragon's blood fruits), since most resources come from wild harvest.

B. Marketing Margin and Efficiency of Dragon's Blood

The collectors/middlemen know the quality of dragon's blood using a burn test by putting a sample of dragon's blood powder on litmus paper then heating the bottom of the paper. To find out the quality or grade, the middlemen use their feelings/guesses based on their past experiences. The more residues left on the paper, the lower the dragon's blood quality. In addition, the collector also relies on an assessment based on the appearance of colors, odors and textures. This method of determining the quality of dragon's blood will only be accurate if it is done by people who have quite a long experience in the dragon's blood business. Meanwhile, to find out the quality of dragon's blood accurately, laboratory tests are carried out which are quite expensive and require more time.

Marketing margin is the difference between the price received by producers and consumers (Soekartawi, 2002). Distribution of marketing margin among actors can be used as an approach to determine the level of efficiency of marketing system, in accordance with the costs, risks and benefits that have been sacrificed and gained by individual market participants. The amount of marketing margin of each actor could be uneven for each channel/marketing level. Marketing margin of dragon's blood was analyzed using the following marketing channels:

1. *Penjernang* (fruit) → village traders (fruit converted into powder) → urban merchants → exporter (Channel 1).
2. *Penjernang* (fruit) → village traders (fruit converted into powder) → urban merchants → wholesalers → exporter (Channel 2).
3. *Penjernang* (resin) → village traders → urban merchants → wholesalers → exporter (Channel 3).
4. *Penjernang* (resin) → village traders → urban merchants → exporter (Channel 4).

The result showed that the marketing margin obtained by each marketing actors was different (Table 3). The different margin was due to different added value that provided by each actors and also the different of transportation cost. The greatest profit margin in marketing of dragon's blood is received by the gatherers (*penjernang*) of dragon's blood. It was because the sacrifice made by *penjernang* to collect dragon blood is quite large and has a high level of difficulty and risk. Moreover, for channel 3 and 4, the added value to the product at this point by *penjernang* was the greatest where production activities were conducted by processing dragon's blood fruits to become resin of dragon's blood.

Based on the calculation results of the existing marketing channels of dragon's blood in the research location, all channels reflects efficient marketing with an average value of marketing efficiency were 17.86%. In marketing channel 3, the transfer of products from producers to the end traders can be held with minimal costs and a fair distribution of income from the prices paid by final traders to all existing trading institutions. Channel 3 was the most efficient

ISSN: 2355-7079/E-ISSN: 2406-8195

Table 3. Distribution of margins and the price of dragon's blood at every marketing channel

Channel	Actor in the value chain	Bought products by actors	Cost		Selling price	Recovery factor	REVENUE (IDR/Kg)	Profit		Market margin	
			Initial unit cost	Added unit cost				Unit profit	%total profit	Unit margin	% final price
1	Penjernang	Fresh Fruit	910,000		2,000,000	100	2,000,000	1,090,000	60.89	1,090,000	42.08
	Village traders	Resin	2,000,000	500,000	2,700,000	100	2,700,000	200,000	11.17	700,000	27.03
	Urban merchants	Resin	2,700,000	300,000	3,500,000	100	3,500,000	500,000	27.93	800,000	30.89
	Total			800,000				1,790,000	100.00	2,590,000	100.00
2	Penjernang	Fresh Fruit	910,000		2,000,000	100	2,000,000	1,090,000	53.43	1,090,000	39.07
	Village trader	Resin	2,000,000	500,000	2,700,000	100	2,700,000	200,000	9.80	700,000	25.09
	Urban merchants	Resin	2,700,000	150,000	3,200,000	100	3,200,000	350,000	17.16	500,000	17.92
	Wholesalers	Resin	3,000,000	100,000	3,500,000	100	3,500,000	400,000	19.61	500,000	17.92
	Total			750,000				2,040,000	100.00	2,790,000	100.00
3	Penjernang	Resin	1,300,000		2,200,000	100	2,200,000	900,000	51.43	900,000	40.91
	Village trader	Resin	2,200,000	200,000	2,700,000	100	2,700,000	300,000	17.14	500,000	22.73
	Urban merchants	Resin	2,700,000	150,000	3,200,000	100	3,200,000	350,000	20.00	500,000	22.73
	Wholesalers	Resin	3,200,000	100,000	3,500,000	100	3,500,000	200,000	11.43	300,000	13.64
	Total			450,000				1,750,000	100.00	2,200,000	13.64
4	Penjernang	Resin	1,300,000		2,200,000	100	2,200,000	900,000	52.94	900,000	40.91
	Village traders	Resin	2,200,000	200,000	2,700,000	100	2,700,000	300,000	17.65	500,000	22.73
	Urban merchants	Resin	2,700,000	300,000	3,500,000	100	3,500,000	500,000	29.41	800,000	36.36
	Total			500,000				1,700,000	100.00	2,200,000	100.00

Table 4. Efficiency of marketing and farmer's share for each marketing channel of dragon's blood

Marketing channel	Total value of cost (IDR)	Total value of products (IDR)	Marketing efficiency (%)	Farmer's share (%)
	(1)	(2)	(1)/(2)	
Channel 1	800,000	3,500,000	22.86	57.14
Channel 2	750,000	3,500,000	21.43	57.14
Channel 3	450,000	3,500,000	12.86	62.86
Channel 4	500,000	3,500,000	14.29	62.86
Average	625,000	3,500,000	17.86	60.00

marketing channel because the profits received by the producers (farmers share's) was also high. In some cases, the benefits of harvesting and marketing of non-timber forest products are unevenly distributed along the chain from the forest to the market, in which the smallest proportion is mostly received by collectors (Neumann & Hirsch, 2000; Aoudji et al., 2012) which is in this case are *penjernang* (Table 3).

Farmer's share received by *penjernang* can also be seen in Table 3. Farmer's share is used to see how much share is received by farmers when conducting marketing activities. This study indicates that the highest farmer share was in channel three and four, which is 62.86%. Farmer's share illustrates the magnitude of the share received by *penjernang*. The greater share the farmers received, the more efficient and profitable marketing channels for *penjernang*. However, it does not necessarily reflect the favorable condition for *penjernang*, because in order to get dragon's blood fruit and powder requires a lot of time and energy to collect dragon's blood from the forest. Sacrifices made by *penjernang* in terms of time, energy and cost are greater than other actors.

IV. CONCLUSION

Relation of actors and behavior of marketing agents of dragon's blood will form a marketing institution with patron-client system, due to an unbalanced position in terms of economic, access and information. Among market participants there will be interdependence with each other that will form a trust based relation.

The value chain in the marketing of dragon's blood involves some actors that are interconnected to one another. There are 5 (five) actors that exist in the marketing of dragon's blood, *penjernang* (collectors of dragon's blood from the forest), village trader (village level collectors and also village level collectors and processors), urban merchant (district level collectors), wholesaler (province level collectors) and exporter. There were four marketing channel that exist in the research location. These four channels reflects efficient marketing with an average value of marketing efficiency is 17.86%. The greatest profit margin in marketing of dragon's blood is received by the gatherers (*penjernang*) of dragon's blood. Based on marketing efficiency criteria, channel 3 is the most efficient marketing channel, with the smallest efficiency value that is 12.86%. From *penjernang* the product will be delivered to dragon's blood traders at the village level. Then it would be sold to urban merchants at the district level. Urban merchants will sell it to the wholesalers at the province level. For the last, this dragon's blood would be transfered to the exporter. This result shows that the most efficient marketing channel was not the shortest channel. Among the four marketing channel, a fairly high farmer share (62.86%) was received by producer farmers (*penjernang*) in channel 3 and 4.

In order to get fair and equitable profit, every marketing actor must have information about the quality of dragon's blood resin, appropriate processing technique, and also non technical

counseling services that encourage every actor of marketing to become an honest market. By maintaining honesty of goods quality, price stability can be maintained. Furthermore, dragon's blood resin is an export commodity where its market depend on demand (market based demand), hence the level of demand, specification of product quality required and the price specified by the buyer (consumer) also tend to be unstable. Therefore, to maintain price stability and demand for dragon's blood resin, it is necessary to develop domestic industry, both traditional and modern pharmaceutical industries as well as paint industry that will require lots of dragon's blood resin.

ACKNOWLEDGEMENT

The authors thank to Bapak Sukarji for the assistance and help during the research. We are also grateful to the Palembang Environment and Forestry Research and Development Institute, Research Development and Innovation Agency, The Ministry of Environment and Forestry for the financial support.

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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.

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