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. 1, April 2019

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

Indonesian Journal of Forestry Research

Vol. 6 No. 1, April 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. 1, April 2019

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Tel: +62-0251-7521671
Fax: +62-0251-7521671
Business hour: Monday to Friday, 08:00 to 16:00 (WIB)
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Indonesian Journal of Forestry Research

Vol. 6 No. 1, April 2019

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Indonesian Journal of Forestry Research

Vol. 6 No. 1, April 2019

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Indonesian Journal of Forestry Research

Vol. 6 No. 1, April 2019

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Indonesian Journal of Forestry Research

Vol. 6 No. 1, April 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).

Maarit Kallio, Ph.D.
Tropical Forestry and Agroforestry
Faculty of Agriculture and Forestry,
University of Helsinki, Finlandia

Liubov Volkova, Ph.D.
Forest Carbon and Fire Emission
School of Ecosystem and Forest Sciences,
Faculty of Science, University of Melbourne,
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Tree Seed Technology and Tree Breeding
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Forest Governance, Forest Policy
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Community Forestry Policy Analysis
Directorate General of Social Forestry and
Environmental Partnerships, Ministry of
Environment and Forestry, Indonesia

Dr. Dede Rohadi
Community Livelihoods
Center for International Forestry Research,
Indonesia

Lukas Rumboko Wibowo, Ph.D.
Forestry Political sociology
Social, Economy, Policy and Climate Change
Research and Development Center, Bogor,
Indonesia

Dr. Yulianti Bramasto
Silviculture
Forest Tree Seed Technology Research and
Development Centre, Bogor, Indonesia

Indonesian Journal of Forestry Research

Vol. 6 No. 1, April 2019

Contents

Indonesian Journal of Forestry Research

ABSTRACTS

ISSN 2355-7079 | Vol. 6 No. 1, April 2019

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UDC/ODC 630*61(594.53)

Ary Widiyanto

FACTORS INFLUENCING FARMERS DECISION IN COMMUNITY-BASED FOREST MANAGEMENT PROGRAM IN KPH CIAMIS, WEST JAVA

(*FAKTOR-FAKTOR YANG MEMPENGARUHI KEPUTUSAN PETANI DALAM PROGRAM PENGELOLAAN HUTAN BERBASIS MASYARAKAT DI KPH CIAMIS, JAWA BARAT*)

Pengelolaan Hutan Berbasis Masyarakat melalui skema *Pengelolaan Hutan Bersama Masyarakat* (PHBM) telah dilaksanakan Perhutani di Jawa sejak tahun 2001. Program ini dibentuk untuk menyelesaikan permasalahan kemiskinan desa dan deforestasi, khususnya penebangan liar. Meskipun demikian, informasi dan evaluasi pelaksanaan program PHBM masih terbatas khususnya di daerah atau Kabupaten terpencil, termasuk Ciamis. Tulisan ini mempelajari faktor sosial-ekonomi, kondisi geografi dan persepsi masyarakat yang mempengaruhi keputusan petani untuk ikut dalam program, kriteria petani dalam memilih jenis tanaman, dan keputusan petani dalam alokasi waktu mereka pada program. Lebih lanjut, tulisan ini menghitung pengeluaran dan pendapatan petani dalam program, dan bagaimana alokasi lahan garapan baik antar petani dalam satu kelompok tani maupun antar kelompok tani. Tulisan ini juga melihat persepsi dari staff Perhutani tentang pelaksanaan program PHBM. Penelitian ini menggunakan pendekatan deduktif, dengan metode kuantitatif dan kualitatif yang dikumpulkan melalui kuesioner dari 90 responden pada tiga kelompok tani (LMDH). Data kualitatif dikumpulkan melalui wawancara dengan anggota LMDH dan staff Perhutani (masing-masing tiga orang). Analisis data menggunakan analisis deskriptif dan naratif. Hasil penelitian menunjukkan bahwa program PHBM dapat meningkatkan rata-rata pendapatan masyarakat sekitar 26,9%. Program ini juga memperkenalkan sistem bagi hasil dan mencoba mengakomodasi inisiatif masyarakat. Dukungan Perhutani dapat dilihat dari kebebasan yang diberikan kepada masyarakat untuk membuat pilihan terkait dengan bagi hasil lahan dan jenis tanaman. Disamping itu, sistem bagi hasil yang diterapkan cukup menguntungkan petani. Faktor yang mempengaruhi keputusan petani dalam pemilihan bagi hasil lahan adalah kondisi geografis, dalam pemilihan jenis tanaman adalah keahlian petani, dan dalam pemilihan jenis pekerjaan adalah prioritas petani.

Kata kunci: PHBM, Pengelolaan Hutan Berbasis Masyarakat, Perhutani, pengambilan keputusan petani

UDC/ODC 630*232:114.31

Uttam Thangjam, Uttam Kumar Sahoo and Pentile Thong

EFFECT OF AGROCLIMATE ON SEED AND SEEDLING TRAITS OF TREE BEAN (Parkia timoriana (DC) Merr.) IN NORTH EAST INDIA

(*PENGARUH AGROKLIMASI TERHADAP BENIH DAN SIFAT-SIFAT BIJI POHON KEDAUNNG (Parkia timoriana (DC) Merr.) DI INDIA TIMUR UTARA*)

Parkia timoriana (DC) Merr (nama umum: pohon kedaung) adalah spesies pohon legum yang ditemukan tersebar di beberapa negara Asia Tenggara termasuk Indonesia, Jepang, Malayasia, Filipina, Thailand dan Vietnam termasuk pertengahan dan kaki Himalaya timur. Itu diidentifikasi sumber benih dan mengelompokkannya ke dalam zona iklim agro yang berbeda berdasarkan indeks kelembaban dan curah hujan. Zona agroklimatik yang dihasilkan dianalisis untuk pengaruh signifikan pada sifat kuantitatif benih dan bibit P. timoriana dan kontribusinya terhadap perkecambahan dan pertumbuhan. Analisis varian menunjukkan variasi yang signifikan ($p < 0,05$) pada semua benih dan polong *P. timoriana* antara zona agroklimatik. Regresi polinomial menunjukkan peningkatan bertahap dalam panjang polong, berat polong, berat biji per polong, jumlah biji per polong dan berat 1000 biji dari zona perhumid ke zona kering. Variasi zona pada perkecambahan benih dan vigor benih berada di urutan arid> lembab> sub-lembab> perhumid. Disarankan bahwa pemulia pohon harus memilih *P. timotiana* dari zona kering (MI = -20 hingga -60) untuk membangun kebun benih untuk hasil yang optimal. Selanjutnya, alat interpolasi ARCGIS dapat digunakan untuk memprediksi sumber benih yang lebih baik dari spesies ini dalam program perkebunan.

Kata kunci: *Parkia timoriana*, agroclimatic zone, moisture index, variation

UDC/ODC 630*261(540)

Suyadi, Sumardjo, Zaim Uchrowi and Prabowo Tjitropranoto

FACTORS AFFECTING AGROFORESTRY FARMERS' CAPACITY SURROUNDING NATIONAL PARK

(*FAKTOR-FAKTOR YANG MEMPENGARUHI KAPASITAS PETANI AGROFORESTRI DI LINGKUNGAN TAMAN NASIONAL*)

Masyarakat pedesaan yang tinggal di sekitar kawasan Taman Nasional pada umumnya adalah petani. Mereka kurang berdaya dan tergolong miskin.Hal tersebut disebabkan oleh kapasitas petani yang relatif rendah. Agar petani lebih berdaya maka perlu ditingkatkan kapasitasnya. Penelitian ini bertujuan untuk menganalisis faktor-faktor yang berpengaruh langsung dan tidak langsung terhadap peningkatan kapasitas petani agroforestri di lingkungan Taman Nasional.Penelitian dilaksanakan di Kabupaten Kuningan dan Majalengka Propinsi Jawa Barat. Lama penelitian empat bulan, mulai bulan Juli sampai dengan Oktober 2017. Teknik sampling yang digunakan cluster random sampling berdasarkan lokasi kelompok tani hutan agroforestri di desa penyangga kawasan Taman Nasional Gunung Ciremai. Jumlah sampel 310 orang anggota kelompok tani hutan agroforestri. Hasil penelitian menunjukkan bahwa kapasitas petani agroforestri di lingkungan Taman Nasioal rendah. Hal ini disebabkan oleh rendahnya faktor pendidikan formal petani, pengalaman usahatani, tingkat kosmopolitan petani, dan lahan petani sempit. Disebabkan juga oleh rendahnya faktor dukungan lingkungan (aksesibilitas ekonomi, kondisi ekologis, peran KTH) dan rendahnya tingkat partisipasi petani dalam KTH agroforestri (partisipasi ekonomi dan sosial).

Kata kunci: Kapasitas petani, partisipasi petani, agroforestri, taman nasional

UDC/ODC 630*61(594.47)

Ja Posman Napitu, Aceng Hidayat, Sambas Basuni and Sofyan Sjaf

DIAGNOSING PERFORMANCE IN GOVERNING UTILIZATION OF FOREST PRODUCTION IN FMU MERANTI–MUSI BANYUASIN, SOUTH SUMATERA

(*DIAGNOSIS KINERJA PENGATUR PEMANFAATAN HUTAN PRODUKSI DI KPHP MERANTI – MUSI BANYUASIN, SUMATERA SELATAN*)

Perbedaan sudut pandang dan pemahaman pengguna dalam memanfaatkan kawasan hutan menyebabkan tumpang tindih areal dan berpotensi menimbulkan konflik pemanfaatan. Penelitian ini

bertujuan untuk mengetahui kepentingan dan pengaruh para pihak sebagai faktor eksogen yang berdampak tidak optimalnya kinerja kelembagaan. Diagnosis kelembagaan digunakan untuk mengetahui bagaimana arena aksi dan situasi aksi dari entitas kelembagaan saling mempengaruhi. Data dikumpulkan dengan menggunakan pendekatan convergent parallel mixed method (CPMM) dan langka kerja analisis menggunakan rapid land tenure assessment (RaTA). Untuk menjelaskan bagaimana faktor eksogen saling mempengaruhi digunakan Institutional Analysis Development (IAD). Hasil penelitian menunjukkan bahwa karakteristik atribut biofisik, atribut komunitas, dan rule in use saling mempengaruhi dalam situasi arena aksi. Selain itu, dari post-prospective analysis menjelaskan bahwa pilihan kebijakan cenderung tidak mempertimbangkan keberadaan masyarakat yang telah menggunakan lahan untuk penghidupan mereka. Kondisi ini menyebabkan terjadinya konflik pemanfaatan antara masyarakat dan pemilik izin. Rekomendasi penelitian: 1) untuk membuat forum komunikasi bagi semua pihak untuk mendapatkan informasi yang jelas tentang pengguna hutan dan mendukung kinerja; 2) perlu pelembagaan masyarakat lokal dalam pengaturan pemanfaatan, dan 3) penentuan pengelolaan dan konsep kelestarian hutan dalam pembuatan kebijakan.

Kata kunci: Diagnosa kelembagaan, faktor eksogen, efektifitas kebijakan, hasil

UDC/ODC 630*114.52

Aditya Hani and Endah Suhaendah

DIVERSITY OF SOIL MACRO FAUNA AND ITS ROLE ON SOIL FERTILITY IN MANGLID AGROFORESTRY

(*KERAGAMAN MAKROFAUNA TANAH DAN PERANNYA TERHADAP KESUBURAN TANAH PADA AGROFORESTRY MANGLID*)

Makrofauna tanah merupakan salah satu bioindikator yang menunjukan kualitas suatu lahan. Kelimpahan makrofauan tanah dipengaruhi oleh kondisi iklim dan pola penggunaan lahan. Agroforestri merupakan salah satu bentuk sistem pemanfaatan lahan yang diharapkan dapat meningkatkan kesuburan tanah. Perubahan pola penggunaan lahan dari monokultur menjadi agroforestri diduga memberi pengaruh terhadap kelimpahan makrofauna tanah. Penelitian ini bertujuan untuk mengetahui populasi makrofauna tanah sebelum dan setelah penerapan pola agroforestri manglid. Penelitian dilaksanakan di Desa Cukangkawung, Kecamatan Sodonghilir, Kabupaten Tasikmalaya. Pengambilan sampel makrofauna dilakukan pada lahan teh tidak produktif, setahun setelah lahan tersebut ditanami dengan pola agroforestri yaitu manglid+jagung+kacang. Luas lahan pengamatan 1 ha yang dibagi menjadi 16 plot pengamatan yang berukuran 1 m x 1 m dan diletakkan secara acak. Pada setiap plot pengamatan dikeruk tanah sedalam 30 cm dan ditempatkan pada bak plastik. Makrofauna yang tertangkap dihitung jumlahnya dan dimasukkan ke dalam botol yang telah berisi alkohol 70%. Identifikasi makrofauna tanah dilakukan di Laboratorium Zoologi LIPI, Cibinong. Hasil penelitian menunjukan bahwa indeks keanekaragaman jenis Shannon dan indeks kekayaan jenis Margalef pada agroforestri manglid nilainya lebih tinggi dibandingkan lahan bekas teh. Faktor yang mempengaruhi peningkatan keanekaragaman makrofauna tanah adalah peningkatan pH, suhu tanah lebih rendah dan kelembapan tanah yang lebih tinggi. Makrofauna tanah yang berperan sebagai pengurai bahan organik di lahan agroforestri sebesar 56,25% sedangkan di lahan teh tidak produktif 20%.

Kata kunci : Agroforestri, bioindikator, makrofauna, pekebunan teh, pengurai.

UDC/ODC 630*232.315.2

Naning Yuniarti, Rina Kurniaty and Dida Syamsuwida

STUDY ON PRIMING METHODS TO ENHANCE THE VIABILITY AND VIGOR OF TREMA (*Trema orientalis* LINN. BLUME) SEEDS

(*PENENTUAN METODE PRIMING UNTUK PENINGKATAN VIABILITAS DAN VIGOR BENIH TREMA (Trema orientalis Linn. Blume*)

Trema adalah jenis tanaman yang termasuk tanaman serba guna. Kayunya digunakan untuk kayu pertukangan, industri kertas dan arang kayu. Daun dan batangnya dapat dijadikan obat herbal, dan kulit batangnya untuk bahan pewarna. Pengembangan jenis ini mempunyai permasalahan yaitu lamanya waktu berkecambah serta viabilitas dan vigor benihnya mengalami penurunan setelah penyimpanan. Sehingga diperlukan perlakuan yang dapat mempercepat perkecambahan dan meningkatkan viabilitas dan vigor, yaitu dengan metode priming. Tujuan penelitian ini adalah diperolehnya metode priming yang tepat untuk meningkatkan viabilitas dan vigor benih trema setelah penyimpanan. Benih trema yang digunakan dalam penelitian ini berasal dari Bali. Rancangan percobaan dalam penelitian ini menggunakan rancangan acak lengkap (RAL) dengan menggunakan perlakuan priming pada benih sebelum disimpan dan sesudah penyimpanan. Perlakuan priming yang digunakan terdiri dari: kontrol, matriconditioning abu gosok, Osmoconditioning dengan perendaman H_2O_2 5%, perendaman/pelembaban dengan air, dan hidrasi-dehidrasi. Untuk perlakuan kontrol (tanpa perlakuan priming), benih langsung dikecambahkan. Parameter yang diamati yaitu daya berkecambah, kecepatan berkecambah, kecambah harian rata-rata. Nilai perkecambahan dan nilai keserampakan tumbuh. Hasil penelitian menunjukkan bahwa perlakuan metode priming terbaik, baik sebelum disimpan maupun sesudah penyimpanan yaitu perlakuan hidrasi dehidrasi. Semua parameter yang diamati memperlihatkan peningkatan setelah diperlakukan dengan metode priming tersebut. Sebelum disimpan, dapat meningkatkan nilai daya berkecambah dan kecepatan berkecambah masing-masing 15% dan 0,9%/etmal. Setelah penyimpanan, perlakuan hidrasi dehidrasi dapat meningkatkan daya berkecambah 17% dan kecepatan berkecambah 1,25%/etmal.

Kata kunci : Benih, trema, priming, viabilitas, vigor.

FACTORS INFLUENCING FARMERS DECISION IN COMMUNITY-BASED FOREST MANAGEMENT PROGRAM, KPH CIAMIS, WEST JAVA

Ary Widiyanto

Agroforestry Technology Research Institute
Jl. Raya Ciamis - Banjar Km. 4, Ciamis 46201, West Java, Indonesia

Received: 14 March 2017, Revised: 11 February 2019, Accepted: 22 March 2019

FACTORS INFLUENCING FARMERS DECISION IN COMMUNITY-BASED FOREST MANAGEMENT PROGRAM, KPH CIAMIS, WEST JAVA. Community Based Forest Management program through *Pengelolaan Hutan Bersama Masyarakat* (PHBM) scheme has been implemented in Perhutani forest in Java since 2001. The program has been developed to alleviate rural poverty and deforestation as well as to tackle illegal logging. However, there was very limited information and evaluation on activities of the program available especially in remote area/regencies, including Ciamis. This paper studies the socio-economic, geographical and perceptional factors influencing farmers decision to join PHBM program, farmers selection criteria for the crops used in the program, and farmer decision to allocate their time in the program. It also examines the costs and income related to the program and how the program land was allocated between different farmers groups and within the farmers groups as well as the perceptions of the state company's (Perhutani) staff members on the program. Deductive approach was used with quantitative and qualitative methods. Quantitative data were collected through questionnaires from 90 respondents at three farmer groups from 3 villages, 30 respondents of each group respectively. Cross tabulation and descriptive statistical analysis were used to analyse quantitative data. Qualitative data were collected through interviewing of 9 key informants, three informants of each farmer group respectively, and two Perhutani's staff. Results showed that PHBM program contributed to about 26.9% to community's monthly income. The program introduced benefit-sharing system and accommodated community initiatives. Perhutani's support was illustrated by freedom of choice of community in selecting the sharing area (land allocated for farmer to manage) and the planted crops. Factor influencing farmers' decision in selecting the sharing area was geographic conditions, in selecting the crops was farmer skills, and in allocating working time was farmers' priority.

Keywords: PHBM, Community based forest management, Perhutani, farmer's decision

FAKTOR-FAKTOR YANG MEMPENGARUHI KEPUTUSAN PETANI DALAM PROGRAM PENGELOLAAN HUTAN BERBASIS MASYARAKAT DI KPH CIAMIS, JAWA BARAT. Program Pengelolaan Hutan Berbasis Masyarakat melalui skema Pengelolaan Hutan Bersama Masyarakat (PHBM) telah dilaksanakan Perhutani di Jawa sejak tahun 2001. Program ini dibentuk untuk menyelesaikan permasalahan kemiskinan desa dan deforestasi, khususnya penebangan liar. Meskipun demikian, informasi dan evaluasi pelaksanaan program PHBM masih terbatas khususnya di daerah atau Kabupaten terpencil, termasuk Ciamis. Tulisan ini mempelajari faktor sosial-ekonomi, kondisi geografi dan persepsi masyarakat yang mempengaruhi keputusan petani untuk ikut dalam program, kriteria petani dalam memilih jenis tanaman, dan keputusan petani dalam alokasi waktu mereka pada program. Lebih lanjut, tulisan ini menghitung pengeluaran dan pendapatan petani dalam program, dan bagaimana alokasi lahan garapan baik antar petani dalam satu kelompok tani maupun antar kelompok tani. Tulisan ini juga melihat persepsi dari staff Perhutani tentang pelaksanaan program PHBM. Penelitian ini menggunakan pendekatan deduktif, dengan metode kuantitatif dan kualitatif yang dikumpulkan melalui kuesioner dari 90 responden pada tiga kelompok tani (LMDH). Data kualitatif dikumpulkan melalui wawancara dengan anggota LMDH dan staff Perhutani (masing-masing tiga orang). Analisis data menggunakan analisis deskriptif dan naratif. Hasil penelitian menunjukkan bahwa program PHBM dapat meningkatkan rata-rata pendapatan masyarakat sekitar 26,9%. Program ini juga memperkenalkan sistem bagi hasil dan mencoba mengakomodasi inisiatif masyarakat. Dukungan Perhutani dapat dilihat dari kebebasan yang diberikan kepada masyarakat untuk

* Corresponding author: ary_301080@yahoo.co.id

 doi:10.20886/ijfr.2019.6.1.1-16

membuat pilihan terkait dengan bagi hasil lahan dan jenis tanaman. Disamping itu, sistem bagi hasil yang diterapkan cukup menguntungkan petani. Faktor yang mempengaruhi keputusan petani dalam pemilihan bagi hasil lahan adalah kondisi geografis, dalam pemilihan jenis tanaman adalah keahlian petani, dan dalam pemilihan jenis pekerjaan adalah prioritas petani.

Kata kunci: PHBM, Pengelolaan Hutan Berbasis Masyarakat, Perhutani, pengambilan keputusan petani

I. INTRODUCTION

Limited access to forest resources by the local communities has raised pressure on forest through land encroachment and illegal timber exploitation (Subarna, 2011). These pressures contribute to deforestation in Indonesia. In order to overcome this, Perum Perhutani -a state owned forest company- has implemented Community Based Forest Management programs since 1970s. These programs are namely, prosperity approach (1971–1982), forest village community development (1982–1985), community forestry (1985–1995), and forest village community empowerment (1995–2000) (Puspitodjati, 2013). Perhutani's latest program that has been implemented since 2001 to present is called *Pengelolaan Hutan Bersama Masyarakat (PHBM)*, which means literally "managing forest with community" (Perum Perhutani, 2001).

Even though the program has been introduced in 2001, the implementation of the CBFM program is different within Perhutani's area. In the case of Ciamis, one of the factors that encourage the implementation of CBFM in Forest Management Unit (KPH), Forest District Ciamis was teak forest encroachment in April 2008 by the community around the forest. At least, 15.2 ha of forest land in Sub-Forest Management Unit (BKPH), Sub Forest District Cijulang was illegally taken over by the community (KPH Ciamis, 2008). To overcome this situation, government through Perhutani offered community to manage forest together. Since then, PHBM program begin in Ciamis Forest District.

PHBM is a program that aims for sustainable forest management through collaboration between Perum Perhutani and forest communities (or alternatively other parties, i.e. local government actors, social groups or NGOs) to achieve forest resources sustainability. The program has multiple objectives, including social, economic and environmental goals (Perum Perhutani, 2007). The social and economic objectives are addressed through improved access to land and forest resources. The ecological aspects are accommodated through improved management and utilization of forest resources and land zonation.

Previous studies show some positive impacts of the program, such as contribution to the income of the household. The implementation of agroforestry in production forests was proved to be successful in minimizing forest disturbance, particularly illegal logging, and increasing job opportunities to rural people (Budiarti, 2011; Ediningtyas, 2007; Rachmawati, 2008). On the other hand, some studies also criticized this program. Rosyadi and Sobandi (2014) said that the community through LMDHs in fact are never closely engaged in PHBM planning activities. Perhutani still become the dominant actor. Moreover, LMDH feels that Perhutani is neglected their roles of LMDH in other PHBM activities. Perhutani, likely, is only pursuing their target in getting benefits merely for their own benefits.

Based on their researches, ARUPA (2012) said that PHBM program as an unfair program. They argued that there is an unbalance system in reward and punishment. Community obligated to protect the forest but only get few advantages from timber production sharing. They also said that there was less community involvement and contribution in the program planning and development.

Moreover, Affianto, Djatmiko, Riyanto, and Hermawan (2005) stated that CBFM can be categorized as an economic business. Besides producing wood and non-wood forest products (Perhutani's interests), CBFM also produces short-term agricultural products (rice, corn and others) and long-term products (fruits and other plants generally), which is in the interests of forest farmers. CBFM land could also produces environmental services, such as eco-tourism and management of drinking water sources.

The main goals of PHBM program are to provide benefits to the community. In this program, community is allowed to plant their own crops in Perhutani's land. However, there was very limited evaluation of activities under this program, especially at remote areas/ regencies included Ciamis. Moreover, it is unknown whether the program complies with the expectations of communities and provides actual benefit to them. How the relationship between Perhutani and community continues and the extent of the community's involvement in the program are important to sustain the success of the program. This paper observes farmer characteristics (geographical and socio-economic) and activities in PHBM program, and to examine factors influencing farmer's decision in implementing program. These decision are particularly related to sharing area (amount of Perhutanis's land that can be managed by farmer), crops that can be planted in Perhutani's land and time allocation or jobs selection (job opportunity inside and outside PHBM).

II. MATERIAL AND METHOD

A. Study Location

The research was conducted in 2015 and 2016 in Ciamis Regency and Banjar Municipality, two regencies in West Java Province, located at the east end of the province, about 121 km from the provincial capital Bandung. They are located at coordinates 108020' to 108040' (east longitude) and 7040'20" up to 7041'20" (south latitude). Ciamis Regency covers 26 sub-districts and 265 villages and Banjar Municipality has 4 sub-districts and 23 villages (Badan Pusat Statistik Kabupaten Ciamis, 2013).

Research cases were three farmer groups located at three different villages, three different altitudes and represented three different cultivation patterns in the Sub Forest Management Unit (BKPH) Ciamis, BKPH Banjar Selatan, and BKPH Banjar Utara; all are included in KPH Ciamis. Pine-coffee (Kertamandala Village), teak-papaya (Purwaharja Village) and teak-cardamom (Sukasari Village) were the most common cultivation patterns in the KPH Ciamis. Map of research location is presented in Figure 1.

B. Methods

Primary data were collected through farmer and key informant interviews, including data on (i) household income, (ii) costs related to the implementation of the PHBM program, (iii) household's perceptions related to economic aspects of the program (costs and income received). Factors influencing farmer's decision in implementing the program were classified into three factors: 1) related to sharing area decision, 2) related to crops selections, and 3) jobs selection. These three factors are the main activity of the community in this program and collected through in depth-interview. Perhutani's officials and farmer group members were purposively selected on the survey. Perhutani official is persons who are in charge in the PHBM section. The key question for Perhutani staff included: 1) who and how to decide the sharing area per farmer, 2) who and how decided the crops, 4) why farmers choose the crops, and 4) some details of sharing agreement between Perhutani and farmers.

Thirty respondents of each selected group were surveyed through questionnaires. From each of these groups three persons were interviewed for detail and deeper information. The key questions were about their activities in the program, benefits of the program for them, and their strategies to maximise benefits from program. Secondary data were included KPH

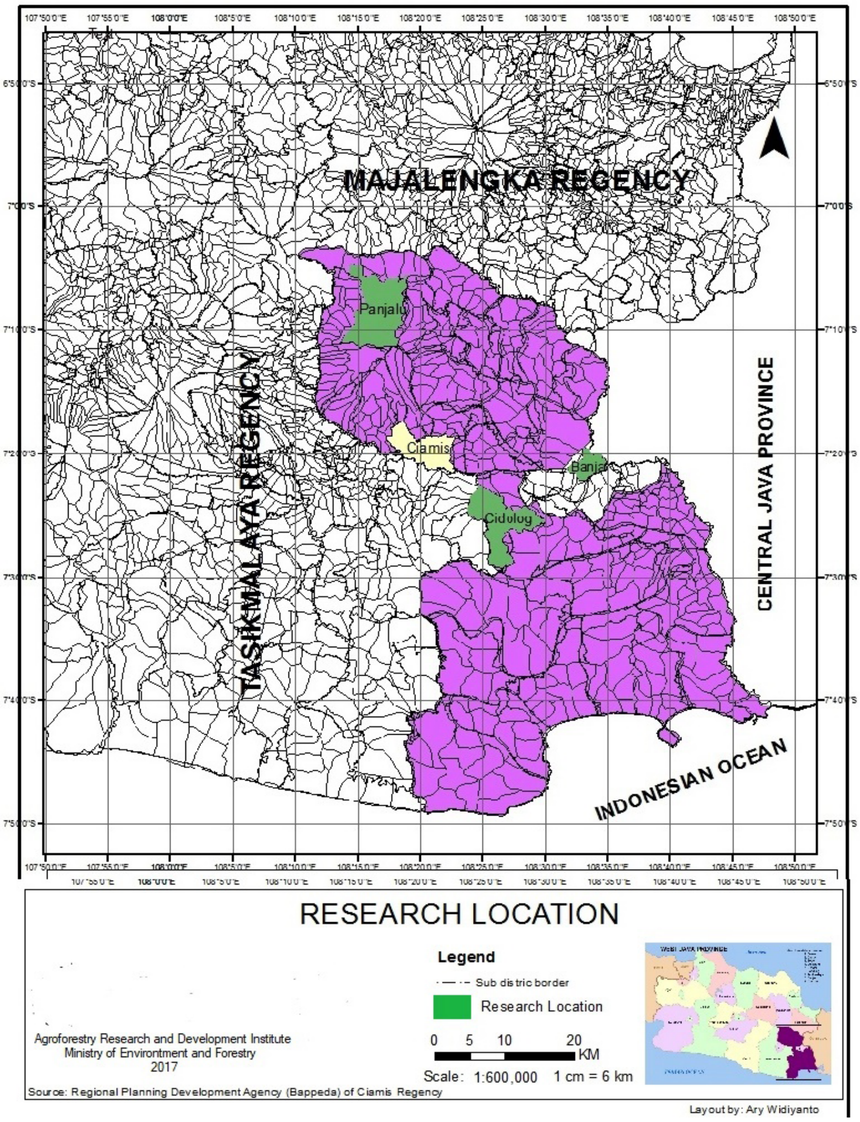

Figure 1. Research locations in green colour

reports, Perhutani reports, news and other documents. The key question for farmers are listed in Table 1.

C. Analysis

Survey questionnaires data were analyzed by using Microsoft Excel. The data consists of farmer's income during implementing the program, cultivation pattern, average sharing area, age, education, and land size owned by farmers. Cost and income of farmers were calculated to determine the economic benefits of the program. The total cost was calculated from labour time and then converted it into wage. The total income included income that derived from selling of products and wages. After harvesting, farmers sell their products. For papaya, 100% of selling income belongs to the famers. For coffee and cardamom, farmers get 80% of selling income after deducting income share for Perhutani. Farmers also get income from wages from Perhutani by planting teak and pine in the beginning of program. In addition, farmers also get wages during the the program from tree fertilizing and maintenance.

The interview data were analyzed by descriptive and narrative methods. Descriptive method was used to describe particular

Table 1. Key questions for farmer

Questions related to land sharing area	Questions related to crop selection	Questions related to jobs selection
How is the land shared for each farmer group? Who does the decision?	How is crop selected for each farmer group? Who does the decision?	What kind of jobs do the farmers have inside and outside PHBM and why they choose these jobs?
Who and how do determine sharing area for each farmer?	Who and how do determine kind of crops for each farmer?	How do farmers allocate their working time for PHBM and non-PHBM activities?
How was the land sharing methods selected and why?	How was the crop selection methods selected and why?	What is farmers' main priority in allocating their time and what is their strategy to do it?
What kind of factors are considered during the land sharing process?	What kind of factors are considered during the crop selection proocess?	What factors were need to be considered in the jobs selection?

phenomenon with sufficient details. The descriptive was interpreted as troubleshooting procedures using state of the subject/research object based on the observed facts. Nasir in Yuwono (2008) stated that the descriptive method is used for studying the problems within society, ordinances applicable within society, as well as two specific situations including relations activities, attitudes, views, as well as an ongoing process and influence of a phenomenon.

Narratives (stories) in the human sciences defined as discourses with a clear sequential order that connect events in a meaningful way for a definite audience and thus offer insights about the world and/or people's experiences of it (Hinchman & Hinchman, 1997).

III. RESULT AND DISCUSSION

A. PHBM Program in Ciamis

In this program, community is permitted to utilize Perhutani's (state) land with an agreement. This research found that there were two kinds of cooperation agreements related commodities between Perhutani and communities. The first agreement is wood and annual crop agreement for instance teak-papaya pattern. The second is wood and non-timber forest product (NTFPs) agreement with two case patterns, namely teak-cardamom and pine-coffee patterns. Before the agreement, farmers were offered by Perhutani to choose the crops that would be planted under Perhutani's stand. Usually, farmers choose the crops based on economic and land suitability consideration. The difference between these agreements is profit sharing among parties. The profit sharing of timber derived from logging and thinning was 75% for Perhutani and 20% for farmers. The remaining 5% was distributed into village government, communication forum, and social activities. The profit sharing of annual crops (papaya) was 100% given to farmers. The profit sharing of non-wood forest products (coffee and cardamom) was 75% for farmers and 20% for Perhutani, and the remaining 5% was distributed into village government, communication forum and social activities (Perum Perhutani, 2001). Table 2 shows in detail of the profit sharing percentage between Perhutani and farmer.

B. General Information of the Three Farmer Groups in PHBM Program

Currently, 106 farmer groups involve in the PHBM program in KPH Ciamis, although not all of these groups are active due several

Table 2. Profit sharing percentage between Perhutani and farmer

No	Parties	Primary plant (Pine-teak, %)	Non-wood forest product (Coffee-cardamom, %)	Annual crop (Papaya, %)
1.	First party (Perhutani)	75	20	0
2.	Second party (Farmer)	20	75	95
3.	Village government	2.5	2.5	2.5
4.	Communication forum	1.5	1.5	1.5
5.	Social activity	1	1	1

Note. Adapted from Perhutani (2012)

Table 3. Three studied farmer groups representing three cultivation patterns of PHBM program in KPH Ciamis

No.	Farmer Group	Cultivation pattern	Village	BKPH	Regency/City
1.	Sinapeul Indah	Pine-Coffee	Kertamandala	Ciamis	Ciamis
2.	Ajisaka	Teak-Papaya	Purwaharja	Banjar Utara	Banjar
3.	Pasir Mukti	Teak-Cardamom	Sukasari	Banjar Selatan	Ciamis

reasons. For instance, the teak-papaya farmer group could only participate during the first three years since the cooperation agreement was signed. When the teak grows and its canopy covers the land, farmers cannot further cultivate the land due to light competition for papaya crops. Accordingly, farmers have to find other location to continue the PHBM program, if they could not wait until the teak wood is being harvested.

The PHBM program involving these three farmer groups has been running for more than seven years. Table 3 shows in detail the cultivation pattern combinations within these three farmer groups.

More detail information regarding to the starting time of the program, size of sharing areas, and the number of members of each farmer group is presented in Table 4. It can be seen from the table that farmers of Sinapeul Indah group have a different residential and activity area. This means that farmers should move from their village to the program location during conducting farming activities, such as land preparation (land clearing), cultivation, plant nursery and harvesting. We can also notice the different cultivation patterns that may relate to geographic characteristic of the areas, i.e. pine-coffee (highland area), teak-cardamom (midland area), and teak-papaya (lowland area). Figure 2 illustrates these different patterns.

The socioeconomic characteristics of respondents varied among all farmer groups. In general, farmers who were involved in the PHBM program have the following characteristics: low income, low education levels, and the main occupation is farmer. All members of the farmer groups actively participate in all stages of the activities in this program. In the first year, members planted crops and trees as part of the cooperation agreement. They were paid (wages) from planting trees (teak or pine). Teak requires about 35–40 years to be harvested, whereas pines require about 25–30 years. Cultivation activities that were conducted by members as part of the agreement include fertilizing, weeding and replanting trees.

The average income of members was Rp 1,088,330, which was lower than the regional minimum of wage (RMW) of Ciamis Regency, which was Rp 1,363,319. The average farmer's income from the PHBM program was Rp 313,837 or about 26.7% of the average members monthly income (Table 3). Without

Table 4. Description of three farmer groups

Description	Group Name		
	Sinapeul Indah	Pasir Mukti	Aji Saka
Geographic characteristic of the location	Highland area (700-800 m above sea level)	Midland area (± 400 m above sea level)	Lowland area (50-100 m above sea level)
Residential area	Rajadesa Village, Rajadesa	Sukasari Village, Cidolog	Purwaharja Village, Purwaharja
Activity Area	Kertamandala Village, Panjalu	Sukasari Village, Cidolog	Purwaharja Village, Purwaharja
Distance to Capital City of Ciamis (km)	38.9	35.6	29.4
Sub Forest Management Unit	Banjar Utara	Ciamis	Banjar Selatan
Tree-crop pattern	Pine-Coffee	Teak-Cardamom	Teak-Papaya
Startingyear of PHBM	2012	2012	2013
Group sharing area ha)	27	14	7.8
Individual sharing area (ha)	0.25-2 (a=0.9)	0.31 (a=0.31)	0.1-0.5 (a=0.21)
Number of members	34	45	40
Land ownership (ha)	0.08-3.19 (a=1)	0-2.24 (a=0.35)	0-1.4 (a=0.38)
Age of farmers (years)	25-62 (a=44)	24-70 (a=48.8)	30-75 (a=50.2)
Family members (people)	2-7 (a=3.5)	2-5 (a=3.1)	2-5 (a=3.6)
Years of education	6-12 (a=6.9)	6-9 (a=6.5)	6-12 (a=7.3)
Total Income per month (x Rp 1,000)	850-1,500 (a=1,071)	1,000-1,500 (a=1,150)	300-1,500 (a=1,043)

Remarks: a =average, Source: Widiyanto (2017)

additional income from the program, about 81% of farmers' incomes were below the RMW of Ciamis Regency. With the program, only 46% of farmers have income below the RMW of Ciamis Regency. This means that the PHBM program provided positive economic contribution to the community. However, this economic contribution could only be enjoyed by papaya farmers for relatively short period (2–3 years) as compared to cardamom farmers (up to 10 years) and coffee farmers (up to 20 years).

The amount of income received from program by each farmer is different within and between farmer groups. Result of statistical analysis shows that there are no significant correlation between incomes from PHBM program with age, land ownership, education and cultivation pattern. Nevertheless, incomes from PHBM were significantly related to sharing area with pearson correlation of 0.964 at 99% of significant level. Likewise, the income received in the first year was different from the second, third, and fourth years. In total, in the first four years, the amount of additional income from PHBM program received by cardamom farmers was higher than income of papaya and coffee farmers. It was caused by several factors: 1) Coffee farmers require substantial capital investment in the first 3 years, higher than cardamom and papaya farmers; 2) coffee harvest began in the third year, whereas

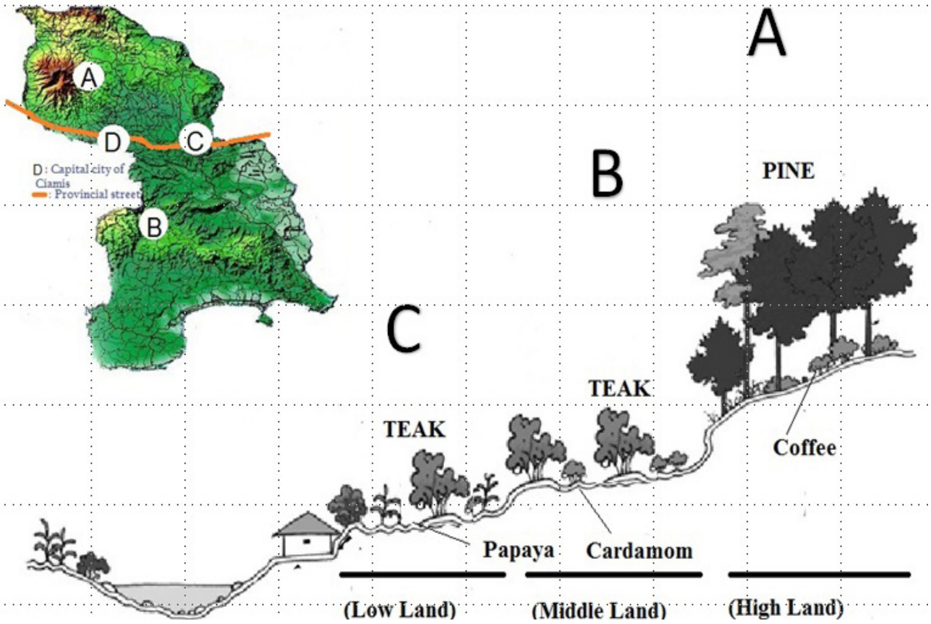

Figure 2. Different cultivation patterns among the three farmer groups of PHBM program

cardamom and papaya were started from the first year; and 3) papaya harvesting was only lasted for two years, whereas cardamom can be harvested until ten years. It seems that coffee farmers received the least income during the first three years. However, the fact that coffee farmers could earn income until 20th year was thought to be the main motivation for farmers to continue growing coffee despite having to spend a lot of capital in the first three years.

The income from timber can be divided into three types. The first is income from firewood at the fifth year of the plantation. All of this income belongs to the community. The second income is derived from thinning. Pine will be thinned two times at the 10th and 15th year of plantation. Teak will be thinned six times at the10th, 15th, 20th, 25th, 30th and 35th year of plantation. The third income was derived from timber harvesting. The harvesting time for pine is at the 30th year and for teak is at the 40th year. Farmers will get 25% of income from harvested timber from both thinning and final harvest. The expected money is big and significantly will contribute to farmers' income although farmers should wait for a long time to get the income from timber.

C. Farmer Groups Activities in PHBM Program

1. Sinapeul Indah: Mountainous Area, Pine-Coffee

Farmers in Sinapeul Indah group have greater land ownership (1.01 ha on average) and larger sharing area (0.9 ha in average) than the other two groups. Compared to the two other groups; the farmers in this group engage the longest time in the PHBM program. In average, they need to spend 227 days for farming activities in the first four years of the program. Coffee harvesting occurs three times a year beginning in the 30th month. The average harvested coffee is 1,067 kg in the third year and about 1,170 kg in the fourth year. They will get the highest coffee production in the fifth until 10th year. The price unit is Rp 3,000/kg in raw and Rp 16,000/kg in coffee powder.

Compare to other cultivation patterns, coffee farmer needs higher capital in the beginning of the program. From the first until the third year, their average net income is Rp 6,563,000, Rp 2,639,000 and Rp 219,000, respectively. Eventually, in the fourth year they get positive income for the first time. After deducting 20%

of their income through sharing with Perhutani, on average they will get Rp 12,014,400 net income.

Farmers chose independently Panjalu Sub-District as the program location for several reasons; 1) the high altitude is suitable for coffee cultivation; 2) coffee requires a special cultivation technique, which is not known by local people (Panjalu Sub-District); and most importantly, 3) coffee cultivation can give them long-term economic benefit. With good plant treatment, coffee could be produced within 20 years, or at least 15 years.

2. Pasir Mukti; Midland, Teak-Cardamom

Compare to other farmer groups, farmers in Pasir Mukti have a higher average monthly income. The income was possibly come from other jobs in addition to the income from their own land.

Cardamom harvesting occurred three times a year beginning in the 8th month with an average harvest per farmer of 178 kg in the first year, 953 kg in second year, and 1,943 kg in the third year. In the fourth year, the production decreased to 1,325 kg. Usually the third and fourth years are the peak of cardamom production. The price per unit is Rp 8,000/kg in raw or fresh condition and Rp 16,000/kg in dry condition. In the first year, some farmers tend to sell in fresh condition, because they need cash money to cover their expenses in the beginning of the program.

In the first year, on average, the loss is about Rp 800,000 per farmer, because the total income still could not cover the total expenses. In the beginning of second year they got positive income of Rp 5,540,800; Rp 11,875,200 and Rp 7,920,000 for the second, third, and fourth year, respectively.

Farmers in the Pasir Mukti group depend on their own land as their main income source. Their main jobs are farmers and labor of landlords. However, with only about 0.4 ha of average land ownership, the income was not enough. Therefore, most of them have other job as labor in general. About 77% of them received about Rp 50,000/day as a labor in agricultural sector.

Farmers choose cardamom as the plant does not need a special treatment. The plant is high tolerance to low light intensity, which is important when the teak grows taller. They considered the PHBM program as an additional job.

3. Aji Saka; Lowland, Teak-Papaya

Farmers of Aji Saka group plant papayas as their crops. Farmers got income in the beginning of the 7th month. Afterwards, they harvested and sold papaya every week. The average harvest was 6,205 kg in the first year and 11,983 kg in the second year, with a price per unit of Rp 1,700 to Rp 2,000 per kg.

In the first year, on average, papaya farmers got Rp 1,503,500 net income, and in the second year, they earn Rp 3,890,000. Afterwards, they should wait for three years, when Perhutani conducted the first tree thinning. During the waiting period, some farmers used the land by cultivating some annual crops, such as peanuts and cassava, while some others just left the land.

In the beginning of the program, Perhutani allowed farmers to decide their sharing area and the crop that would be planted. Farmers planted papaya from California variety, which had a higher price (Rp 2,000/kg) as compared to local variety (Rp 1,000/kg). The selling price was the main reason of farmers in selecting California varieties.

In average, their monthly income was smaller as compared to cardamom and coffee farmers. With a total sharing area of 7.8 ha and 40 total members, in average, each member only manages about 0.21 ha. To get additional income, they should look for additional job. The additional jobs were very important, because papayas only produced for two years. The third year's production was very small, and could not cover the operational costs; therefore, they changed papayas to other plants such as peanuts and cassava.

D. Factor Influencing Farmer's Decision in PHBM Program Activity

In this program, farmers were given the authority to determine the amount of sharing area received by each member as well as the types of crops that they will plant. Farmers in each group had different strategy in making their choices. Most studies that have modelled farmer decision-making have assumed a single objective of profit maximization as the motivation for decision-making behaviour (Wallace & Moss, 2002). In such situation, the decision-maker is usually seeking an optimal compromise among several objectives or trying to achieve satisfying levels of his goals (Wallace & Moss, 2002). In PHBM case, farmer decision is also influenced by non-economic motivation. Some activities were also conducted voluntary, motivated by farmers willing to protect their environment (Rakhmadi, 2014; Sukhmawati, 2012).

Based on the interview, farmer decided to join the new program to improve their livelihoods, and strategically chose the sharing area and crop combination based on the following:

1. Geographical conditions (altitude, distance from capital city), which influence farmer's strategy in dividing shared area for each farmer.
2. Skills, which influence people's strategy in crops selection. Beside land suitability, economic feasibility, and microclimate, skill is also one factor considered in the crop selection, and
3. Their priority in allocating time to work, which influence people's strategy in their livelihood strategy. In this research can be found in midland and lowland. Farmer see this program as a secondary job. They have another job either in on-farm or off-farm job.

1. Geographical Conditions

The first decision to make was the location of the PHBM land. Their decision was highly influenced by geographical condition, such as whether their locations were scattered or clustered, and close or far from the main road. These three farmer groups were located at three different locations and altitudes. The pine-coffee pattern was in highlands (mountainous area), the teak-cardamom pattern in midlands, and teak-papaya in lowlands and close to the town and main road. Located in highlands, with the program's areas scattered and spread, the coffee farmers divided their land based on member condition. Members who had more experience got a larger sharing area. They assumed that experienced member could work faster than new member. The larger land the longer the time needed to maintain the crop Topographical conditions, besides socio-economic conditions, were closely related with crops management such as crops combination as stated by Fujiwara et al. (2018).

The cardamom farmers agreed to share the community land equally. This decision was taken by considering that the program's location lies in one overlay. Therefore, it was easy to divide the sharing area equally. The decision influenced their income. Compared to the other cultivation patterns, this pattern has the most equal income distribution. Meanwhile, the papaya farmers have sharing areas that are located in several places (scattered) and bordered by other land use and the road. The papaya farmers agreed to divide the land based on the distance from their homes. The closer to home, the larger the sharing area because they assumed a broader area would require more maintenance and time.

These choices affected the income of each farmer. Larger sharing areas tend to give greater income. Some exceptions were exist due to crops' harvest productivity, which is closely related to plant treatments and fertilizers.

2. Skills

The second decision to make was related to crop selection. Every crop has its own characteristic and special requirement of skill. Hence, farmer choose the crop by considering their skill and experience in agriculture. Consequently, their choices were highly determined by skill and technique in specific crop. In brief, coffee growers chose coffee based on their experiences. Some farmers chose cardamom because it was less necessary treatment of plant. Some farmers chose papaya because they have experience in planting other varieties of papaya. This new variety is not so different in the maintenance but has better prices.

In Ciamis Regency, the Rajadesa Sub-District was known as the biggest coffee producer in West Java Province, apart from Bandung. Coffee plantations require special skills. Coffee farmers from this area got their skill and knowledge from their experiences in joining transmigration program in Lampung and Aceh, which were the centre of coffee production in Indonesia, in the 1970s and 1980s. After the PHBM program began in 2001 and implemented in 2008 in Ciamis Regency, some of the transmigrant came back to Ciamis and developed coffee plantations.

Coffee plantation needs special skills and techniques. Meanwhile, cardamom and papaya plantation did not need such special skills. These factors influenced farmer decision in crop selection. Farmer with particular skill tend to choose their crops based on their skill, otherwise they choose plants with no special treatment requirement.

3. Time Allocation Priority

Cardamom farmers considered the PHBM program as an additional job. Their main jobs are farmer and labour in farming sector. This was the main reason why farmer in this farmer group choose cardamom as their crops. Cardamom cultivation did not need special treatment, which means farmers can spend fewer times in the program.

Additional jobs were available to farmer depend on their location. Cities provide more various jobs compared to rural areas, on both formal and informal sectors as well as on off-farm sector. Aji Saka farmers benefited from this aspect. They got more opportunities of additional jobs, mostly as labour in off-farm industries. As a result, as comparison to coffee farmers, papaya and cardamom farmers spent lesser time in this program activity (Figure 3).

Related to this priority aspect, Wallace and Moss (2002) stated that such behaviour was motivated by the desire to maximize levels of satisfaction or utility. It can thus be argued that it was important to understand the manner in which farmers allocate their resources and their likely responses to changes in agricultural policy. Knowledge is required to know farmers motivational factors goals, objectives and values, which are the focal points of their decisions. Program location distance from their house was influencing farmers' spent time in the program. The further the distance means the lesser their activity in the program (Yudilastiantoro, 2011).

Similarly, Azmi (2008) stated that bigger farmers land ownership and their job in non-farming sectors decreasing their willingness to join CBFM Program in Bogor, West Java. Although joining the program, this will not be their first priority and they won't spend much

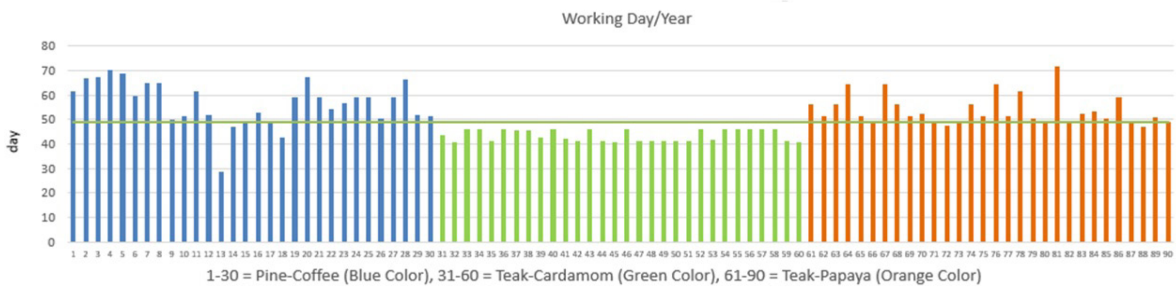

Figure 3. Working days per year by each farmer group

time for implementing the program activities. Similarly with Sabastian et al. (2014) and Fujiwara et al. (2018), the household characteristic and job opportunities both on-farm and off-farm in Gunung Kidul is significant factors affecting farmers' decisions to manage timber trees.

Winberg (2010) reported some factors that attract people to participate in Participatory Forest Management in Ethiopia, which were clear benefits and incentives that outweigh their investments in managing the forests. On the other hand, government commitment also needs to be stable without contradictory actions to ensure trust and dedication to the agreement from the community side.

Farmers should consider some factors before they make some decisions. Some of them are: current and future prices, costs, yields and weather. A farmer must decide the best combination of crops and best management practices (BMPs) for a given year (Ng, Eheart, & Cai, 2011). Willock et al. (1999) said that a model of farmers' decision making would include a large range of valid variables and should take into account prior psychological theory. Moreover, this model will assemble individual differences, rural resource management, business management, and mathematical/statistical modelling. An outline model of farmers' behaviour and decision making was constructed as modified from Willock et al. (1999) (Figure 4).

In this research, geographical conditions (i.e. altitude, distance from city, microclimate), skills (technique in particular crop cultivation), and priority (time allocation in the program) can be classified as antecedent variables. Moreover, these variables when combined with their objectives in farming (such as economic and daily needs) influencing their decisions in the context of sharing area, crops selection, and jobs selection. In the remote site with high altitude, farmers chose to plan pine and coffee, because (a) pine is a tree species suitable to be grown in higher altitudes; (b) in the most remote village there were less off-farm labour opportunities, so the farmers could choose labour intensive crop such coffee. Coffee also requires high initial investments, but provides income for longer period of time (20 years).

In the low land sites, which were located closer to the larger town with more wage labour opportunities and markers for fruits, farmers chose less labour intensive crop to be planted with teak (tree species suitable for lower altitudes). These crops are included

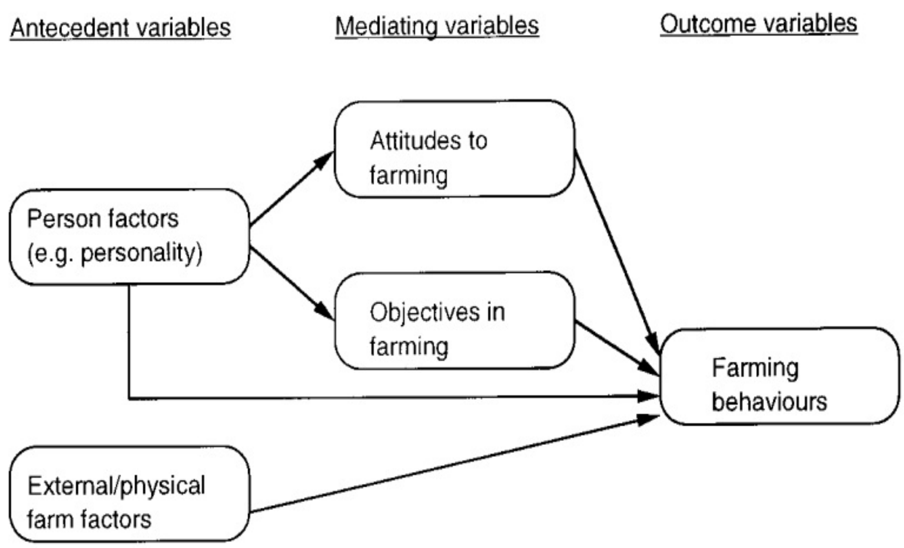

Figure 4. Schematic relationships among individual differences and behaviour (Source: Willock et al., 1999)

papaya and cardamom, since most their labour was used for wage labour, and growing papaya and cardamom under PHBM program was secondary/additional income source for them. Their main activity and priority is their own land. Papaya only can grow under teak stand for three years. Therefore, it can't be long term source of income. Cardamom can grow well under tree stand and did not need special treatment and maintenance after first and second year. Hence, farmer could allocate their time in other job or activity.

Margarian (2009) said that farmers' strategy could be divided into two types; 1) quantity-followers on the land-market, might be judged as "conservative" by observers, and 2) quantity-leaders in strategic competition, leave an entrepreneurial impression on observers. She explained that these strategies represent alternatives that evolve endogenously from strategic interaction, rather than attributed to differing exogenous conditions or cultural differences. But, beyond this classification, their decision and strategy sometimes depend on specific and idiosyncratic circumstances; countless individual strategies of adoption evolve.

According to Margarian (2009) classification, in this research case, papaya and cardamom farmers' behavior can be classified as traditional or conservative behavior, which was ascribed towards farmers whose main aim consists in stabilizing their farm. Therefore, farmers tend to avoid risk and make small steps of growth. Meanwhile, coffee farmers' behavior can be categorized as entrepreneurial attitude, which was ascribed towards farmers, who invest capital and labor where they are most profitable. However, in crop selection, one of the most considerable factor is land and climate suitability.

Moreover, these annual crops were very important for the farmers, in the tree-crops cultivation pattern. Annual crops produce commodities for both household consumption and market sale. In teak-crops pattern, besides supplying food for households, smallholder teak systems provide about 40% of household income from both agricultural and timber crops (Roshetko et al., 2013). Farmers income from PHBM program from annual crops harvesting (such as paddy and peanut) are also influencing their activeness in agricultural activity (Waluyati et al., 2017). On the other hand, some researchers said those annual crops contribution were not yet optimum, by comparing livelihood resource from teak forest and benefit obtained (Wasito et al., 2011; Wasito et al., 2011a).

Study by Budiarti (2011) found that community perception about PHBM program and community livelihood strategy are influenced by internal factor such as farming experiences, kind of jobs, and formal education and external factor such as number of land ownership. The more number of lands owned by community, the lesser number of times they spent in the program. In this research case, the external factor that influencing farmer decision in time allocation was different and did not apply for coffee farmers. Although they have larger land than cardamom and papaya farmer does, they must spent longer time in the program, because coffee needs special treatments and skills.

Different results were also found in Karanggayam Sub-District, Kebumen. In this region, communities did not have right to determine their own crops and number of sharing area in farmer groups. All activity, such as sharing area allocation, kind of crops, resin sap, harvesting, replanting, and other activities were fully determined by Perhutani. The decision did not comes from stakeholder discussion (in Communication Forum as dialog organization at sub-district level), but already determined by Perhutani, either in sub forest district or forest district level. As the result, community participation in this program was very low (Anomsari, 2015). In community forestry program in protected forest in Garut, the amount of shared area also determine by the government. Sharing area determined by economic conditions of community around the forest and tenurial conflict (Subarna, 2011).

IV. CONCLUSION

This study showed that PHBM program could provide economic contribution to the community. Community's average incomes increased after program implementation. This program contributed about 26.9% to farmers' average monthly income. The PHBM program introduced sharing agreement and tried to develop potential of community initiatives. Perhutani's supports could be seen in farmer group freedom of choice in selecting the sharing area for each farmer and in selecting the crops. Perhutani's contribution to farmers could also be seen in the benefit sharing through sharing agreement. In the sharing agreement, Perhutani gave 20% of their wood production, 80% of coffee production, and 100% of papaya production to farmers. Factors influencing farmers' decision were related to geographical conditions on selecting the sharing area was, farmer skills on selecting crops, and farmers' priority in determining resource (labor) allocation in the program. Lessons learnt from PHBM program in Ciamis are farmers should select the most appropriate cultivation pattern to maximise the benefits and Perhutani should consider the amount of sharing area that directly correlated with farmers' income.

ACKNOWLEDGEMENT

The authors would like to thank to The Ministry of Environment and Forestry of the Republic of Indonesia for funding this research. We also thanks to PT. Kideco Jaya Agung and the environmental division officers, especially Boorliant Wardhana for granting permission and providing supporting facilities to conduct this research. We would also like to thank Priyono, Agung, Warsidi and Arbain for assisting the data collection and data entry during the fieldwork.

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EFFECT OF AGROCLIMATE ON SEED AND SEEDLING TRAITS OF TREE BEAN (*Parkia timoriana* (DC) Merr.) IN NORTH EAST INDIA

Uttam Thangjam, Uttam Kumar Sahoo* and Pentile Thong

Department of Forestry, School of Earth Sciences & Natural Resource Management, Mizoram University, Aizawl-796004, India

Received: 15 August 2018, Revised: 02 February 2019, Accepted: 27 April 2019

EFFECT OF AGROCLIMATE ON SEED AND SEEDLING TRAITS OF TREE BEAN (*Parkia timoriana* (DC) Merr.) IN NORTH EAST INDIA. *Parkia timoriana* (DC) Merr. (common name: tree bean) is a legum tree species found distributed in several South-East Asian countries including Indonesia, Japan, Malayasia, Phillippines, Thailand and Vietnam including the mid and foothills of eastern Himalayas. It was identified seed sources and grouped them into different agro climatic zones based on moisture index and precipitation. The resultant agroclimatic zones were analyzed for significant influences on quantitative traits of seeds and seedlings of *P. timoriana* and their contribution to germination and growth. Analysis of variance showed significant variation ($p<0.05$) in all seeds and pod traits of *P. timoriana* between agroclimatic zones. Polynomial regression showed a gradual increase in pod length, pod weight, seed weight per pod, seed number per pod and 1000 seed weight from the perhumid zone to arid zone. Zonal variations on seed germination and seedling vigour was in the order of arid > humid > sub-humid > perhumid. It was recommended that tree breeders should choose *P. timoriana* from the arid zone (MI = -20 to -60) for establishing seed orchard for optimum yield. Further, the ARCGIS interpolation tool could be used for predicting better seed sources of this species in plantation programmes.

Keywords: *Parkia timoriana*, agroclimatic zone, moisture index, variation

*PENGARUH AGROKLIMAT TERHADAP BENIH DAN SIFAT-SIFAT BIJI POHON KEDAUNG (*Parkia timoriana* (DC) Merr.) DI INDIA TIMUR UTARA). *Parkia timoriana* (DC) Merr. (nama umum: pohon kedaung) adalah spesies pohon legum yang ditemukan tersebar di beberapa negara Asia Tenggara termasuk Indonesia, Jepang, Malayasia, Filipina, Thailand dan Vietnam termasuk pertengahan dan kaki Himalaya timur. Itu diidentifikasi sumber benih dan mengelompokkannya ke dalam zona iklim agro yang berbeda berdasarkan indeks kelembaban dan curah hujan. Zona agroklimatik yang dihasilkan dianalisis untuk pengaruh signifikan pada sifat kuantitatif benih dan bibit* P. timoriana *dan kontribusinya terhadap perkecambahan dan pertumbuhan. Analisis varian menunjukkan variasi yang signifikan (p <0,05) pada semua benih dan polong* P. timoriana *antara zona agroklimatik. Regresi polinomial menunjukkan peningkatan bertahap dalam panjang polong, berat polong, berat biji per polong, jumlah biji per polong dan berat 1000 biji dari zona perhumid ke zona kering. Variasi zona pada perkecambahan benih dan vigor benih berada di urutan arid> lembab> sub-lembab> perhumid. Disarankan bahwa pemulia pohon harus memilih* P. timotiana *dari zona kering (MI = -20 hingga -60) untuk membangun kebun benih untuk hasil yang optimal. Selanjutnya, alat interpolasi ARCGIS dapat digunakan untuk memprediksi sumber benih yang lebih baik dari spesies ini dalam program perkebunan.*

Kata kunci: Parkia timoriana*, agroclimatic zone, moisture index, variation*

* Corresponding author: uksahoo_2003@rediffmail.com

 doi:10.20886/ijfr.2019.6.1.17-26

I. INTRODUCTION

Parkia timoriana (DC) Merr. (Family: Mimosaceae) is one of the well known multipurpose tree species of the tropics and sub tropics and has a wide distribution in South East Asian countries including Indonesia, Japan, Malaysia, Philippines, Thailand, Vietnam and Northeast India (Salam et al., 2009; 2010). This is the only species of Parkia, which is found on both sides of the Wallace's line, primarily distributed in evergreen rain forest, moist mixed deciduous and dry evergreen forests. Altitudinal variation of this species usually ranges between 0 and 600 m, most common up to 300 m but rarely reaches 1300 m in North East India and Bangladesh, and Borneo where it grows up to the upper limit of dipterocarp forest (Hopkins, 1994).

In India the species is grown mostly in home gardens and fallow lands of shifting cultivation, and the species is in high demand for dietary supplement. The flower and fruits of this species have beneficial nutritional and medicinal properties (Rathi et al., 2012). However, the tree is vulnerable to the pest insect *Cadra cautella*, a moth whose larva bores into the seed to pupate, feeding on the seed interior and filling it with webbing (Thangjam, Damayanti & Sharma, 2003).

Parkia biglobosa, another species of this genus in Africa has shown lack of regeneration and stand senescence, which might result in complete disappearance over time (Teklehaimanot, 2004; Raebild, Hansen & Kambou, 2011). Over-exploitation, insect infestation, shortening of fallow period and drier climate could cause complete disappearance of this species unless immediate measures are undertaken (Roy et al., 2016). Though anthropogenic and insect infestation poses threat to the survival of this species, climatic effects on the other hand could magnify the problem. This study evaluates the effects of source on seed, pod and seedling traits of *P. timoriana* and to examine to what extent the variability between sources reflects climatic factors.

Many studies have examined the relationship between seed source or seed zones on germination and growth both within species and between species (Xu et al., 2015; Palinikumara et al., 2015; Aigbe, Fredrick & Omokhana, 2016; Moya et al., 2017), however, no quantitative estimates on role of species' adaptation on different climates exist for *P. timoriana*. Our analysis is designed using the climatic model of Thornthwaite (1948) and further mapping with ArcGIS (ESRI, USA) interpolation tool, which fit the provenance related climatic data of *P. timoriana* in various agroclimatic zones. Information on morphological and genetic variation of seed and pod characters are nevertheless important for afforestation and tree improvement programme (Tomar & Rattan, 2012; Fredrick et al., 2015; Gardarin et al., 2016; Gupta et al., 2016). It was hypothesized significant variation in quantitative traits of *P. timoriana* across agro climatic zones which may help in identifying suitable seed source for optimum resource utilization.

II. MATERIALS AND METHOD

A. Site Selection and Zonation

Parkia timoriana (DC) Merr. was identified using the book "Flora Neotropica" (Hopkins, 1986). The *P. timoriana* growing population in Northeast India were first extensively surveyed from market during December to March (pod harvesting season) followed by their occurrence and distribution in natural stands and homegardens. Based on their abundance and distribution, 12 seed source covering four northeastern states of India (viz. Manipur, Meghalaya, Mizoram and Nagaland) were selected for the study (Figure 1). These seed sources were further clustered into four agroclimatic zones (viz. perhumid, humid, subhumid and arid) following the Thornthwaite (1948) climatic classification. Various agroclimatic variables such as potential evapo-transpiration (PET), precipitation, mean monthly temperature of each seed source was considered for calculating moisture index

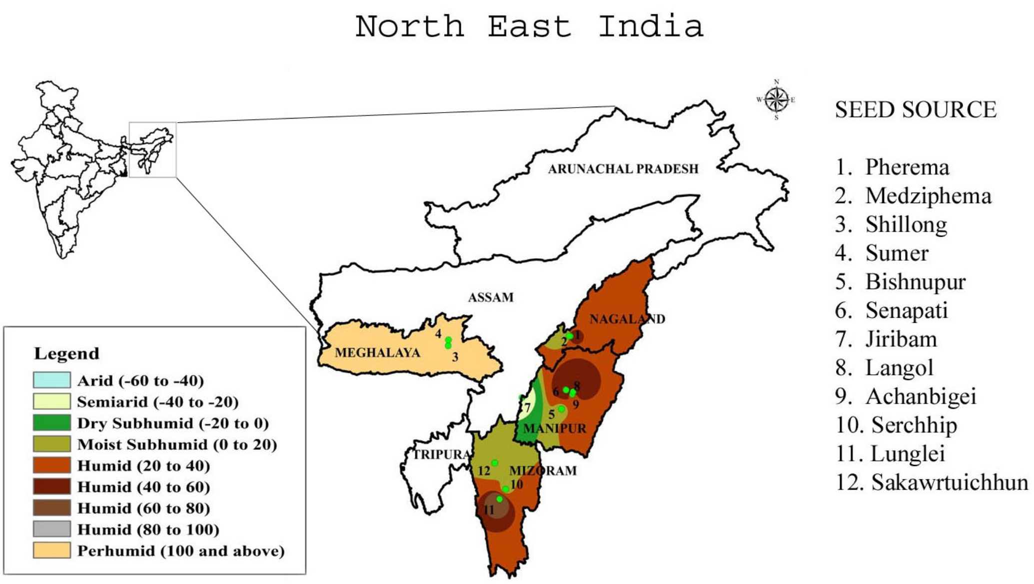

Figure 1. Map showing zonal distribution of *Parkia timoriana*, drawn using Arc GIS interpolation tool

(MI) and annual heat index (I) following Thornthwaite (1948) as follows:

$$\text{Annual heat index, I} = \sum_{i=1}^{12} i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\text{Where, i} = \text{monthly heat index} = \left(\frac{t}{5}\right)^{1.514}$$

and t = mean monthly temperature (˚C)

$$\text{PET} = 1.6\left(\frac{10.t}{I}\right)^{\alpha}.\frac{L}{12}.\frac{N}{30} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where,

$$\alpha = 675.10^{-9}.I^3 - 771.10^{-7}.I^2 + 1792.10^{-5}.I + 0.49239$$

L = the theoretical sunshine hours for each month

N = number of days for each month.

$$\text{MI} = \frac{100s - 60d}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, s = surplus water, which is defined as the sum of the monthly difference between precipitation (P) and PET for those months when P exceeds PET (cm); d = water deficiency, which is defined as the sum of the monthly difference between PET and precipitation (P) and for those months when PET exceeds P (cm); n= water need, which is the sum of monthly values of PET for the surplus of deficiency months (cm)

The MI derived thus was interpolated to generate respective agro climatic map by using ARCGIS interpolation tool (Childs, 2004). Interpolation is a spatial analysis technique in which values are predicted by averaging the known point values. The moisture index values of sampling sites were used to generate a continuous surface giving us predicted value of agro climate for the entire region.

B. Pod Collection and Seed Extraction

Twenty mature pods were collected from each of ten candidate trees (twelve years old) from twelve sources representing four states of northeast India viz. Manipur, Meghalaya, Mizoram and Nagaland. These pods were harvested manually by using a scythe made from a long bamboo pole. Collected pods were then air dried for 30 days; 10 days under direct sunlight and 20 days under shade. Drying of seeds in intact pods may enhance seed maturation and seed dry weight accumulation consequently increasing viability. Measurement of the length of pod was done by using a measuring tape, while width was measured by using digital calliper. Weights of pods and seeds were taken in a digital weighing balance. Extraction of the seeds was done manually by

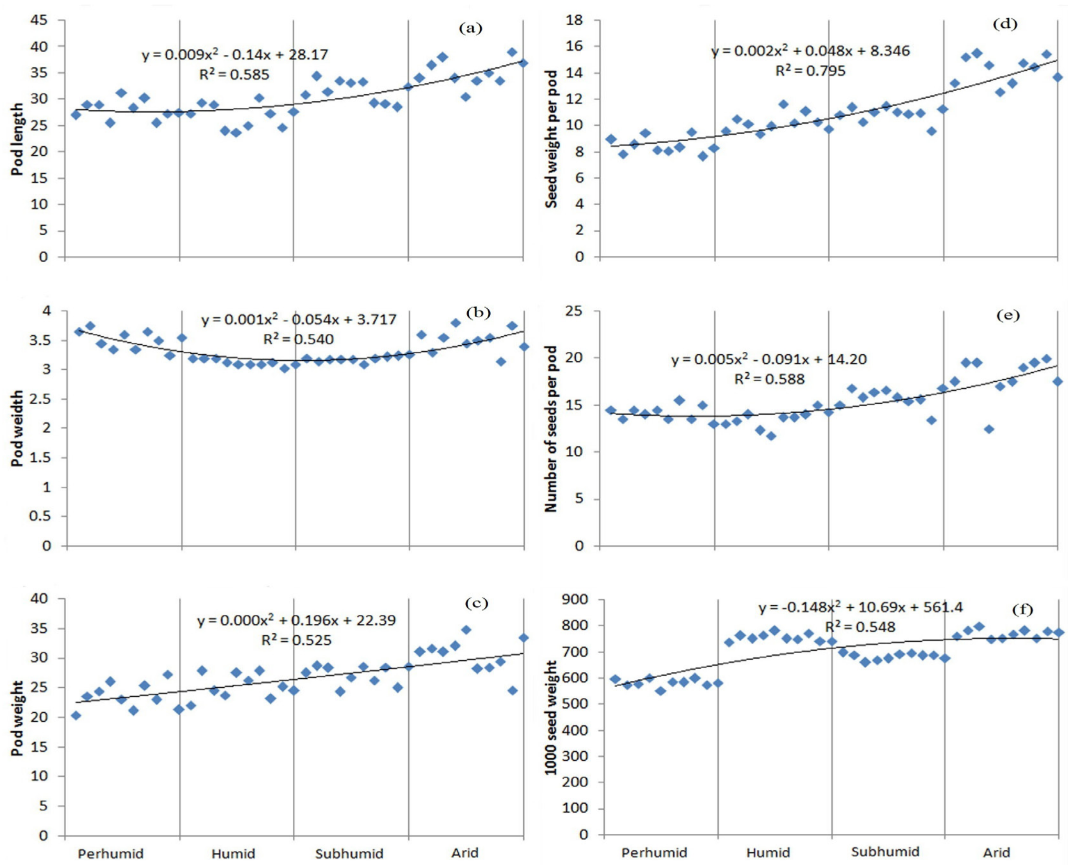

Figure 2. Effect of agroclimatic zones on pod and seed characters of *P. timoriana*

using secateurs and seeds with insect and fungal attack were discarded at the same time.

C. Seed Germination and Seedling Growth Traits

After extraction, seeds from each source were soaked in a 1000 ml beaker filled with distilled water for 24 hours. Soaking of seeds in water before sowing enhances germination due to increased water and oxygen intake (Thangjam & Sahoo, 2017) and can help separation of viable and non-viable seeds. A total of 384 seeds were then sown separately in polythene bags (20 x 17 cm) containing sieved (1 mm) garden soil. Watering was done every alternate day and daily records were maintained until 30 days or till seedlings ceased to emerge. A seed is considered as germinated when a healthy white radical of about 2 mm length protrudes through the integument. The seedlings were allowed to grow until 90 days so as to assess various germination attributes such as: germination percentage (GP), mean germination time (MGT), germination index (GI), germination energy (GE) and seedling vigour (SV). The GP was calculated as the number of seeds germinated to the total number of seeds sown, expressed as percentage. The MGT was calculated following Scott's equation (Scott et al., 1984) as, $MGT = \Sigma T_i N_i / S$ (where, T_i is the number of days from the beginning of the experiment, N_i the number of seeds germinated per day and S is the total number of seeds germinated). GI was calculated following Esechie (1994) as, $GI = (G_1/1) + (G_2/2) + \ldots\ldots\ldots + (G_x / x)$ (where, G is the germination on day 1, 2…, and x represents the corresponding day of germination). GE was obtained as GI at maximum daily germination speed and SV was calculated by multiplying GP with the seedling length.

Measurements were taken every 15 days starting from the two leaved stage until the completion of the study which was when?.

Table 1. Climatic variables of 12 seed source of *Parkia timoriana* as per Thornthwaith (1948)

Sl. No.	Seed source	State	Temperature (˚C)	Rainfall (cm)	PET (cm/year)	MI	Code	Agro climatic zone
1	Pherema	Nagaland	24.29	322.37	14.3	80.33	B4	Humid
2	Medziphema	Nagaland	28	117.97	24.16	-35.73	D	Arid
3	Shillong	Meghalaya	17.43	353.05	82	237.46	A	Per-humid
4	Sumer	Meghalaya	21.54	306.3	106.69	123.68	A	Per-humid
5	Bishnupur	Manipur	20.47	123.69	101.76	-3.45	C1	Sub-humid
6	Senapati	Manipur	21.82	153.66	106.54	24.4	B1	Humid
7	Jiribam	Manipur	28.58	194.23	252.79	-39.42	D	Arid
8	Langol	Manipur	21.08	148.21	105.56	1.69	C2	Sub-humid
9	Achanbigei	Manipur	23.75	159.12	134.13	15.84	C2	Sub-humid
10	Serchhip	Aizawl	25.17	220.76	156.54	11.83	C2	Sub-humid
11	Lunglei	Aizawl	25.58	308.04	164.01	57.96	B2	Humid
12	Sakawrtuichhun	Aizawl	24.92	254.8	151.52	3.4	A	Sub-humid

Growth parameters that were assessed includes: shoot length, root length, shoot dry weight, root dry weight, collar diameter, total biomass, relative growth rate (RGR), average growth rate (AGR) and seedling vigour. RGR and AGR were calculated following Thangjam and Sahoo (2017).

D. Statistical Analysis

Both univariate and multiple regressions were performed to examine if the regeneration and growth traits are associated with clinal and/or climatic variation. These analyses were also used to derive a polynomial equation predicting the relationships between various traits in an agroclimate. Two way analysis of variance (ANOVA) were performed to understand if there were significant differences among agroclimatic zones for the seed and pod traits. Coefficient of variation (CV) was calculated by dividing the zonal standard deviation of a given trait (σprov) by the overall average of the zone for that trait ($\overline{X}$). CV was compared between the sampled populations to measure the degree of genetic differences.

III. RESULT AND DISCUSSION

A. Agroclimatic Zonation of Seed Source

Discernable variations in temperature, rainfall, PET and MI were observed among the locations of occurrence of the twelve seed sources of *P. timoriana* (Table1). The moisture index (MI) ranged from -39.42 unit (Jiribam, Manipur) to 237.46 unit (Shillong, Meghalaya). These regions covered all four major agroclimatic zones; arid, subhumid, humid and perhumid. Minimum MI or place with maximum aridity was seen in Jiribam (-39.42), followed by Medziphema (-35.73). These regions despite having average rainfall have high potential evapo-transpiration (PET) resulting in higher aridity. Further, interpolation of the moisture index data for the twelve sample points using ArcGIS showed minor variability in prediction of agroclimatic range from that of the observed Thornthwaite zonation. This might be due to lesser number of raster points taken which decreased the probability for prediction.

B. Effect of Agroclimatic Zones on Seed and Pod Characteristics

Highly significant differences ($P<0.001$) were found for the seed and pod traits between

Table 2. Analysis of variance on seed and pod characters of *Parkia timoriana* due to agro climatic zones

Traits	Source	SS	df	MS	F ratio	P value	CV%
Pod length	Between zones	2507.969	3	835.99	39.88	<0.0001	22.3
	Within zones	1249.412	59	21.18	1.01	0.466808	
	Error	3710.272	177	20.96			
Pod width	Between zones	7.354125	3	2.45	29.65	<0.0001	6
	Within zones	3.557975	59	0.06	0.73	0.919831	
	Error	14.62993	177	0.08			
Pod weight	Between zones	1591.709	3	530.57	19.05	<0.0001	11.1
	Within zones	1246.087	59	21.12	0.76	0.890859	
	Error	4928.679	177	27.85			
Seed weight pod^{-1}	Between zones	1054.153	3	351.38	42.77	<0.0001	22.1
	Within zones	201.5135	59	3.42	0.42	0.999917	
	Error	1454.173	177	8.22			
Seed number pod^{-1}	Between zones	739.1167	3	246.37	31.2	<0.0001	13.2
	Within zones	462.9833	59	7.85	0.99	0.497838	
	Error	1397.883	177	7.90			
1000 seed weight	Between zones	1322665	3	440888.4	38.13	<0.0001	12.3
	Within zones	464891.9	59	7879.524	0.68	0.955842	
	Error	2046396	177	11561.56			

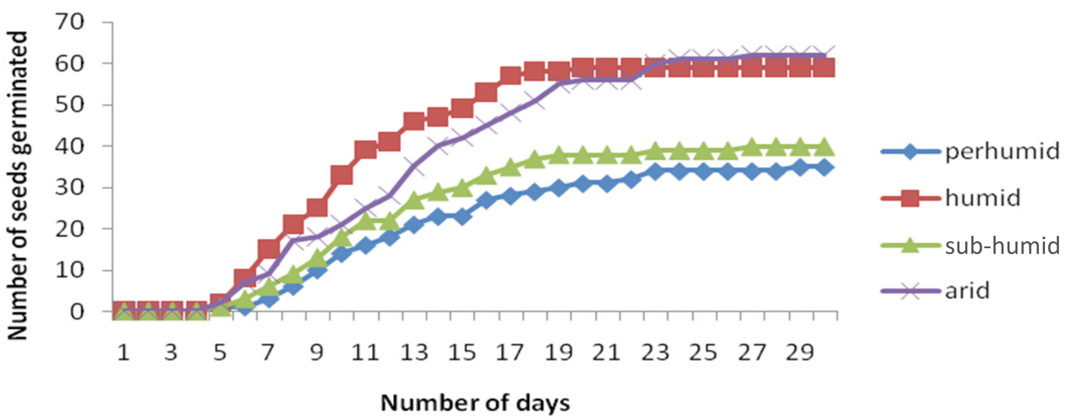

Figure 3. Relationship between zonal distribution of *P. timoriana* and its germination time

the agro climatic zones of *Parkia timoriana* in the North-Eastern states of India (Table 2). The highest coefficient of variation among the traits was observed in pod length (CV = 22.3%), closely followed by seed weight per pod (CV = 22.1%) and least in pod width (CV = 6%). Polynomial regression curve drawn for pod and seed characters against agroclimatic zones (Fig. 3, a to f) showed a gradual increase in pod length, pod weight, seed weight per pod, seed number per pod and 1000 seed weight, as one moves from from per humid to arid zone. However, pod width showed higher values in perhumid and arid zones than the humid and subhumid zones.

The speculation of this clinal pattern was very important to study as these were linked to initiation and cessation of plant growth and/or adaptation of a species to different environments. Few studies on clinal response

Table 3. Germination behaviour of the seeds of *P. timoriana* from different agro climatic zones

Zone	Number of seeds sown	Germination %	Number of days for initiation of germination	Mean germination time (days)	Germination Index	Germination Energy
Per-humid	96	36.5±3.1	5±2	13.5±1.5	13.9±1.4	29.2±0.0
Humid	96	61.5±16.9	5±1	10.9±0.7	21.0±8.3	49.6±13.8
Sub-humid	96	41.7±11.5	5±0.8	12.0±0.7	15.5±6.4	32.9±8.1
Arid	96	64.6±4.2	5±0.5	13.2±0.5	24.5±2.9	56.3±4.2

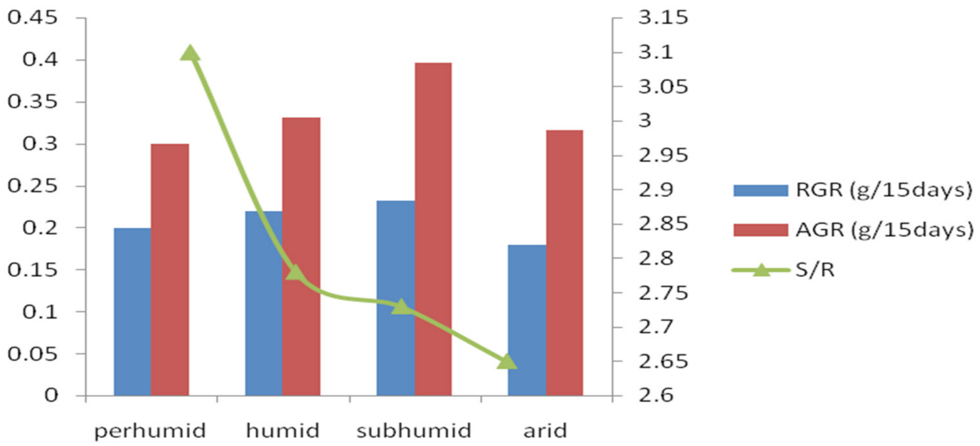

Figure 4. Effect of zonal distribution on relative growth rate (RGR), average growth rate (AGR) and shoot to root ratio (S/R) of *P. timoriana*

or provenance effect on *Dalbergia sissoo* (Singh & Bhatt, 2008), *Pinus roxburghii* (Ghildiyal, Sharma & Gairola, 2009) and *Jatropha curcas* (Ghosh & Singh, 2011) pointed out the significant effects of environmental adaptation and genetic effect on defining various qualitative and quantitative traits. We observed an increase value of most of the studied traits when sampling goes from per-humid to arid zones (Figure 3). Northeast India exhibited a varied agroclimatic zones having very high rainfall and potentially lesser evapotranspiration like Shillong (Perhumid) to a place having lesser rainfall with high aridity and temperature like Jiribam (Arid). Similar climatic amplitudes was reported for *Parkia biglobosa* in Sudano-Sahelian zone of West Africa (Quedraogo et al., 2012).

C. Effect of Agroclimatic Zones on Seed Germination and Seedling Growth

Seed germination in *P. timoriana* seeds was found maximum in arid zone samples (64.58%), and lowest in per-humid zone samples (36.46%). Similarly, speed of germination and germination energy was maximum in arid and minimum in per-humid zone (Table 3). The shortest mean germination time (10.9 days) was found in humid while per-humid took the longest time (13.47 days). Cumulative germination curve (Figure 3) showed shortest germination (16 days) for humid followed by sub-humid and arid (23 days) and per-humid (27days). The value of germinability, germination energy and germination index followed an order of arid > humid > sub-humid > per-humid. A similar trend was seen (Figure 2f) in the regression line drawn between seed weight and agro climatic zone. This supports that arid and sub-humid zones being correspond to maximum seed weight and resulted into giving the best germination percentage. Strong positive relations between seed weight and

Table 4. Relationship between seedling length, biomass and collar diameter after 90 days of growth for different climatic zones

Zone	Seedling length (sdl)	Biomass (bms)	Collar diameter (cd)	Regression equation	r^2 (%)	F(α=0.05)
Per-humid	57.5±2.7	2.3±0.1	4.5±0.1	sdl=185.61+65.62bms-62.44cd	28	0.61
Humid	55.5±2.0	2.3±0.1	4.4±0.3	sdl=4.83+25.49bms-1.77cd	96	7.96E-05
Sub-humid	60.8±2.1	2.7±0.1	5.1±0.1	sdl=44.58+14.08bms-4.18cd	54	0.0099
Arid	66.9±4.7	2.5±0.2	4.8±0.2	sdl=22.05cd-2.29bms-32.23	88	0.042

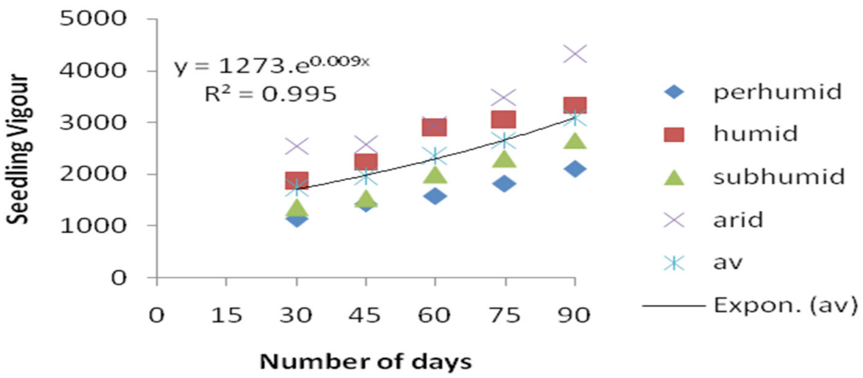

Figure 5. Relationship between seedling vigour, zonal distribution and time in days, taken alternately after every 15 days interval

germinability were also reported earlier for this species (Thangjam & Sahoo, 2016). Multiple regression analysis showed significant ($P<0.05$) variations between seedling length, biomass and collar diameter humid, sub-humid and arid zone. Similarly the coefficient of determination of the above parameters revealed that these three zones have more than 50% values that fit the model (Table 4). Per-humid zone on the other hand gave poor determination coefficient (R^2=28%) along with non significant F value (0.61).

The effect of zonal distribution on the rate of growth of the seedling (RGR), average growth rate (AGR) and shoot to root ratio is shown in Figure 4. RGR was highest for seeds from sub-humid zone (0.232 g) while lowest for seeds from arid zone (0.179 g). Average growth rate (AGR) after 90 days was maximum for seeds from sub humid zone (0.396 g), while minimum from per-humid zone (0.299 g). On the contrary, ratio of root to shoot in biomass production revealed that seeds from perhumid zone accounted to maximum difference (2:6.19) while minimum was found in arid zone (2:5.30).

Simple regression curve between seedling vigour and number of days (Figure 5) showed a distinct growth line in the average growth whose observed values are least deviated from the mean (R^2= 0.995). Seeds drawn from arid zone gave the maximum seedling vigour while per-humid zone resulted in minimum seedling vigour. Therefore using these equations one could predict a dependent value by knowing the other two independent values. Along with germination parameters, above seedling growth parameters also correspond to high value in case of arid and sub humid zones. Our results are in conformity with the findings of other workers (Souza & Fagundes, 2014; Kolodzijek, 2017) who acknowledge that seed size and weight have strong influence on germination as well as growth and biomass of a plant. The environmental influences in our study were presumed to be minimal as the seedlings from all seed sources were grown in a commongreenhouse environment. The results further support the hypothesis that geographic and ecological clines could influence the seed, pod and seedling traits to a great extent.

IV. CONCLUSION

Significant variation in seed, pod and regeneration characters of P. timoriana from four agroclimatic zones were observed. In a glasshouse trial conducted in the XX climate zone the performance of the species in terms of germination and seedling vigour was in the order of arid > humid > sub-humid > per-humid. This performance was strongly related to seed weight and pod size irrespective of the source. Though the species shows wide ecological amplitude, the arid climate yields the best results.

ACKNOWLEDGEMENT

The senior author (UT) gratefully acknowledges financial support in the form of a research fellowship from the Union Grants Commission (UGC), New Delhi, India, to conduct this study.

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FACTORS AFFECTING AGROFORESTRY FARMERS' CAPACITY SURROUNDING NATIONAL PARK

Suyadi*[1], Sumardjo[2], Zaim Uchrowi[2] and Prabowo Tjitropranoto[2]

[1]Education and Training Center for Environment and Forestry of Makassar,
Jl. Perintis Kemerdekaan Km 17.5 Makassar, South Sulawesi Indonesia
[2]Department of Communication Science and Community Development, Faculty of Human Ecology,
Bogor Agricultural University, FEMA Hall Wing 1 5th floor, Dramaga Bogor, West Java Indonesia

Received: 18 November 2017, Revised: 23 April 2019, Accepted: 27 April 2019

FACTORS AFFECTING AGROFORESTRY FARMERS' CAPACITY SURROUNDING NATIONAL PARK. The rural communities living around the National Park are generally farmers. They are less empowered and classified as poor. This is due to the relatively low capacity of the farmers. In order to be more empowered, the farmers need to improve their capacity. This study aimed to analyze the factors that directly and indirectly affect the capacity building of agroforestry farmers around the National Park. This study was conducted in Kuningan and Majalengka districts of West Java Province for four months, from July to October 2017. This research used cluster random sampling technique based on the location of agroforestry Forest Farmer Group (FFG) in the buffer zone of Gunung Ciremai National Park. The sample size was 310 members of agroforestry Forest Farmer Group. The results showed that the capacity of agroforestry farmers around the National Park was low. This is due to the low level of formal education, farming experience, cosmopolitan level, and small sized farmland of farmers. It is also caused by low environmental support factors (economic accessibility, ecological conditions, FFG role) and low participation of farmers in agroforestry both economically and socially.

Keywords: Farmers' capacity, farmers' participation, agroforestry, national park

FAKTOR-FAKTOR YANG MEMPENGARUHI KAPASITAS PETANI AGROFORESTRI DI LINGKUNGAN TAMAN NASIONAL. Masyarakat pedesaan yang tinggal di sekitar kawasan Taman Nasional pada umumnya adalah petani. Mereka kurang berdaya dan tergolong miskin.Hal tersebut disebabkan oleh kapasitas petani yang relatif rendah. Agar petani lebih berdaya maka perlu ditingkatkan kapasitasnya. Penelitian ini bertujuan untuk menganalisis faktor-faktor yang berpengaruh langsung dan tidak langsung terhadap peningkatan kapasitas petani agroforestri di lingkungan Taman Nasional.Penelitian dilaksanakan di Kabupaten Kuningan dan Majalengka Propinsi Jawa Barat. Lama penelitian empat bulan, mulai bulan Juli sampai dengan Oktober 2017. Teknik sampling yang digunakan cluster random sampling berdasarkan lokasi kelompok tani hutan agroforestri di desa penyangga kawasan Taman Nasional Gunung Ciremai.Jumlah sampel 310 orang anggota kelompok tani hutan agroforestri. Hasil penelitian menunjukkan bahwa kapasitas petani agroforestri di lingkungan Taman Nasioal rendah. Hal ini disebabkan oleh rendahnya faktor pendidikan formal petani, pengalaman usahatani, tingkat kosmopolitan petani, dan lahan petani sempit. Disebabkan juga oleh rendahnya faktor dukungan lingkungan (aksesibilitas ekonomi, kondisi ekologis, peran KTH) dan rendahnya tingkat partisipasi petani dalam KTH agroforestri (partisipasi ekonomi dan sosial).

Kata kunci: Kapasitas petani, partisipasi petani, agroforestri, taman nasional

* Corresponding author: suyadi_dephut@yahoo.com

 doi:10.20886/ijfr.2019.6.1.27-41

I. INTRODUCTION

The rural communities living around the forests are generally less empowered and relatively poor. This is due to the relatively low capacity of farmers. In order to be more empowered in their everyday lives, the farmers need to improve their capacity. Capacity building of agroforestry farmers can be done through the development of farmer's empowerment, namely by giving knowledge and skill needed by farmers. The development of this empowerment reflects the realization of farmers' self-reliant (Dewi, 2018; Mulyadi, 2013; (Senoaji, 2011).

Data of BPS (2017) showed that 17.28 million people or 62.25% of 27.76 million poor people live in rural areas in and around the forests. The villages bordering the forest areas are generally the center of poverty (Dewi, 2018; Adalina, Nurrochman, Darusman, & Sundawati, 2015). This condition is partly caused by the lack of access to forest resources to support their welfare. This is consistent with the findings of Puspitojati, Darusman, Tarumingkeng, and Purnama (2012) and Langat, Maranga, Aboud, and Cheboiwo (2016) who explained that the community is mostly dependent on forest resources. Commonly, they live near forests and collect forest products for self-consumption or work in forest areas. In this sense, community empowerment in forestry development is the key answer to optimize community access (Dewi, 2018; Neil, Golar, & Hamzari, 2016). Handoko (2014) explained that sustainable forest development in Indonesia is still faced with problems such us management obstacles, low management capacity and poor law enforcement. This is due to the weak coordination between law enforcers, regulation of the confiscation process, limited human resources, funds, facilities and infrastructure.

The welfare of agroforestry farmers is largely determined by their self-reliant in farming. This self-reliant can be realized if agroforestry farmers have good self-capacity. Agroforestry farmers are categorized as having good capacity if they have competence in the cultivation of forestry crops, agriculture, plantation, livestock or fishery. Agroforestry farmers also need to understand about the processing of cultivate products as well as their marketing. In order to improve the agroforestry farmer's self-capacity, supporting factors need to be considered. Supporting factors that are considered to have an effect in improving the capacity of agroforestry farmers are the participation level of agroforestry farmers both economically and socially. The participation of agroforestry farmers may increase if it is supported by good individual characteristics of farmers and environmental support (Herman, Sumardjo, Asngari, Tjitropranoto, & Susanto, 2008; Mutmainah & Sumardjo, 2014; Sumardjo, 1999; Suprayitno, Gani, & Sugihen, 2011).

Considering that agroforestry farming, the self-capacity should be inherent in the farmers is the competence in the cultivation technique, the competitiveness of product processing, the competence in marketing and independence, namely the ability to cooperate, competitiveness, and compatibility. If the competence and self-reliant are actually controlled by the farmers, then the farmers can be declared having a high capacity (Sumardjo, 1999).

Thus, studies focusing on the capacity building of agroforestry farmers around the National Park is very important. This paper determines the factors that influence the capacity building of agroforestry farmers around the National Park both directly and indirectly.

Based on the above description, this study aimed to analyze the effect of factors: (1) individual characteristics of agroforestry farmers, (2) environmental support, (3) farmers participation level in agroforestry FFG on the capacity of agroforestry farmers around Gunung Ciremai National Park in Kuningan and Majalengka District of West Java Province.

II. MATERIAL AND METHOD

A. Time and Place

The study was conducted for four months, from July to October 2017. Research Locations were in Kuningan and Majalengka Districts of West Java Province. These sites were selected due to its position located around Gunung Ciremai National Park which is a conservation area of Forest Management Unit (FMU).

B. Method

The unit of analysis in this study was agroforestry farmers. The population size in this study was 1043 agroforestry farmers. The population is a member of the agroforestry Forest Farmer Group (FFG) living in the buffer villages of Gunung Ciremai National Park. Sampling technique used in this study was random sampling which was carried out by clustering the location of Agroforestry Forest Farmer Group (FFG). The sample size used was 310 respondents consisting of 191 respondents from Kuningan District and 119 respondents from Majalengka District.

The type of research used was descriptive research with survey design. Primary data collection was performed by questionnaires, direct observations in the field, and in-depth interviews either with farmers or with other informants. Farmers agroforestry interviewed 310 people and 20 other informants namely forestry extension officers, forestry police, and village apparatus.

Secondary data were obtained from various offices/agencies concerned that are Gunung Ciremai National Park, Forest Management Center Regional V Province West Java, Statistics of Kuningan Regency, and Statistics of Majalengka Regency.

C. Data Analysis

The data collected were analyzed by path analysis. Data processing and analysis were performed by SPSS (Statistical Product and Service Solution) version 22. Dependent variables in this research are individual characteristics of agroforestry farmers (X_1) and environmental support (X_2). Individual characteristics of agroforestry farmers included five indicators, namely age ($X_{1.1}$), formal education ($X_{1.2}$), land tenure ($X_{1.3}$), experience ($X_{1.4}$), and cosmopolitan level ($X_{1.5}$). Environmental supports consist of economic accessibility indicators ($X_{2.1}$), ecological conditions ($X_{2.2}$) and agroforestry forest farmer group ($X_{2.3}$). Whereas the independent variables are a participation of farmers in agroforestry forest farmer group (Y_1) and capacity of agroforestry farmers (Y_2). The participation of farmers in agroforestry's forest farmer group includes indicators of economic participation ($Y_{1.1}$), social participation ($Y_{1.2}$). While the capacity of agroforestry farmers includes farmers' agribusiness competency ($Y_{2.1}$) and self-reliant ($Y_{2.2}$).

III. RESULTS AND DISCUSSION

A. Individual Characteristics of Agroforestry Farmers

Agroforestry is a business system that maximizes land use. Therefore, land tenure including area and ownership become very important factors for agroforestry farmers. Agroforestry is a form of land use that combines forestry crops with agricultural crops and/or livestock on the same land. Agroforestry farmers manage land with mixed crops, namely timber, fruit and vegetables.

Individual characteristics of agroforestry farmers around the National Park in this study are indicated by age, formal education, land tenure, farming experience and cosmopolitan level. Agroforestry farmers in Gunung Ciremai National Park are classified as being of productive age, low educated, small sized farmland, low farming experience, and low cosmopolitan level. The description of the distribution of agroforestry farmers according to individual characteristics in Kuningan and Majalengka districts in 2017 is detailed in Table 1.

The productive age of agroforestry farmers around Gunung Ciremai National Park of Kuningan and Majalengka districts is in the early to middle adult categories, which were about 18-50 years old (55.16%). While 44.84% tended toward unproductive age because they are

Table 1. Distribution of agroforestry farmers according to individual characteristics and categories in Kuningan and Majalengka Districts in 2017

Individual Characteristics of Agroforestry Farmers	Category		Sample Size	%
Age	Early adult	18 -35	39	12.58
	Mid-adult	36 – 50	132	42.58
Average : 50 years	Final-adult	>50	139	44.84
Formal Education	Elementary School	2- 6	183	59.03
	Junior High School	7- 9	61	19.68
	Senior High School	10- 12	57	18.39
Average : 8 years	Bachelor	13- 18	9	2.90
Land Tenure	Very narrow	0.01 – 1.00	309	99.68
	Narrow	1.01 – 2.00	1	0.32
	Large	2.01 – 3.00	0	0.00
Average : 0,48 hectare	Very wide	3.01 – 4.00	0	0.00
Farming Experience	Very low	1 -18	141	45.48
	Low	19 -34	115	37.10
	High	35- 51	49	15.81
Average : 21 years	Very high	52- 67	5	1.61
Cosmopolitan Level	Very low	0 – 25	63	20.32
	Low	26 - 50	167	53.87
	High	51 - 75	70	22.58
Average Score : 39	Very high	76 - 100	10	3.23

already old or classified as final-adult with the age of more than 50 years. The farmers' ability to work in managing land with agroforestry system is affected by age. Land management with agroforestry system requires productive age because the workload is intensive. Physically, agroforestry enterprises require farmers who are still in the productive age ranging between 18-50 years (Hudiyani, 2013; Premono and Lestari, 2013; Suherdi, Amanah & Muljono, 2014). Furthermore, Suherdi et al. (2014) asserts that in productive age, the farmer is a strong physically has adequate knowledge and ability and good intensity of social relations, so as to be able to do farming well.

The formal education of agroforestry farmers in Gunung Ciremai National Park of Kuningan and Majalengka districts was dominated by farmers who graduated from elementary and junior high schools (78.71%). This will have an impact on efforts to increase farmers' capacity. This condition is consistent with findings of Kusumedi and Jariyah (2010); Premono and Lestari (2013), and Suherdi et al. (2014) who reported that agroforestry farmers generally graduated from elementary and junior high schools. This is in line with Winata and Yuliana (2012) who states that in agroforestry, forest farmers are well highly educated, they only have farming experience that has been with them since a young age. Nevertheless, low level of formal education does not prevent forest farmers from gaining knowledge for their advancement, particularly in farming.

All farmers' land used for agroforestry farming in Gunung Ciremai National Park of Kuningan and Majalengka districts are classified as narrow and very narrow. The size of farmers' land for agroforestry business ranged from 0.01-2 hectares. The size of the land will greatly determine the volume of trees produced in the agroforestry business. Agroforestry is a business system that maximizes land use. Therefore, land tenure including area and ownership becomes a very important issue for agroforestry farmers. On the larger land owned by the farmers, the selected plants tend to be monoculture. Whereas the farmers who have narrow land prefer to plant various types of plants (polyculture) in order to meet the needs of subsistence and to have savings at the same time. The land area managed by farmers may come from their own land, leasing or sharecropping system . These systems will have an effect on their management, particularly for land used to cultivate annual crops or long-term crops. Likewise, Hudiyani (2013) and Salampessy, Bramasto, and Purnomo (2012) explained that the area of land controlled by farmers for business has a significant difference to farmers' participation.

Farming experience of agroforestry farmers in Gunung Ciremai National Park of Kuningan and Majalengka districts was low (82.58%). These agroforestry farmers are generally native in their villages so that farming has been done for generations. Farmers in terms of agroforestry farming, on average, have 21 years of experience. This experience is still relatively low because there are 67 years of experience of farming. Experience in agroforestry farming may support the capacity building process of farmers. According to Padmowiharjo (1994), one's experience is a knowledge experienced by the person in an unspecified period of time. A pleasant and satisfying experience will have a positive impact on the same behavior and will be applied to the next situation.

The cosmopolitan level of agroforestry farmers in Gunung Ciremai National Park of Kuningan and Majalengka districts was low (74.19%). This condition showed that agroforestry farmers in Gunung Ciremai National Park are less open to information from outside. They consider that information from outside may not increase their capacity. Suprayitno, Gani, and Sugihen (2011) in their research revealed an opposite reality.. Farmers who have wide access to various sources of information will have more information resulting broader knowledge and insight, better attitudes and improved skills. Similarly, Herman, Asngari, Tjitropranoto, and Susanto (2008) explained that the cosmopolitan level significantly affects the capacity of vegetable farmers both in Pasuruan and Malang districts. This means that the increase of the cosmopolitan level of farmers may also provide an increase in farmers' capacity.

B. Environmental Support

Environmental support in this study is indicated by economic accessibility, ecological conditions, and FFG roles. Economic accessibility and FFG role of agroforestry farmers around National Park were low, while the ecological condition was high. Distribution of agroforestry farmers according to the environmental support and its category in Kuningan and Majalengka districts in 2017 is detailed in Table 2.

Economic accessibility around National Park of Kuningan and Majalengka Districts was classified as low and very low (85.16%). This condition proves that in developing their business, agroforestry farmers still depend on the strength of personal or family capital. They still do not rely on capital support from public, private, and/or cooperative financial institutions. The result of in-depth interview confirmed that they are not interested in getting suport from financial institutions (Banks) that offer loans of farming capital. Such disinterest is due to the high cost interest rate of the bank. The farmers have an opinion that the agroforestry farm is like gambling. If they have good luck, they will be able to gain big profit, otherwise, if they have bad luck, they will suffer loss. This is due to the unclear factor of product prices.

Ruhimat (2015) explains that there are seven attributes on the economic dimension that have the potential to affect the sustainability of agroforestry farming, namely the level of economic effectiveness, the stability of the selling price of the crops, the source of farming capital, the place of selling crops, the diversification of income sources, the system of agricultural product sale and the contribution of agroforestry to total income of farmers.

Tabel 2. Distribution of agroforestry farmers according to the environmental support and its category in Kuningan and Majalengka districts in 2017

Environmental Support	Category*	Sample Size	%
Economic Accessibility	Very low	147	47.42
	Low	117	37.74
	High	41	13.23
Average Score : 32	Very high	5	1.61
Ecological Condition	Very low	7	2.26
	Low	55	17.74
	High	112	36.13
Average score : 72	Very high	136	43.87
Agroforestry farmer group	Very low	88	28.39
	Low	115	37.10
	High	70	22.58
Average score : 41	Very high	37	11.94

Remarks: The range of score is 0-100. *) category of 0-25: very low, 26-50: low, 51-75: high, 76-100: very high

The ecological condition of agroforestry farms in Gunung Ciremai National Park was good (80%). The topography of the land in Mount Ciremai National Park is generally hilly, but road access is relatively good so it is easily accessible through transportation tools such as four-wheeled vehicles. This condition makes it easier for farmers to do their farming activities such as the transportation of seeds, fertilizers, and agricultural products. Agroforestry is a form of land use that combines forestry crops with agricultural crops and or livestock on the same land to optimize economic, ecological and social functions. Farmers' land is strongly supported by regional access. The topographical condition of the agroforestry business area is also crucial in the selection of business commodities.

In addition, the access of agroforestry areas to the market will also be considered by the farmers. Access to the market may affect price certainty and this will certainly have an impact on the sustainability of the agroforestry business. Similarly, soil fertility will also determine the pattern of farming. Market certainty is the next aspect affecting the level of motivation of farmers around the forest to participate in the management of candlenut forest. The ultimate goal of a farm, in addition to fulfilling household needs, is that the agricultural products can also be sold or may provide financial benefits. Marketing of candlenuts by farmers around the candlenut forest in Maros district, in general, does not encounter many obstacles because there are already parties who are ready to accommodate or buy the products whenever farmers sell it. This provides assurance for the financial sustainability of farmers' households (Suprayitno et al., 2011).

C. Farmers' Participation in Agroforestry Forest Farmer Group (FFG)

Farmers' participation in agroforestry FFG of Mount Ciremai National Park is indicated by economic and social participation. Farmers' economic participation in agroforestry was relatively weak at 88.06% which is in the low and very low categories. While the level of social participation of farmers in the FFG was relatively good at 54.19% which is in high and very high categories. Farmers' economic participation in FFG is measured through the selection of plants according to FFG agreement, the use of capital obtained through FFG, and the amount of cooperation that has been established by farmers. While farmers social participation in FFG is measured by

Table 3. Distribution of agroforestry farmers according to their participation in Forest Farmer Group and its category in Kuningan and Majalengka districts in 2017

The Level of Farmers Participation in Agroforestry FFG	Category*	Sample Size	%
Economic Participation	Very low	196	6323
	Low	77	24.84
	High	26	8.39
Average Score : 24	Very high	11	3.55
Social Participation	Very low	44	14.19
	Low	98	31.61
	High	107	34.52
Average Score: 54	Very high	61	19.68

Remarks: The range of score is 0-100. *) Category of 0-25: very low, 26-50: low, 51-75: high, 76-100: very high

farmers' activeness in the activities of mutual cooperation, praying, celebration, FFG meeting, or helping the neighbors hit by disaster. Distribution of agroforestry farmers according to the level of farmer's participation in FFG and its category in Kuningan and Majalengka districts in 2017 is detailed in Table 3.

Farmers' participation in FFG is the mental and emotional involvement of farmers in situations of FFG activities that encourage them to contribute in an effort to achieve the desired goal. This involvement may be due to following others or future orientation. This is in line with Ruhimat (2013), Salampessy et al. (2012), and Suprayitno et al. (2011). who explained that farmers' participation is a form of active involvement of farmers in a particular business or program. Activity or program initiatives may come from outside the community or emerge from within the farming community itself. The level of agroforestry farmers' participation can be seen from the technical, managerial and social aspects. Technical participation involves farmers being actively involved in the cultivation of agroforestry enterprises that cultivate forestry crops and crops, livestock or fisheries. Managerial participation concerns in planning agroforestry farming activities, aspects involved in agroforestry farming activities, aspects of enjoying and/or utilizing the results of agroforestry farming activities, and monitoring aspects of agroforestry farming activities. While social participation concerns on how far farmers are actively involved in agroforestry efforts based on the purpose of maintaining land damaged by landslide or water drought.

Tjitropranoto (2005) explained that increasing participation of farmers towards the interactive direction in the provision of technology can be done by appointing farmers to become cooperators of an adaptation test, implementer of technological title, and so on. This may increase the farmers' self-capacity. Furthermore, the participation of farmers can still be improved by giving opportunities as the executor of technological degree or demonstration plot, implementer of adaptation test with intensive guidance from the researcher, because the ability of the farmers is in no doubt anymore. Farmers' participation can be improved so that it reaches the level of interactive participation and self-development by providing opportunities to farmers as cooperators on research and/or assessment activities. This situation provides an opportunity for maximum interaction between farmers and researchers/extension workers. This intensive interaction stimulates the farmers to obtain information and understand the technology more deeply, thus farmers may not only utilize it but also develop the technology of agricultural business.

This result is also in line with Rayuddin, Zau and Ramli (2010) who explained that

Table 4. Distribution of agroforestry farmers according to capacity and category in Kuningan and Majalengka Districts in 2017

Capacity of Agroforestry Farmers	Category*	Sample Size	%
Agribusiness Competency	Very low	16	5.2
	Low	151	48.7
	High	119	38.4
Average score :50	Very high	24	7.7
Farmers' Self-Reliant	Very low	22	7.1
	Low	145	46.8
	High	135	43.5
Average score: 48	Very high	8	2.6

Remarks: The range of score is 0-100. *) category of 0-25: very low, 26-50: low, 51-75: high, 76-100: very high

farmers' participation in rural development is measured through full participation, moderate participation, and fewer participation approaches. It is further explained that the level of farmers' participation will emerge and can be manifestly realized if it is supported by the opportunity, willingness, and ability to participate and be consciously involved. Similarly, Suprayitno et al. (2011), stated that the increase of farmers' participation can be done by increasing motivation to increase income, gain recognition, conserve forests and farmers' capabilities such as technical, managerial and social skills.

D. Agroforestry Farmers' Capacity

The capacity of agroforestry farmers is indicated by the agribusiness competence and the self-reliant of farmers. Agribusiness competence and self-reliant of agroforestry farmers in Gunung Ciremai National Park of Kuningan and Majalengka districts were low (53.9%). Agribusiness competence is measured through the ability of farmers to apply agroforestry business techniques, agroforestry product processing, and how to sell products at higher and more sustainable prices. Agroforestry farmers' self-reliant is measured by the level of the ability to cooperate, competitiveness and compatibility of farmers. The ability to cooperate is the ability to make decisions quickly and precisely in agroforestry sector. Competitiveness is the ability to make agroforestry enterprises become more superior than those of others. Compatibility is the ability to cooperate and partner with other parties that are mutually beneficial. Distribution of agroforestry farmers according to the capacity and category in Kuningan and Majalengka districts in 2017 is detailed in Table 4.

The capacity is the ability of a farmer to be able to carry out agricultural activities, establish the objectives of farming properly and achieve the goals that have been set in the right way, answer challenges, and qualify as a superior farmer (Herman et al., 2008 ; Anantanyu, 2011). Naturally, each individual always has an inherent capacity. The ability of farmers to meet their needs in accordance with their potential is a capacity that should not be ignored in order to achieve sustainable agriculture (Herman et al., 2008).

Tjitropranoto (2005) explained that an understanding of individual characteristics and self-capacity of farmers will determine their level of potential or readiness in accepting the technology introduced to them; conversely by knowing the potential and level of readiness of farmers in receiving agricultural technology, thus agricultural technology that will be introduced to farmers can be adjusted with their potential and readiness. By this approach, farmers will not only apply new sustainable technology, but will also develop their agricultural business using the new technology. It also shows that agricultural technology introduced to farmers should be adjusted to the self-capacity and resources and facilities owned. Adjustment to the capacity of farmers, both self-capacity and resources or facilities, will ensure the sustainability of technology applied.

Furthermore, Herman et al. (2008) explained that capacity is internalized aspects in farmers' characteristic which is indicated by the knowledge, attitude, and skills to run the farming activities. In order to succeed in conducting farming, high capacity is needed so that farmers are able to identify potentials and take advantage of existing opportunities so that farming is executed in accordance with the intended purpose.

According to Sumodiningrat (1999), empowerment of farmers is seen from several points of view namely: creating a situation that allows farmers to develop; enhancement of farmers' capacity to build farming through funding, training, infrastructure development, physical and social infrastructure, and regional institutional development; protection with partiality to weak farmers; d. creating mutually beneficial partnerships. The empowerment of farmers is the basic capital for the realization of being self-reliant. Empowerment and self-reliant of farmers are an inseparable unity. Sumardjo (1999) explains that farmers' self-reliant refers to the right or ability (competence) of farmers to manage their self-capacity responsibly. Sumardjo (1999) asserts that the other characters of a true self-reliant are having advanced cognitive, affective and psychomotoric, efficient and highly competitive behaviors so that farmers are able to think or make decisions quickly and accurately, as well as be able to partner and build mutually reinforcing and beneficial cooperation.

E. Factors Affecting Farmers' Participation in Agroforestry Farmer Group (FFG)

Farmer's participation in Gunung Ciremai National Park of Kuningan and Majalengka Districts is indicated by economic and social participations in FFG which is directly affected by cosmopolitan level of farmers, economic accessibility and forest farmer groups. This means that the willingness of farmers to receive information from outside, as well as the ease of economic access, particularly farm capital and the active role of FFG in the interest of its members may increase the participation of agroforestry farmers in their group.

Based on the result of regression analysis which is part of path analysis, it showed that individual characteristics of farmers and environmental supports have direct effect on farmers' participation around National Park. Variables of individual characteristics of farmers and environmental support had a contribution of 40.1% in explaining the changes occurred in agroforestry farmer's participation level around the National Park, while the rest, 59.9% is explained by other variables outside the model including counseling, training, or comparative studies.

Partially, it is seen that age, formal education, land tenure, farming experience and ecological conditions do not have a direct influence on the variable of farmer participation in FFG. This is because farmers are old, farmers' education is generally low, namely elementary school and junior high school, low farming experience, and small sized managed land. While the cosmopolitan level, economic accessibility and FFG role have a significant effect on the variables of farmers' participation in FFG. Regression coefficient of factors affecting farmers' participation in FFG in Kuningan and Majalengka districts in 2017 is detailed in Table 5.

The variables of age, formal education, land tenure, farming experience, and ecological conditions that have no significant effect on agroforestry farmers' participation, hence these factors are eliminated from the model. Thus, the structural equation is as follows:

$$Y_1 = 0.280X_{1.5} + 0.152X_{2.1} + 0.373X_{2.3} + \epsilon_1 \quad ..(1)$$

Based on the coefficient value (+), the variables $X_{1.5}$, $X_{2.1}$ and $X_{2.3}$ have a positive influence on the variable Y_1, which means that an increase of 1 unit of variables $X_{1.5}$, $X_{2.1}$ and $X_{2.3}$ will increase the variable Y_1 to 0.280, 0.152, and 0.373, respectively, assuming all other independent variables remain constant. It can be interpreted that the increase of farmer cosmopolitan level, economic accessibility and FFG will be able to increase the participation of agroforestry farmers in FFG both economically and socially. The willingness of farmers' to receive information from outside can directly affect farmers' participation in FFG. Similarly, the ease of partnering with financial institution and forest farmer group activities also has a direct effect on the increase of agroforestry farmers' participation in FFG.

Factors directly affecting farmers' participation in FFG based on the path analysis is presented in Figure 1. In relation to the level of participation and self-reliant of farmers, the age of farmers does not indicate a significant difference (Hudiyani, 2013; Salampessy et al., 2012; Aprolita, Amanah, & Susanto, 2008). While Herman et al.(2008) asserted that the level of education has a significant effect on the capacity and self-reliant of farmers. As described by Suprayitno et al. (2011), age showed a dominant influence on the level of ability of farmers around the forest. Older farmers have long lived in the forest and have long interacted with forest, managed and utilized the forest products, thus their ability in managing forest has been integrated and became part of everyday life.

In relation to the level of participation and self-reliant of farmers, the level of formal education of farmers does not indicate a significant difference (Hudiyani, 2013; Salampessy et al. 2012). While Herman et al. (2008) asserted that the level of formal education of farmers has a significant effect on the capacity and self-reliant of farmers. Aprolita et al. (2008) revealed that the level of formal education has a high correlation coefficient with the level of self-reliant on the capital. This indicates that the higher level of formal education of respondents, the higher the level of self-reliant in the capital.

F. Factors Affecting Agroforestry Farmers' Capacity

The capacity of agroforestry farmers in Gunung Ciremai National Park of Kuningan and Majalengka districts is directly affected by the levels of formal education, cosmopolitan, ecological conditions, FFG and participation of farmers in agroforestry FFG. This means that the higher the formal education of the farmers, the more is the willingness of farmers to receive the information from outside, the easier access of roads, the more active the role of the FFG, and the higher the level of farmers' participation in FFG that ultimately increases the capacity of agroforestry farmers around the National Park.

Based on the result of regression analysis which is part of path analysis, the individual characteristics of farmers, environmental support and farmer's participation in FFG around the National Park directly affect the capacity of agroforestry farmers which is

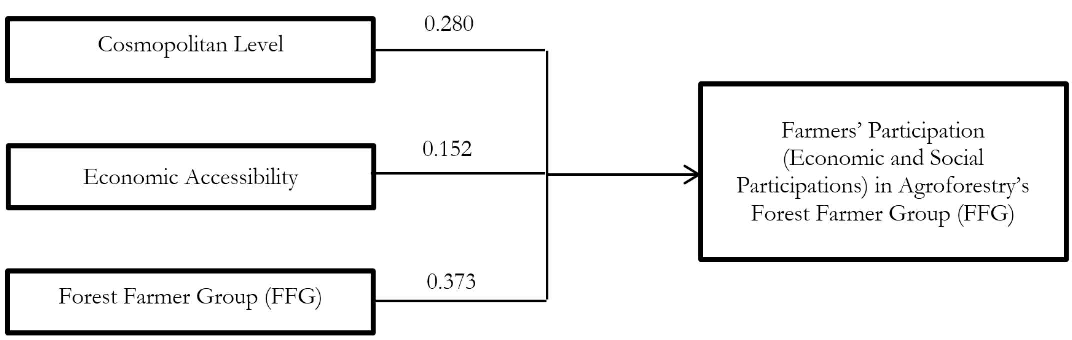

Figure 1. Factors directly affecting farmers' participation in Agroforestry Forest Farmer Group (FFG)

Table 6. Regression coefficient of factors affecting agroforestry farmers' capacity in Kuningan and Majalengka districts in 2017

Factors Affecting Agroforestry Farmers' Capacity	Regression Coefficient	Significance
Constant		0.000
Age ($X_{1.1}$)	-0.047	0.501
Formal Education ($X_{1.2}$)	-0.147	0.004**
Land Tenure ($X_{1.3}$)	0.073	0.152
Farming Experience ($X_{1.4}$)	-0.054	0.433
Cosmopolitan Level ($X_{1.5}$)	0.202	0.001**
Economic Accessibility ($X_{2.1}$)	0.083	0.127
Ecological Condition ($X_{2.2}$)	0.334	0.000**
FFG($X_{2.3}$)	0.148	0.010**
Farmers' Participation in FFG (Y_1)	0.183	0.002**
R Value: 0.603		
R^2 Value: 0.363		

Remarks: *) Significantly different at the level of 0.05, **)Significantly different at the level of 0.01

indicated by agribusiness competence and self-reliance of farmers. The individual characteristics of farmers and environmental support contributed to farmers' participation in agroforestry's FFG of 36.3% in explaining the changes occurred on the variable of agroforestry farmers' capacity around the National Park, while the rest 63.7% is explained by other variables outside the model.

Partially, it can be seen that age, land tenure, farming experience, and economic accessibility have no significant effect on the capacity of agroforestry farmers in FFG. Whereas formal education, cosmopolitan level, ecological condition have a significant effect on farmers' participation in FFG. The regression coefficient of factors affecting the capacity of agroforestry farmers in Kuningan and Majalengka districts in 2017 is detailed in Table 6.

Based on the above explanation, then the structural equation is as follows:

$$Y_2 = (-0.147X_{1.2}) + 0.202X_{1.5} + 0.334X_{2.2} + 0.148X_{2.3} + 0.183Y_1 + \epsilon_1 \quad \text{..............................}(2)$$

The coefficient value (+)of variables $X_{1.5}$, $X_{2.2}$, $X_{2.3}$ and Y_1 has a positive influence on the variable Y_2 which indicates that the increase of 1 unit of variables $X_{1.5}$, $X_{2.2}$, $X_{2.3}$ and Y_1 will increase variable Y_2 equal to 0.202; 0.334; 0.148; and 0.183 units, with the assumption that other independent variables remain constant. While the coefficient value (-) of variable $X_{1.2}$ has a negative effect on the variable Y_2 which indicates an increase of 1 unit variable $X_{1.2}$ will reduce the variable Y_2 of 0.147 unit, with the assumption that other independent variables remain constant.

The Factors that directly and indirectly affect the capacity of agroforestry farmers around the National Park based on path analysis are presented in Figure 2. Based on the results above, it proves that the cosmopolitan level and FFG have direct and indirect effects on the capacity of agroforestry farmers. This means that if the cosmopolitan level of farmers and FFG are improved, it will directly or indirectly increase the capacity of agroforestry farmers, either agribusiness competence or self-reliant. Economic accessibility does not directly affect the change in farmers' capacity but indirectly affect it through the level of farmer participation in agroforestry FFG. This indicates that the better the economic accessibility, the better the farmers' participation in agroforestry and it will further increase the capacity of the farmers. While the formal education of farmers and ecological conditions directly affect the change in agroforestry farmers' capacity, without any change in the level of farmer participation in

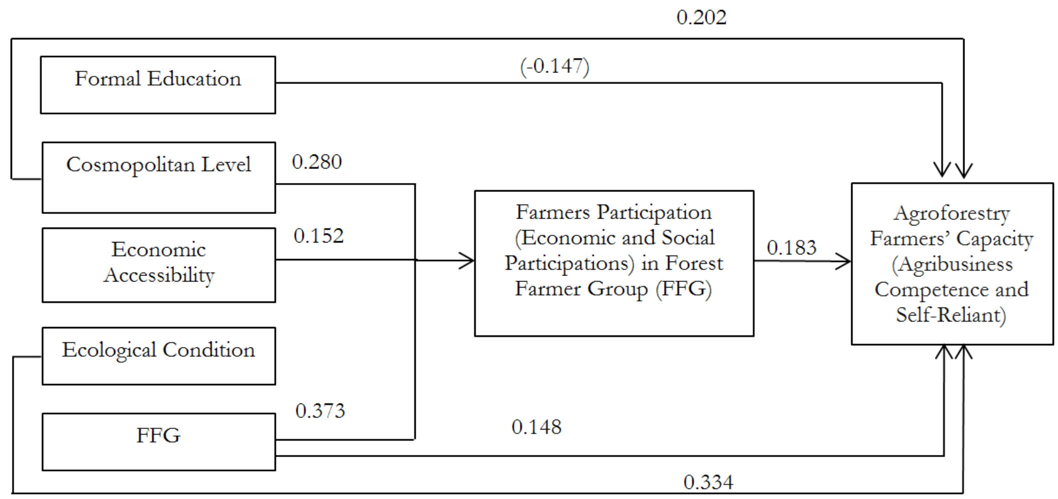

Figure 2. factors directly and indirectly affecting the capacity of agroforestry farmers

agroforestry FFG. This indicates that the higher the formal education of agroforestry farmers and easier road access, the higher the capacity of agroforestry farmers. The formal education of farmers (Figure 2) has a negative effect on the capacity of agroforestry farmers. It explains that agroforestry farmers who have a high education are not interested in agroforestry. They will look for other businesses that are better suited to their educational level, thus their land is not managed optimally.

Based on results of this study, factors affecting the capacity of farmers are formal education, cosmopolitan level, economic accessibility, ecological conditions, the role of FFG, and the level of farmer participation in agroforestry's FFG. These factors affect the capacity of agroforestry farmers either directly or indirectly. These findings are in line with the results obtained by Mutmainah and Sumardjo (2014) that personal factors including age, educational level, and farming experience may have an impact on the high level of farmers' participation in the empowerment process. Similarly, the results obtained by Ristianasari, Muljono, and Gani (2013) described factors that are related to community's self-reliant including socio-demographic characteristics, interaction and access, and empowerment program approaches. The results of this study support the findings of Aprolita et al. (2008) who stated that self-reliant is not dependent on other people, however, it will increase if there is cooperation between catfish farmers. Indicators related significantly to self-reliant are formal education, the number of family member, cosmopolitan level, business experience, and access to credit. The self-reliant of catfish fishers is not dependent on age and educational level of fishers, but the motivation to live better so that the needs of everydays life can be fulfilled.

IV. CONCLUSION

The weak individual characteristics of farmers directly affect the low capacity of agroforestry farmers around the National Park area. The most influential aspects are the level of formal education and cosmopolitan of farmers. Farmers' education is generally low, namely elementary school and junior high school. In general, they are less active in agroforestry farming or are less serious in cultivating land, thus their capacity becomes low.

Weak environmental supports also directly affect the low capacity of agroforestry farmers around the National Park area. The most influential aspects are the ecological conditions and the role of FFG. Farm road access needs to be maintained and its quality needs to be improved. The hilly topography needs to be guarded against landslides by planting many kinds of protective trees. In addition, water sources need to be maintained and managed properly so as to provide justice for farmers.

The low level of farmer participation in agroforestry FFG directly affects the low capacity of agroforestry farmers around the National Park area. The levels of farmer participation are indicated by aspects of economic participation and social participation. Farmers' involvement in FFG economic activities, whether in terms of business capital, seed demand, fertilizer, equipment, or product marketing is able to increase their capacity. Similarly, by actively attending meetings, recitals, working together, and helping neighbors hit by disaster, are also factors able to increase their capacity.

The low capacity of agroforestry farmers around the National Park area is also indirectly influenced by the economic accessibility, farmers' cosmopolitan level, and the role of FFG. Increasing aspects of economic accessibility, cosmopolitan level, and the role of FFG have been able to increase the participation of farmers in agroforestry FFG, which further enhances the capacity of agroforestry farmers around the National Park area.

In term of capital needs fulfillment, agroforestry farmers still rely heavily on the economic capacity of the family. They have not been interested in making use of government or private financial institutions and cooperatives. This is due to the complexity of the financial institutions' bureaucracy and the high interest rates on loans.

RECOMMENDATIONS

The formal education of agroforestry farmers needs to be increased through package programs A, B or C. Meanwhile, cosmopolitan levels may be improved through training, seminars, workshops or internet-based forestry extensions.

The role of FFG for farmers needs to be increased through forestry extension conducted by forestry extension agents with a higher intensity, empowering FFG as a learning tool, fostering cooperation, facilitating farming needs, or solving farmers' problems.

Economic accessibility needs to be increased by facilitating bureaucracy, unsecured or non-interest venture capital loans facilitated by the government.

Improved coordination between local government (institutions of forestry education in regencies or provinces) and central government (Ministry of Environment and Forestry) needs to be conducted so that better cooperation can be established in the framework of the implementation of forestry extension as an effort to increase the capacity of agroforestry farmers around the National Park area.

ACKNOWLEDGEMENT

The authors would like to thank the Head of Education and Training Center for Human Resources of the Ministry of Environment and Forestry, Head of Education and Training Center for Environment and Forestry Makassar, Head of Gunung Ciremai National Park, Head of Forest Management Center Regional V Province West Java. We would also like to thank parties who have contributed to this study, especially to members of agroforestry farmer groups in the buffer villages of Gunung Ciremai National Park in Kuningan and Majalengka districts who have been involved in this study.

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DIAGNOSING PERFORMANCE IN GOVERNING UTILIZATION OF FOREST PRODUCTION IN FMU MERANTI–MUSI BANYUASIN, SOUTH SUMATERA

Ja Posman Napitu*[1], Aceng Hidayat[2], Sambas Basuni[1] and Sofyan Sjaf[1]

[1]Biologi Research Center, Km.46, Jl. Raya Bogor, Cibinong, Bogor, West Java 16911, Indonesia
[2]Forest Product Research and Development Center, Jl. Gunung Batu 5, Bogor, West Java 16610, Indonesia
[3]Non-Timber Forest Product Technology Research & Development Institute, Jl. Dharma Bakti No. 7, West Lombok, Indonesia

Received: 4 October 2017, Revised: 1 February 2019, Accepted: 29 April 2019

DIAGNOSING PERFORMANCE IN GOVERNING UTILIZATION OF FOREST PRODUCTION IN FMU MERANTI –MUSI BANYUASIN, SOUTH SUMATERA. Perspective differences of users related to forest area utilization has caused tenurial conflicts, as well as, possible utilization conflicts. This study aimed to understand stakeholders' interests and influences as exogenous factors that caused the non-optimal institutional performance. This study used an institutional diagnostic approach to understand how the situation and action arena is from inter-influencing institutional entities. Data collection used the convergent parallel mixed method (CPMM) approach, while analysis used the rapid land tenure assessment (RaTA) method. Further, this study used the Institutional Analysis Development (IAD) method to explain how the exogenous factors influence each other. The results showed that the characteristics of biophysical attributes, community attributes, as well as, rule in use were inter-influencing within the action arena. Besides, based on the post-prospective analysis result, policy decision opted by the government tend to not consider the community's existence, who have been using the land for their livelihood. This situation has caused utilization conflicts between communities and concession holders. Thus, this study recommends: 1) the stakeholders to establish a communication forum for all parties to obtain clear information about forest utilization and to support institutional performance; 2) institutionalizing local community to govern forest utilization, and 3) determining management and concept of sustainable forest, as well as, policy making.

Keywords: Institutional diagnosis, exogenous factor, policy effectiveness, outcome

DIAGNOSIS KINERJA PENGATUR PEMANFAATAN HUTAN PRODUKSI DI KPHP MERANTI – MUSI BANYUASIN, SUMATERA SELATAN. Perbedaan sudut pandang dan pemahaman pengguna dalam memanfaatkan kawasan hutan menyebabkan tumpang tindih areal dan berpotensi menimbulkan konflik pemanfaatan. Penelitian ini bertujuan untuk mengetahui kepentingan dan pengaruh para pihak sebagai faktor eksogen yang berdampak tidak optimalnya kinerja kelembagaan. Diagnosis kelembagaan digunakan untuk mengetahui bagaimana arena aksi dan situasi aksi dari entitas kelembagaan saling mempengaruhi. Data dikumpulkan dengan menggunakan pendekatan convergent parallel mixed method *(CPMM) dan langka kerja analisis menggunakan* rapid land tenure assessment *(RaTA). Untuk menjelaskan bagaimana faktor eksogen saling mempengaruhi digunakan* Institutional Analysis Development *(IAD). Hasil penelitian menunjukkan bahwa karakteristik atribut biofisik, atribut komunitas, dan rule in use saling mempengaruhi dalam situasi arena aksi. Selain itu, dari post-prospective analysis menjelaskan bahwa pilihan kebijakan cenderung tidak mempertimbangkan keberadaan masyarakat yang telah menggunakan lahan untuk penghidupan mereka. Kondisi ini menyebabkan terjadinya konflik pemanfaatan antara masyarakat dan pemilik izin. Rekomendasi penelitian: 1) untuk membuat forum komunikasi bagi semua pihak untuk mendapatkan informasi yang jelas tentang pengguna hutan dan mendukung kinerja; 2) perlu pelembagaan masyarakat lokal dalam pengaturan pemanfaatan, dan 3) penentuan pengelolaan dan konsep kelestarian hutan dalam pembuatan kebijakan.*

Kata kunci: diagnosa kelembagaan, faktor eksogen, efektifitas kebijakan, hasil

* Corresponding author: njpnapitu@gmail.com

 doi:10.20886/ijfr.2019.6.1.43-60

I. INTRODUCTION

Forest provides great benefits to people, but the destruction of forest threatens human life and other beings, (Daily, et al. 1999; Colfer, Sheil, Kaimowitz, & Kishi, 2006; Chakravarty, Ghosh, Suresh, Dey, & Shukla, 2012). Deforestation and degradation occur in Indonesia, it cannot be denied, are partly due to poor forest management system during the Right of Forest Concession/HPH-era and illegal logging activities (Kartodihardjo, 1998; Holmes, 2002; Pilgrim, Cullen, Smith, & Pretty, 2007).

Approximately, in 1950 Indonesia's total forest area was 159 Mha (Million hectares), but decreased to 91 Mha in 2015. Oil palm and rubber plantations, cropping areas, as well as, settlements are the most causing factors to deforestation and degradation (FAO, 2015; Tsujino, Yumoto, Kitamura, Djamaluddin, & Darnaedi, 2016). So, the change may occur due to forestry sector and non-forestry sector activities.

Further, changes occur in forest area are due to permits granted for the industrial forest plantation (IFP), ecosystem restoration (ER), community plantation forest (CPF), village forest (VF), and community forest (CF). While, in the non-forestry sector, deforestations are generally caused by the Forest Area Utilization Permit (FAUP - Izin Pinjam Pakai Kawasan Hutan (IPPKH)) including mining, infrastructures, non-procedural plantation, and transmigration area. Therefore, these permits for, both forestry and non-forestry, within the forest area are potentially causing utilization conflicts due to area overlapping (Gamin, Nugroho, Kartodihardjo, Kolopaking, & Boer, 2014). Economic motives among dwellers are also thought to pose problems in forest management (Tsujino, Yumoto, Kitamura, Djamaluddin, & Darnaedi,2016).

The above-mentioned issues have become critical topics in almost every forestry-related meeting. Several actions and programs to countermeasure the issue from the government side are:

a. The development of Sustainable Forest Management program (SFM/PHPL), as well as, Community-Based Forest Management (CBFM), by the Ministry of Environment and Forestry (MoEF), such as: communal plantation forest (CPF/HTR), community forest (CF/HKm), and forest village (FV). See Table 1 for targets and accomplishments of the aforementioned government programs.
b. The execution of Indonesia's Forestry Congress VI, with the theme "Reposition of Indonesia's Forestry towards Good Governance".
c. Establishing site level management area, such as the Production Forest Management Units (PFMU/KPHP).

There are five causal linkages, which threaten forest management, i.e.: a) irresponsible concession permissions for corporations (Kartodihardjo, 1998), b) lack of science and experts (Kartodihardjo, 2013b), c) governmental alignments to private concession

Table 1. Target and realization

Permit	Target Hectare Unit	Realization Hectare Unit	%
CPFP/HTR	734,397	19,270	26.59*
CF/HKm	328,452	94,372	28.73*
FV/HD	318,024	67,737	21.29*
IFP-SFM	234	76	32.47**
IFP-SFM	296	107	36.15**

Source: *PSKL (2015) **KAMH (2013)

holders (Suhendang, 2013), d) corruption, collusion, and nepotism activities (Hermosilla & Fay, 2005; Tacconi, 2007; Kartodiharjo, 2016), and e) lack of active participation from communities to support MoEF targets related with forest management (Gulbrandsen, 2004). Thus, it can be said, that continuous conflict of utilization and unstable management are a form of policy failure (Kartodihardjo, 2013). Also, conflicts due to unaccepted extension of concession permit by the communities are a form of bad governance (Sheil & Wunder, 2002; Larson & Ribot, 2007).

Mostly, conflicts are caused by lack of proper social interaction, which resulting in poor institutional performance in forest management (Ostrom 2010; Ostrom & Basurto, 2011). In this case, different perspectives among the involved stakeholders about the cause of conflicts are able to change and affecting their interactions. This can be seen when people who use forests for their livelihoods are not permitted to do so by the government, while licenses are granted to outside companies in the same locations instead (Tucker, 1999; Kartodihardjo, 2013). Even, people who seek for their livelihood within the forest area tend to be perceived as having illegal activities by the government, but not the companies, that are used to destroy forests (Tacconi, 2007).

In this regard, the Meranti FMU, based on the results of their operational assessment, was categorized as to having sufficient category. This is because, they still lack support organizationally, either from village communities, or having an insufficient role from surrounding stakeholders due to community roles have no institutionalization (Hendartin, Nugroho, & Kartodihardjo, 2011). Institutionalization itself is related with the determination of: management form, rules of utilization, as well as, who use the forest area. These factors are causing the institutional performance to be inoptimal, cannot be separated from the exogenous factors (Suwarno, Kartodihardjo, Kolopaking, & Soedomo, 2015), which influence each other, such as: a) attributes of biophysical characteristics of natural resources; b) community attributes (community, government and private/business owners), and c) regulation used (Elinor. Ostrom & Hess, 2007; Ostrom, Gardner, & Walker, 1994). Frequently, all of those three attributes might lead to competition on various transformation patterns , both management and mutual claims of land (Dolšak & Ostrom, 2003; Tucker, & Ostrom, 2005; Fleischman et al., 2014).

Institutional diagnosis was carried out to explain communities' role as part of the communal forest management attributes (Larson & Ribot, 2007). Then, the analysis results of exogenous factors were used to explain: a) the correlation of the exogenous factors from community attributes to the action arena, as well as situation of the action (Sunderlin et al., 2005), b) how various attributes of the community factors could affect rules, that are determining the outcomes (Jagger, Luckert, Duchelle, Lund, & Sunderlin, 2014), and c) position and roles of each participant in using information, as well as how is their interaction, that affect other actors (Ostrom, 1990; Andersson, 2004; Cantiani, 2012). The outcomes of this research are defined as the policy decision choice of each party. Clear information were needed to determine, whether to choose the choice of the parties or to change the rules (Suwarno, 2014). In this case, the required information includes; a) exogenous factors; b) costs incurred, and c) expected benefits (Agrawal, 2001).

Based on the above description, this research was conducted to answer three main questioned problems, as follows: 1) what factors influence the institutional performance of forest area utilization arrangement? 2) Institutionally how to strengthen government's position within such utilization arrangements? 3) How would be the form of communities' role surrounding the concession area to legitimize government-backed permissions for corporations? Formulations to the above problems were the basis of why this research is significant

II. MATERIAL AND METHOD

This research was conducted in the Meranti FMU, and aimed to explain how exogenous factors are inter-influencing each other. This study was carried out by diagnosing institutional regulatory frameworks using Institutional Analysis and Development (IAD) method (Ostrom & Hess, 2007).

The convergent parallel mixed method (CPMM) (Creswell, 2013) was used to collect all data,namely: land change, literature study, history and map of changes. This study also used in-depth interviews of 123 key informants, consisted of 97 people from 8 observed villages, 4 MoEF officials, 8 District Forestry Service officials, 4 Provincial Forestry Service officials, 5 staffs of the Technical Implementation Unit of the MoEF, and 5 managers from concession holders in the forestry sector. Other additional informants were obtained by the snowballing method. This study used the Rapid Land Tenure Assessment (RaTA) method for data analysis (RaTA) (Galudra et al., 2010).

III. RESULTS AND DISCUSSION

Exogenous factors affect each other in the arena of action of the interests of the parties (Ostrom, 2005); (Ostrom, Gardner & Walker, 2006). Based on the diagnostic, the institutional framework performance in Meranti FMU are: a) biophysical characteristic attributes, b) community attribute, c) rule in use, d) action and situation arena, e) outcome, and f) evaluation criteria.

A. Characteristic of Biophysical attribute

The Meranti FMU consists of three regulated forest types, i.e.: fixed production forest/HPT area 53.36%, Production forest/HP area 38.68% and Protected forest/HL area 7.96%. There are two types of utilization types for non-protected forests i.e.: a) allowed for forest wood product utilization, such as Industrial Forest Plantation/IFP Communal Forest Plantation/CFP, Community Forest/CF, and Forest Village/FV; b) PAUF (Izin Pinjam Pakai Kawasan Hutan - IPPKH), such as for mining, infrastructure, or transmigration areas.

There are various biophysical characteristic attribute within the FMU area. This consists of renewable resources, such as: timber forest product, non- timber forest product, oil palm, rubber plantation, rice fields, etc.; as well as non-renewable resources, i.e.: oil, coal, and tin-lead. All of those resources greatly influence the choice among users, which is largely determined by their interactions, which might be in the form of intervention to policy-making processes, since it is susceptible to clouts from those who have financial powers (see Maryudi et.al.2018). The latter actors could also be influenced by other institutional factors for using resources in forest area, such as: political environment, regulatory and legal environment, economic- and technological environment (Dolšak & Ostrom, 2003). Talking about other biophysical attributes, there are various land covers in the study location. Secondary forest, which mostly consists of ecosystem restoration

Table 2. Forest land cover

Land Cover	Area (hectares)	%
Secondary forests	95,999.55	39.32
Planted forests	69,085.07	28.29
Plantation	13,002.93	5.33
Shrubs	29,898.14	12.25
Mixed farming	35,948.14	14.72
Mining	107.07	0.04
Settlement	121.43	0.05
Total	244,162.33	100

Source: KPHP Meranti, (2015)

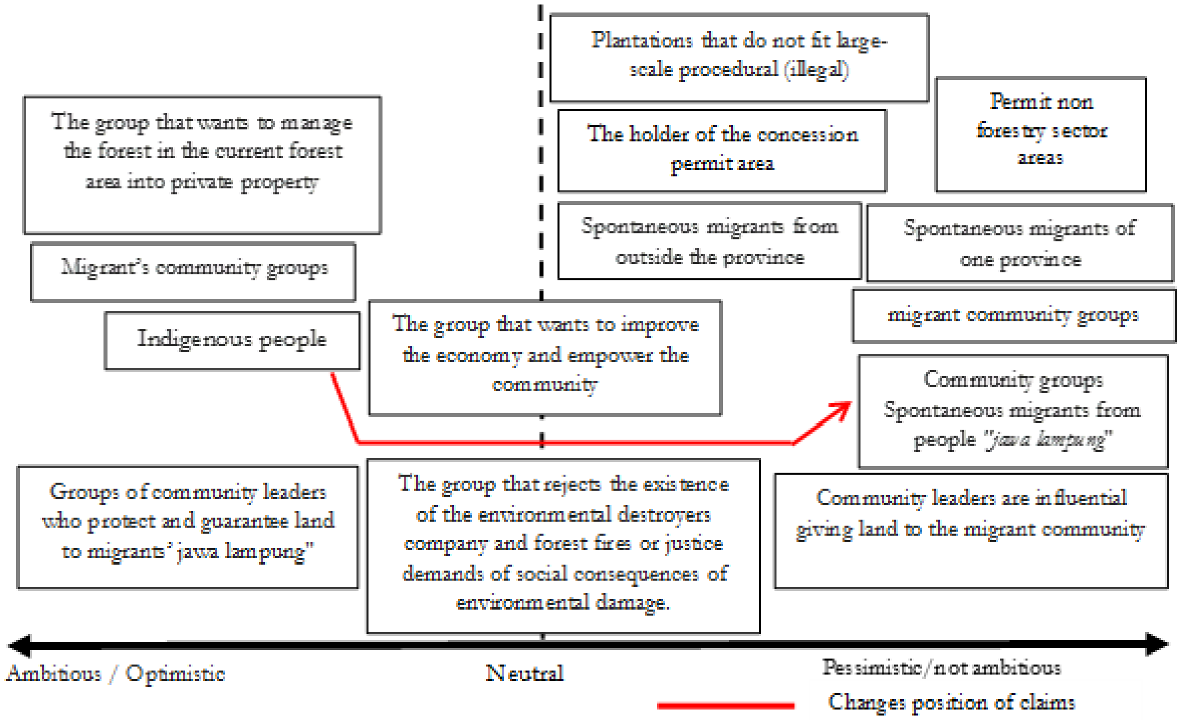


Figure 2. The change of community position on land claim

(ER) and protected forest area, are covering 39.32% of the land. Meanwhile, there is also 28.29% planted forest, which was originally primary forest during the forest production rights era (FPR – hak pengusahaan hutan (HPH)). Details of various land covers are shown in Table 2, meanwhile see Table 3 for the detailed utilization-based area; including claimed, overlapping area by the community.

B. Characteristics of Communities

Decision making in action situations could be influenced by collective choices of institutional communities, although it might lead to ineffective regulation, due to different interests (Agrawal & Ostrom, 2001). Analysis of community attributes is important to identify roles of each participant, whether to influence or be influenced by policy outcomes (Mwangi & Markelova, 2009).

There are key factors to analyze community attributes, i.e.: behaviors, level of understanding, homogeneity level, the size of composition and inequality of assets (Suwarno, 2014). Community groups in the Meranti FMU were classified by their origin, as follows: a) indigenous, b) migrants, c) spontaneous migrants of the same province, d) spontaneous migrants from other provinces, e) spontaneous migrants of "Java-Lampung" people. The aforementioned classification is illustrated in Figure 2.

The results found three types of claim orientation by the community, as follows: a) rights claimers, those who wanted to manage land by acquiring current forest area into private property, b) socio-economic oriented group, those who wanted to improve their economy and empower community, c) environment-concerned group that rejects the existence of corporation, which damaging environment and causing forest fires. The latter group also demands justice for social impacts from environmental damages they experience. There exist several characteristic-based communities, such as: a) those whose cultural values concur with government-made policies; b) Those who are capital owners and influenced by knowledge, and c) those who reject current policies.

Table 3. Predicted community land claims and biophysical condition

Land cover	Predicted area (hectares)	Biophysical condition
FMU Meranti areas (community occupation and non-permit areas/*wilayah tertentu*)		
Community Forest	9,848.51	Mixed plantation/Kayu Komersil Rimba Campuran (KKRC)
Planted forests	788.45	*Acacia Mangium*, *Eucalyptus*, and Jabon
Plantation	9,581.01	Oil palm aged 7-15 years, Rubber
Shrub/farm	5,396.80	Types of savannah and KKRC diameter <30 cm
Agricultural land mixture	9,843.80	Rubber, oil palm, and coffee plantations, cocoa, fruits.
Mining	30.95	Oil and petroleum
Settlements	121.43	Public building, houses, government offices, road facilities
Sum	35,610.95	
Industrial Forest Plantation /IFP area		
Plantation estate, community plantation, and Settlement	55.933,88	Plantation estate, shrubs, rubber, oil palm about 3-5-years old, Rubber age about 10-15 years and settlement
Restoration ecosystem area		
Rubber plantation, Settlement	2.500,01	Rubber plantation (age: 10-15 years)
Total overlapping areas	94.044,84	

Source: Processed primary data (2016) and Strategic Plan FMU Meranti 2013-2014 (2013)

This study also observed five types of community claiming intention toward current utilization and management policies, i.e.: a) ambitious, who have strong desire to take over forest area and shifting status quo; b) neutral, those who submissive to policy changes c) non-ambitious, those who do not have desire to claim forest area; d) optimistic, those who think they are able to do the claim, and e) pessimistic, those who do not think they are able to win their claim. Often, different interests might also change the above intentions, from non-ambitious to ambitious, or vice versa.

The above-mentioned claiming intentions were observed within the transmigrant community, which has splitting standpoints about programs run by the Meranti FMU. Some people within this community are ambitious. These people, though most of it is indigenous, reject spontaneous Lampung migrants, who illegally occupied an area to establish village. They, also intend to claim some of the forest area as communal plantation forest (CPF – hutan tanaman rakyat (HTR)). The rest are non-ambitious, who think they need counsels and socializations from government.

C. Rule in Use

The rule in use could be seen from how each party is able to use and obtain benefits from forest area. Further, this is explainable from the existence of two access mechanisms, i.e.: structure-relation of access mechanism, and rights-based access mechanism (Ribot and Peluso, 2003). In this study, working rules were visible from: effective rules, related to forest and land utilization, within communities; as well as, government policies related to regulated forest utilization. Land ownership occurs with various processes over time. Community rules among indigenous people have been ruling for generations, which are distinguishable from five forms of access mechanism (Table 4).

Forest utilization is regulated under the Law No. 41/1999 about Forestry, which direct the government as forest resource manager for the sake of public welfare as generally stated within the 33rd Article of 1945 Constitution. This is, since forest has great potential, not only from its timber, non-timber products and biodiversity, but also from the underlying soil containing oil and minerals.

Further, utilization within the production forest area is not only for forestry-related

Table 4. Access mechanism for community land use

Form of access	Community origin	Rules/norms
1. Hom-steading, shelter or stay (home)	Indigenous people (Kubu people)	Land for livelihood, hunting, home-steading
2. *Para rimbo*	Musi people	Rubber/mixed estates are in patron-client relationship among *Pesirah* and indigenous people.
3. Shifting cultivation	Musi/ Komering Tribe	Shifting cultivation for crops/dryland farming arrangements (cycles) to maintain soil fertilization.
4. Community core plantation/ PIR or smallholder	A spontaneous migrant from Musi people, Komering people, Rupit people, and Rawas people, and from Java people)	Oil palm plantation is obtained by trading with the figure/village head
5. Illegal transmigration area (village establishment without proper license from authority)	Often said: *Jawa Lampung* Migrant from Lampung	Managing open access land ex-IFP obtained by buy-selling from leader persons of villages

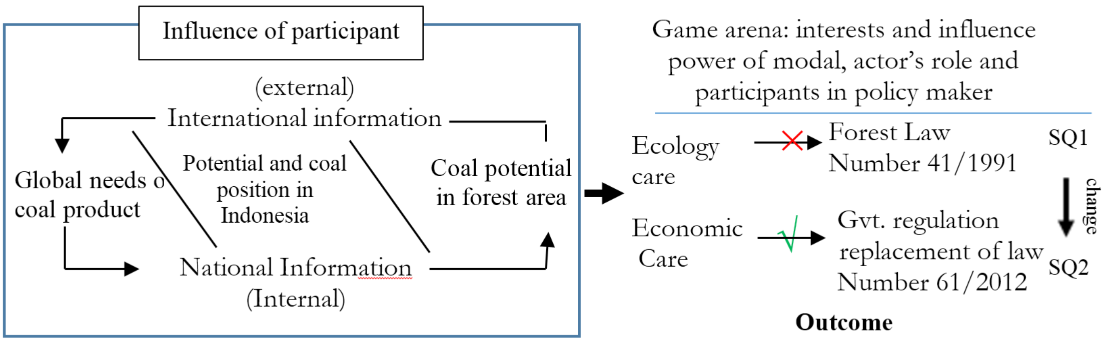
Source: Processed primary data (2016)

industries, such as industrial forest plantation (IFP – hutan tanaman industri (HTI)) but also for non-forestry sectors. Due to globally spreading demand, those particular areas are also licensed for non-forestry sectors, i.e.: coal and oil mining, even for infrastructural purposes as regulated in Law-Replacement Government Regulation (LRGP – Peraturan Pemerintah Pengganti Undang-Undang (Perpu)) No. 61/2012 about Mining Activities within Forest Area. The above complexity is also because of the abundant amount of permissions a licensee can hold. Such license, forest area utilization permission (FAUP – izin pinjam pakai kawasan hutan (IPPKH)), is granting several permissions to its holders: exploration activities, wood production, as well as, mining for non-mineral materials. Based on the Directorate General of Planology report, in 2012 licenses were issued for 971.825 ha mining area and 258 units of buildings within forest area, which increased to 820.294,34 ha and 238 building units for the same purpose in 2013 (Kemenhut, 2014).

The aforementioned situation clearly shows how a complex license granting for forest area utilization, in this context, could cause area overlapping and other difficulties. In this situation, a powerful user, in pursuing its interest, can influence the decision-making process, which might result in both poor organizational performances, as well as policy issues (Dann 1994; Kartodihardjo 2008). In accordance with the above complicacy, this study has also observed policy shift, where previous policy decision (SQ1) was overlapped with newer policy decision (SQ2) (see Fig. 3). This case is visible from 704 ha of concession grant for coal mining (based on license no.: 336/ Menhut-II/2012) on the CFD area, which was previously validated by license no.: 249 /Menhut-II/2009 (see Table 4 and 5 for reference). The above example indicates the involvement of game-changing information, whether from internal or external sources, to policymakers, which affect the policy outcome. This is, since policymakers often choose subjectively the economic benefits rather than ecological awareness in the game arena (see Figure 3).

D. Action and Situation Arena

Arena situations within the action arena, which are confined in institutional framework, affect information and transaction costs to participants. Thus, this might also impact policy choice situation, which often leads to



Remarks?: √ = Decision choices (changed) (SQ2) X = the previous decision (lost) (SQ1) SQ = Status Quo

land utilization change and overlapping, as well as, conflicts.

1. Information and transaction costs

Information significantly determines how policymakers choose their decision, whether to grant or refuse, permit proposals. Applied consideration might vary, from the type of venture, produced goods, or extracted materials; which also includes potential impacts on environment and economic-related values. Not only for the policymakers, information is also required by venture owners, including IFP, to understand current market condition, i.e.: product prices, production costs, as well as, global market updates. Further, from the available information participants could gain knowledge about decision making factors, such as: market perception and political transaction costs (Kartodihardjo 2008). Moreover, during the application process, negotiating ability might limit the needs of both sides, such as: proposed area, location, and potential products.

Once a business thought to be feasible, the next possible decision is about how to increase production, which is going to involve, both biophysical and community characteristics, in the form of interaction among parties. Often, such interactions cause high transaction costs for corporations during decision-making process due to the existence of overlapping area (Kartodihardjo, Nurrochmat, & Justianto, 2015). The amount of the significant transaction costs would depend on key policymakers, whether beneficial or not for them, and often ignoring community interests. The above-mentioned case was well explained by one of the informants, as follow:

"Indeed, sometimes we have to understand (the policymakers' intentions) too if we do not understand and are not sensitive to such (intentions)...., we would never know when our permission will come out. The amount of the cost depends on his position. Indeed, in this society, it can be arranged" -

Maman LH (67) IFP Manager-

The action arena could be more complicated if interests of local elites and their politics are involved. This is, since during local elections – as candidates eager to gain more fund to cover their campaign costs, such transactional activities are increasing. While at the same time concession holders sense the necessary to get closer to bureaucratic administration for the sake of their interests. This means, that structural power could affect corruption events (Baseowi et al. 2012), as described by the source:

"The company is obliged to 'donate', because 'he' is, the former head of the sub-district here. He knows companies here and the village head is his subordinate. (Thus) if we do not 'donate', we cannot work in this area."

-Heri (54) IFP manager-

There is a gap between management objectives and the implementation of forestry regulations, due to such kind of interactions between corporate individuals and policy-makers (Suwarno, 2014). Thus, any sanctions imposed to private forestry sector for their non-compliant activities against regulations

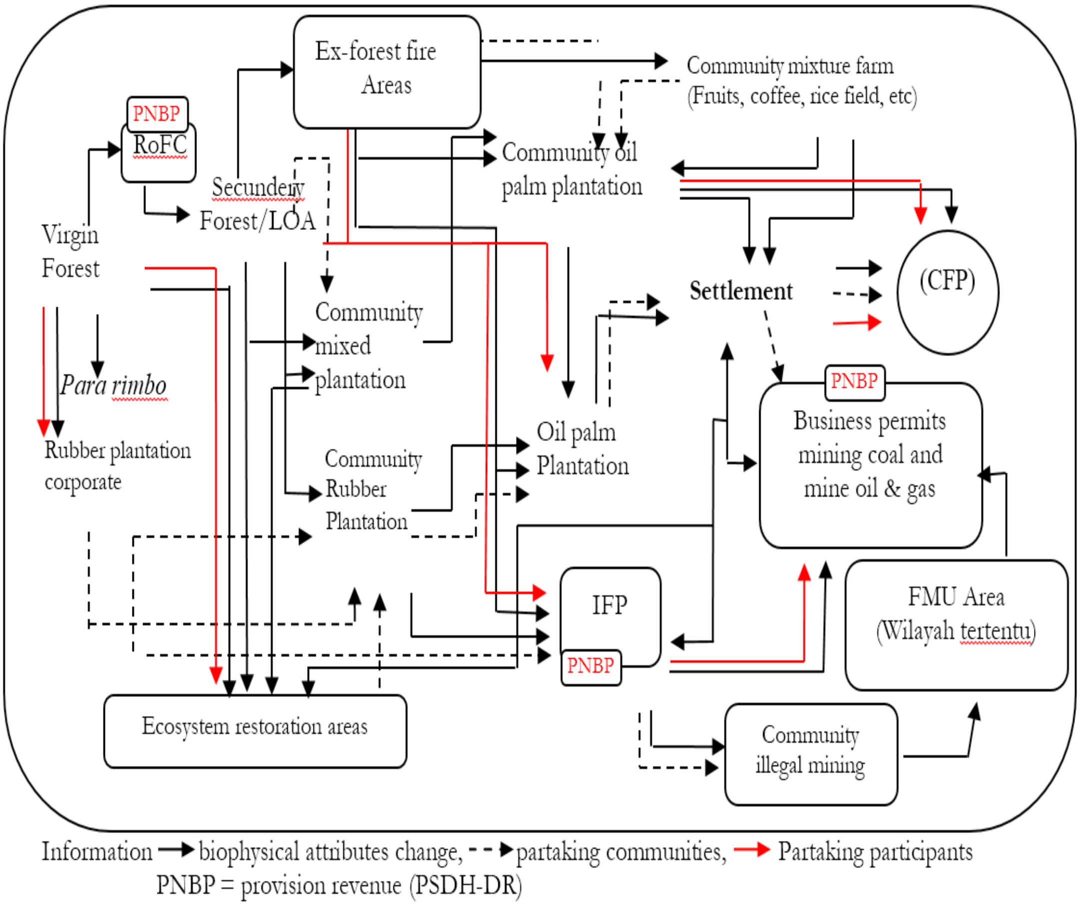


Figure 4. Changing process of biophysical characteristics of forest areas

are also influenced by corruption practices (Hidayat, 2007). However, to do research about the aforementioned corruptive interaction is difficult, even for corporate HRD, due to its high sensitivity, as well as, possible cover ups. Such transaction cost, which in the above context is bribery, in the action arena involve local officials and companies, whether legal or not, as well as other users (Nurtjahjawilasa. Kartodihardjo, Nurrochmat, & Justianto, 2015). Further, this also shows that the Meranti FMU is lacking optimal performance supports from all parties.

2. Overlap and take over areas

It is common for forestry officials, either from central ministry or local services, to perceive that land used by local people within the forest area is a law transgression. This is, since these officials often ignore communities surrounding forest area as part of the environment from socio-cultural interactions and processes. Their livelihood activities within forest area are seen as to only having economic motive. Meanwhile, policymakers often grant concession licenses on community area, although it could potentially cause access overlapping and tenurial conflicts. Such problems could occur because kinds of misguided activities, i.e.: a) permission granting to one or more new users on a currently utilized area; b) revocation of permission extension, which leads to open access area and gather free loaders, and c) permission granting on cropped customary area.

The existence of diverse biophysical conditions and dynamic user changes lead to complex interactions of exogenous factors within the action arena. Biophysical changes and

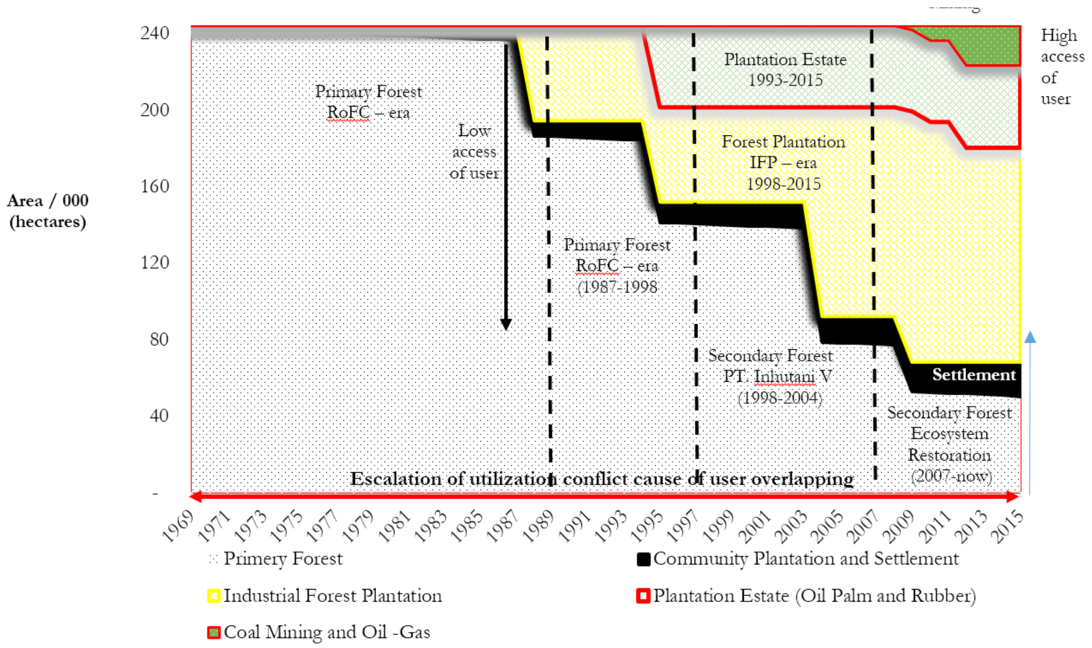


Figure 5. User change of position and transformation utilization conflict

user interests in the action situation determine the outcomes, which are desirable for, both actors and participants, when the decision maker agrees upon their choice (See Figure 4 for the processes of the aforementioned biophysical attributes changes).

Further, such interactions might also lead to policy interventions, which could be caused by: a) presence of new land users; b) biophysical changes of the area; c) user dynamics; d) addition to the community attributes, and e) 'rule to use' changes. In the Meranti FMU, the above case was observed from the land use change history, where the previous FPR area were altered to IFP due to policy shifts, while some of the latter area were eventually occupied by groups of people, and were conflicting. Then, decision was remade for the occupied area, from the previously IFP to CPF, to muffle the conflicts. Initially, the establishment of the FMU in Indonesia was influenced by discourses of policy de-concentration among the policymakers (Ekawati, 2013). So, it is an ineffective policy decision if the implemented policy, in this case the FMU establishment, does not improve institutional performance (Kartodihardjo, 2008; Budiningsih, Ekawati, Gamin, Sylviani, Suryandari, & Salaka, 2015). Even, policy decision, in this case permit issuance, without community recognition, would lead to conflicts in forest area, which is so-called as 'legal but not legitimate permission' (Sinabutar, Nugroho, Kartodihardjo, & Darusman, 2015). The changes of forest area was started since 1969. It referred to permits of Minister Decree and regional regulation (Table 5 and Table 6) as shown in Figure 5.

E. Outcome

The results of, both dynamic interactions and complicating situations, within the forest area of the Meranti FMU are: 1) land use access lost for local people, and 2) existing users emigration from forest area. At the end, such complicacies in forest area lead to utilization conflicts of each user (Wibowo, Race, & Curtis, 2013). Further, the aforementioned complexities are only for the sake of licenses, which are categorized into two, forestry and non-forestry sectors, as follows:

1. Forestry sector

Permittance issued for forestry sector are regulated in the Minister of Forestry (MoF) Decree No. P.31/Menhut-II/2014. Total area

Table 5. Forestry Sector Permits

User	Basic decision (Outcome)	MoF determined area (Hectares)	Area of Meranti FMU (Hectares)	%
REKI (Primary forest)	293/Menhut-I1/2007	52,170.00	50,153.00	20.55
BPP – I (IPF)	337/Menhut-II/2004	59,345.00	38,187.00	15.65
BPP –II (IPF)	79/Kpts-II/2009	24 ,050.00	24,283.00	9.95
RHM (IPF)	90/Menhut-II/2007	67,100.00	12,131.00	4.97
SBB (IPF)	249/ Menhut-II/2009	55,055.00	53,639.00	21.98
WAM (IPF)	252/Menhut-II/2009	6,290.00	6,547.00	2.68
Eks Pakerin (IPF)	226/Kpts-II/1998	43,380.00	23,375.00	9.58
Samhutani (IPF)	86/Kpts-II/1999	58.88	58.88	0.02
FMU areas concession	689/Menhut-II/2012	35,641.00	35,641.00	14.61
Total		343,089.88	244,014.88	100

for forestry sector is 343,089.88 ha, while 244,014.88 ha of it is in the Meranti FMU. See Table 5 for the detail.

2. Nonforestry sector

Permittance issued for non-forestry sector within the forest area, in the form of FAUP license, which are regulated under several decrees, i.e.: 1) MoEF Decree No. 50/Mlhk/Sekjen/Kum-1/6/2016 Jo; 2) MoF Decree No. 65/Menhut-II/2013 jis, and 3) MoF Decree No.: 43/Menhut-II/2008. Until April 2015, total area of this category was 5,653.07 ha (see Table 6).

F. Evaluation Criteria

In evaluation criteria, institutional effectiveness based on the aforementioned regulations of forest area utilization, against various interventions, was visible from how parties intervene the regulatory body. The successful policy choices are about how the solving problems are.

Criteria for the institutional evaluation in the Meranti FMU, with an objective management approach, were based on the Government Regulation No. 3/2007 Jo. No. 6/2008, as follows: a) social impacts of current policy decisions; b) economical contribution from, both forestry and non-forestry sectors; c) the amount of labors work in both sectors, community empowerment, and conflicts; d) impact of the currently applied policies to SFM objectives. Those criteria were analyzed by post-prospective analyses.

1. Impact of policy failure

The policy outcomes, such as overlapping area, are perceived by land users as institutional obstacles. Meanwhile, the community's rights of authority are seen as an institutionally endogenous problem rather than institutional exogenous factor. As there are land claims from some of the users to others, which violate their rights, it shows the existence of policy failures that fail to solve the main problems (Kartodihardjo, 2008). The above conflicting land claims have led to forest destructions and are complained by local people, as said by one of them below:

"The production forest area of the Meranti group that was formerly managed by the logging company (FPR) Asia-log Co. and Padeca Co., was later replaced by Niti Remaja Co., before subsequently replaced by state-owned company Inhutani V., but the FPR activities actually were causing to forest destruction. And now, to use the remaining timbers, the government gave permission to IFP (holders). (We have been experiencing) forest degradation, frequent forest fires, as well as, scarce fresh water. We, indigenous people here, would like to ask 'what exactly is the forestry service doing?"

Iskandar (54)
Community leader of Sako Suban Village

The above statement represents similar experience of others within the study location:

Table 6. Non-Forestry Sector Permits (until April 2015)

User	Basic decision (Outcome)	Area (hectare)	Type(s) of forest function	Activity/Product
PT. MAL (1)	SK. 423/Menhut-II/2011	505.17	HP	Coal mining
PT. MRB	SK. 101/Menhut-II/2014	691.05	HP	Coal mining
PT. GSM	SK. 862/Menhut-II/2013	353.70	HPK	Tin foil mining
PT. NIP	SK. 331/Menhut-II/2012	99.90	HP	Coal mining
PT. BM	SK. 466/Menhut-II/2012	616.71	HPK	Coal mining
PT. KPS	SK. 864/Menhut-II/2014	1,532.96	HPT	Coal mining
PT. TM.	SK.740/Menhut-II/2011	354.90	HPK	Coal mining
CP Co. (1)	SK. 29/Menhut-II/2012	75.88	HPT	Oil-Gas mining
CP Co. (2)	SK. 140/Menhut-II/2014	30.33	HP	Pipeline
CP Co. (3)	SK. 158/Menhut-II/2014	212.59	HL,HPT,HP	Petroleum
CP Co. (4)	SK. 133/Menhut-II/2013	13.70	HP	Petroleum
PT. MI	SK. 185/Menhut-II/2012	19.02	HPK	Road coalmine
PT. MAL (2)	SK. 267/Menhut-II/2012	10.10	HP	Port of coal
PT. DSSP P	SK. 480/Menhut-II/2013	46.80	HP,HPK	Electric Power
PT. SBB	SK. 336/Menhut-II/2012	704.00	HP	Port
PT. JOB P .	SK. 460/Menhut-II/2009	248.53	HP	Pipeline
PT. CP (5)	SK. 561/Menhut-II/2013	48.59	HL,HPT,HP	Road
PT. CP (6)	SK. 561/Menhut-II/2013	92.73	HP	Pipeline
PLN (electric power)	SK. 800/Menhut-II/2014	2,335.00	HP,HPK	*Sutet* 275kv
PT. PU	71/Kpts-II/92	3,100.00	HPK	Rubber plantation
PTPN VII	584/Kpts/I/2007 (governor decree)	16,800.00	APL/HPK	Oil palm plantation
PT.BSS	01/SK-IL/MUBA/1998 (Badan Pertanahan Nasional/BPN)	11,000.00	APL/HP	Oil palm plantation

Source: BPKH Region II Palembang (2015), Forest Service South Sumatra (2012) (unpublished)
Information: HP = production forest, HPK = conversion production forest, HPT = fixed production forest

a poor long-term forest development concept, while its short-term goals have only economic orientation, which are depleting the resources. The point is, that the concept Indonesia have, in regards of forest management, is unsustainable, where we would have to pay the costs of such forest degradation in the future.

In fact, such precedence has been proven by the poor current situation in the Meranti FMU, i.e.: 1) smaller secondary forest area (52,170 ha) compared to production forest area (± 339,000 ha); 2) decreasing incomes due to natural resource lost, and 3) high forest rehabilitation costs due to ecological destruction. Aside of forest damages, however, the corporation of the provides jobs and community empowerment activities.

2. Economic contributions

A realistic approach to assess the evaluation criteria can be seen in non-tax government revenues (NTGR – penerimaan negara bukan pajak (PNBP)) from the forestry sector. The above NTGR-based institutional performance assessment could provide national cash flows and transaction costs from forestry sector, whether decreasing, steady, or increasing; which is also depicting the effectiveness of policy decisions. This, since the disappearance of transaction costs means, that the government has succeeded to control illegal activities, so thus institutional goals are achievable (Ostrom 2005).

Statistically, there are depleting amounts of NTGR in Musi Banyuasin Regency, since 2012. However, the values are contrasting with the

Table 7. Share acceptance from the FRP-FR

Year	Musi Banyuasin (Million rupiahs)	South Sumatera (Million rupiahs)
2008	49,793.91	52,661.60
2009	98,248.89	104,175.22
2010	41,934.39	50,451.47
2011	117,227.58	185,266.28
2012	32,256.45	156,040.48
2013	12,324.75	42,890.22
2014	10,078.42	20,708.13
2015	8,263.62	28,752.82

Source: Primary data analysis from personal discussion about NTGR with the MoEF (2008-2015) (Unpublished)

total NTGR of Palembang Province, which increases due to higher tax imposed, in the form of forest value replacement fund (FVRF – pengganti nilai tegakan (PNT)), on FAUP licenses, particularly for coal mining in Lahat and Muara Enim Regency (Table 7).

Further, Indonesia also have fund compounding mechanisms for environmental impacts from forestry area: reforestation fund (FR – dana reboisasi (DR)) and forest resources provision (FRP – provisi sumberdaya hutan (PSDH)). These are regulated in the Government Regulation No. 92/1999 jo. No. 59/1998; and the Decree of Forestry Minister No.: 18/Menhut -II/2007.

3. Performance organization

Policy choice evaluation to the Meranti FMU establishment was conducted to observe what impacts and how are their managerial performances at site level. This study also observed the outcome of regulations to evaluate the institutional dynamic of the action and situation of arena, which mainly related to the decentralization – a policy, that governs the authority delegation of central government to its lower structure, either institutions or local governments. However, such policy might lead to forest degradation, if it is uncontrolled (Gregersen, Contreras-Hermosilla, White, & Phillips, 2005).

The FMUs, as at-the-site management units have a reciprocal relationship between biophysical attributes, community characteristics, and community rules of forest utilization. Meanwhile, the evaluation criteria, in this study, were used for observing the interaction of each parties in acquiring the utilization area. Moreover, with certain rules of the game, it is possible for the parties to intervene and change the outcomes, as well as, position of the role of Meranti FMU.

Furthermore, FMUs establishment as part of the working unit of local staff (WULS – Satuan Kerja Perangkat Daerah (SKPD) management to support local governments was a form of policy choice. Thus, the evaluation criteria for the performance assessment were taken from the 2015-2024 Mid-Term Forest Management Plan (MTFMP – Rencana Pengelolaan Hutan Jangka Menengah (RPHJM)), as follows: 1) synched and implementation outcomes of planned, budgeted activities; 2) workloads; 3) human resources availability; 4) technical barriers, as well as 5) operational obstacles. Based on the observation, previously budgeted activities were unbudgeted in the next year, i.e. community development (see Table 8).

In 2015 the results of the analysis of performance evaluation criteria in the Meranti FMU for the budgeted programs implementation list (BPIL – daftar isian pelaksanaan anggaran (DIPA)) were: a) incompatible activities and implementation with the results of field observation; b) costs inefficiency from non-

Table 8. Comparison of plans and its realizations of FMU strategic programs in forestry sector year 2015-2016

Kind(s) of Activity	Activity Breakdowns(s) Based on Budgeted Plans	2015	2016
1. Carry out of forest management			
a. Forest governance and management	Addition of Facilities and Infrastructure	In-list	In-list
	Arranging the Short-Term Forest Management Plan (STFMP)		
	STFMP 2015	In-list	-
	STFMP 2016	In-list	-
	STFMP 2017	In-list	In-list
b. Forest utilization	Unplanned	-	
c. Forest use area	Unplanned	-	
d. Rehabilitation and reclamation	Forest and land rehabilitation	In list	
	Forest and land rehabilitation improvement		unlisted
e. Forest Protection and forest conservation	Forest area reservation and protection	In list	In list
	Forest fires control	In list	In list
	Potential conflicts & resolution identification in FMUs	In list	
	Improving Potency Identification of FMUs	-	unlisted
2. Implementation of forest policy			
	Unplanned	-	-
3. Implementation of Forest Planning, Organization, Control, and Protection			
	Potency Identification for the entire FMU area	In list	
	Improving Potency Identification of FMUs	-	unlisted
4. Protection and assessment implementation in forest management			
	Improving forest management protection techniques	In list	In list
	Forest protection, safety, control, & management techniques	In list	In list
5. Investing and collaboration funds management for the FMUs area utilization			
	Business plan arrangement of the FMUs	In list	-
	Business plan improvement for the FMUs		unlisted

Source: Budgeted programs implementation list (DIPA) 2015-2016 (Unpublished)

revisable budgets of incompatible projects in the Meranti FMU, since the budgets are arranged by the Controlling and Utilization Office of Production Forest (CUOPF – Balai Pemantauan dan Pemanfaatan Hutan Produksi (BPPHP)); c) no budgets arranged for community empowerment & participation, as well as, capacity building, that are important for conflict resolution, and d) Discontinuous business development activities ,as well as, agreement with communities related to conflict identification and resolution, which caused negative perceptions among communities about the Meranti FMU performance.

Related with the aforementioned situation, there are several influencing factors of the Meranti FMU program, whether implementable or not according to the BPIL, i.e.: 1) prerequisite-related aspects (71%); 2) social (55%); 3) ecological (56%), and 4) economic (73%).

However, based on the observation, such programs have lack of, both compatibility and implication, to the community needs. The implementation scores for each aspect are, as follows: 1) 24% for prerequisite-related aspect; 2) 12% for social; 3) 15% for ecological, and 4) 13% for economic (see Figure 6).

The above results show, that many of the budget spending activities carried out by the Meranti FMU are just a business as usual, e.g.:

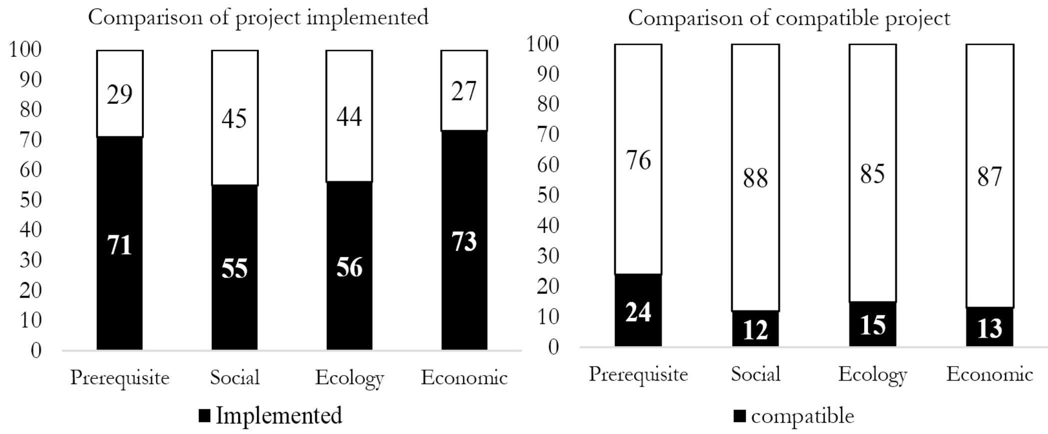


Figure 6. Comparison realization implemented and compatible of project based on DIPA 2015-2016 and RPHPJP 2013-2024

meetings, official travels, as well as, performance-unrelated procurements for infrastructures. This, also show, that the business as usual activities, done by the Meranti FMU, are only to establish their existence and legitimacy from communities with the license issuing authority they have, which is contrasting with the policy outcome from the fact, that there are tenurial conflicts due to land utilization overlapping problems.

IV. CONCLUSION

The result showed that the institutional diagnosis of forest utilization arrangements in the Meranti FMU is strongly influenced by interests of parties, which has caused overlapping utilization. Uncontrolled interests of the parties and overlapping utilization is an indication of a non-optimal institutional performance. There are several correlating elements for institutional, i.e.: the characteristics of biophysical attributes; community attributes, and influential rules in use within the action arena, which altogether form a game changing complex interaction pattern based on possible outcomes of user interests. We also found, that the government chooses to neglect the existing user, particularly the indigenous people as the owners of rights authority.

Further, the policymakers used to their law-backed authorities for every license issuance without gaining legitimisation from available stakeholders, which displays policy failures due to the existence of corrupting activities among capital owners and government individuals. Such situations lead to: 1) ineffective policy implementation; 2) forest degradation from the tragedy of the commons situation; 3) decreasing NTGR income; 4) utilization conflicts, and 5) imbalance in cash flows between planned budgets and revenues.

The study also found, that there are changes of policy outcome, which tend to ignore biophysical conditions and surrounding communities. Such outcomes are strongly influenced by internal information, which are provided by influential parties. Moreover, the policy decisions often consider only short-term economic motives, which in fact lead to environmental degradation and tenurial conflicts among users.

Recommendation

a. Create communication forums for all parties to receive clear information about forest utilization and to support institutional performance of forest area management
b. Institutionalization the role of community in the utilization arrangements.

c. Community activities that have been facilitated by the granting of management licenses and arrangements adapted to the concept of forest sustainability.
d. Policy-maker should take the community and biophysical conditions of the forest area in regulation.

ACKNOWLEDGEMENT

Thanks to the Meranti FMU in Musi Banyuasin, South Sumatra, village chiefs in the study site, as well as, the Centre of Education and Training for Human Resource of the Ministry of Environmental and Forestry.

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Indonesian Journal of Forestry Research Vol. 5, No. 2, October 2018, 61-68 ISSN: 2355-7079/E-ISSN: 2406-8195

DIVERSITY OF SOIL MACRO FAUNA AND ITS ROLE ON SOIL FERTILITY IN MANGLID AGROFORESTRY

Aditya Hani* and Endah Suhaendah

Agroforestry Technology Research Institute
Jl. Raya Ciamis - Banjar Km. 4, Ciamis 46201, West Java, Indonesia6

Received: 28 August 2018, Revised: 15 April 2019, Accepted: 30 April 2019

DIVERSITY OF SOIL MACRO FAUNA AND ITS ROLE ON SOIL FERTILITY IN MANGLID AGROFORESTRY. Soil macro fauna is one of the bio indicators in determining the quality of the land. The total soil macro fauna is influenced by the climatice condition and land utilization pattern. Agroforestry is one of type land utilization that is expected to improve the soil fertility. Land utilization changing from monoculture into agroforestry is predicted to influence the soils macro fauna. This study is aims to find out the population of soil macro fauna before and after applying manglid agroforestry. The research was conducted in Cukangkawung, Tasikmalaya District, West Java Province. Sample of macro fauna was taken from non-productive land of tea plantations and one year after the land was planted by manglid + corn + peanut by using agroforestry. Samples were taken in Feb-March 2015 and once more in Feb-March 2016. The observation land area is 1 hectare that is divided into 1 m x 1 m - 16 observation plots that was placed randomly. In each plot, a hole of 30 cm in depth was made and the dug out soil was placed on the plastic container. The collected macro fauna was counted and placed into a bottle that was filled with 70% alcohol. The macro fauna identification was conducted in LIPI zoology laboratory. The research shows that the diversity indexes for Shanon and Margalef on manglid agroforestry are higher than on the ex tea land. Factors that influence the soil macro fauna diversity improvement is pH, low temperature of soil and high soil moisture. Soil macro fauna becomes organic decomposer in agroforestry for about 56,25% and 20% in non-productive land of tea plants.

Keywords: Agroforestry, bio indicator, macro fauna, land of tea plants, decomposer

KERAGAMAN MAKROFAUNA TANAH DAN PERANNYA TERHADAP KESUBURAN TANAH PADA AGROFORESTRY MANGLID. Makrofauna tanah merupakan salah satu bioindikator yang menunjukan kualitas suatu lahan. Kelimpahan makrofauan tanah dipengaruhi oleh kondisi iklim dan pola penggunaan lahan. Agroforestri merupakan salah satu bentuk sistem pemanfaatan lahan yang diharapkan dapat meningkatkan kesuburan tanah. Perubahan pola penggunaan lahan dari monokultur menjadi agroforestri diduga memberi pengaruh terhadap kelimpahan makrofauna tanah. Penelitian ini bertujuan untuk mengetahui populasi makrofauna tanah sebelum dan setelah penerapan pola agroforestri manglid. Penelitian dilaksanakan di Desa Cukangkawung, Kecamatan Sodonghilir, Kabupaten Tasikmalaya. Pengambilan sampel makrofauna dilakukan pada lahan teh tidak produktif, setahun setelah lahan tersebut ditanami dengan pola agroforestri yaitu manglid+jagung+kacang. Luas lahan pengamatan 1 ha yang dibagi menjadi 16 plot pengamatan yang berukuran 1 m x 1 m dan diletakkan secara acak. Pada setiap plot pengamatan dikeruk tanah sedalam 30 cm dan ditempatkan pada bak plastik. Makrofauna yang tertangkap dihitung jumlahnya dan dimasukkan ke dalam botol yang telah berisi alkohol 70%. Identifikasi makrofauna tanah dilakukan di Laboratorium Zoologi LIPI, Cibinong. Hasil penelitian menunjukan bahwa indeks keanekaragaman jenis Shannon dan indeks kekayaan jenis Margalef pada agroforestri manglid nilainya lebih tinggi dibandingkan lahan bekas teh. Faktor yang mempengaruhi peningkatan keanekaragaman makrofauna tanah adalah peningkatan pH, suhu tanah lebih rendah dan kelembapan tanah yang lebih tinggi. Makrofauna tanah yang berperan sebagai pengurai bahan organik di lahan agroforestri sebesar 56,25% sedangkan di lahan teh tidak produktif 20%.

Kata kunci: Agroforestri, bioindikator, makrofauna, pekebunan teh, pengurai

* Corresponding author: adityahani@gmail.com

 doi:10.20886/ijfr.2019.6.1.61-68

I. INTRODUCTION

Soil organism has an important role as chemical and ecosystem engineer, and biological regulator (Widyati, 2013). Soil macro fauna is one of soil organisms that have many types and advantages. Its existence is influenced by biotic and abiotic factors inside the soil (Dwiastuti, 2016). The biotic factors are micro flora and plant species, while the abiotic factors are physical and chemical characteristic of soil. The physical characteristic consists of soil structure and texture, while the soil chemical characteristic consists of pH, salinity, soil organic materials and minerals (Nurrohman, Abdulkadir, & Sri, 2015). Water inside the soil influences the number of nematodes. However, the antagonist biotas are able to breed inside less water – soil (Swibama, Putra, Susilo, Hairiah, & Suprayogo, 2010). Dewi, Handayani, & Sumani (2008) wrote that land management can increase or decrease the soil macro fauna population.

Agroforestry as land utilization pattern is applied by many farmers. They expect gaining more income and harvesting products continuously by applying the agroforestry technique. Farmers can choose it because it can guarantee and improve the food needs, quality of nutrition, and because of culturate factor (Tjatjo, Basir, & Umar, 2015). Tree in agroforestry system will produce a better environment. Suryani & Dariah (2012) wrote that tree has canopy to protect soil from erosion, while root of tree will prevent the leaching the soil nutrients. This can maintain the soil organic material, land fertility, and the numbers of soil organisms.

Nowadays, there is a lot of tea garden with low productivity. One of the causes is low soil fertility. It is because the biomass of tea leafs is imbalanced with the fertilizing activity. The input of organic material into the land is less because of less litter produced by tea leafs. Some farmers in Tasikmalaya change tea plants into seasonal plants or woods or agroforestry. Manglid is one of the developed tree species in Tasikmalaya because manglid is suitable to the land condition (mountain/ plateau). Land utilization that is changed from tea garden monoculture into manglid agroforestry with seasonal plants gives effect on the number of population of soil macro fauna. Agroforestry causes land utilization, organic and non-organic fertilization, and litter of main plant and harvesting product of seasonal plants. Soil fauna is used as soil bio-indicator because it has a high respond to soil utilization, soil characteristic and climate (Swibama et al., 2010). Castro-Huerta, Falco, Sandler, & Coviella (2015) wrote that macro fauna activity is influenced by climate, soil characteristic, and organic residue. Macro fauna has a role in decomposing organic material where the residue is mineralized by the bacteria (Hilwan & Handayani, 2013). The research is aimed to compare the number of population of soil macro fauna before and after manglid agroforestry. The comparison is aiming to determine the effect of agroforestry on soil biological fertility.

II. MATERIAL AND METHOD

A. Research Site

The research was conducted in Cukangkawung, Sodonghilir Sub – District of Tasikmalaya, West Java Province from February until March 2015 and February until March 2016. Cukangkawung's position is 107º18'30"-108º25'00" of East longitude and 07º04'30"-07º11'00" of South latitude, and 850 m above sea level (masl). The required tools were hoe, plastic container, bottle, roll meter, label, tweezers, GPS, soil tester, and stationary. The required material was alcohol (70%).

B. Method

Sample of macro fauna was taken from non-productive land of tea plants and one year after the land was planted by manglid + corn + peanut by using agroforestry, the measurements were repeated. The observed land area was 1 hectare that was divided into ramdomly placed 1 m x 1 m - i.e. 16 observation plots which were repeated three times so that the total number of observation plots was 48 plots.. In each plot, a hole with 30 cm depth was made and the dug outsoil was placed into the plastic container. The macro fauna was counted and placed into the bottle that was filled with 70% alcohol. The macro fauna identification was conducted in LIPI (Indonesian Institute of Sciences) zoology laboratory.

C. Analysis

The obtained data and information of macro fauna was analyzed by using the Shannon – Wienner diversity index and Margalef species wealth index by using the formulation as follow:

$$H' = -\sum_{i=1}^{n}\left(\frac{ni}{N}\right) Ln \left(\frac{ni}{N}\right) \quad \text{..........................(1)}$$

$$R' = \sum \frac{s-1}{Ln\ N} \quad \text{..(2)}$$

Remark:
H' = Shannon – Wienner diversity index
R' = Margalef species wealth index
ni = number of population of each species
N = total number of all population
s = number of species

To find out the relationship among the abiotic variables (soil pH, temperature, and moisture), Shannon – Wienner diversity index, and Margalef species wealth index, Pearson correlation test by using SPSS is applied.

III. RESULTS AND DISCUSSION

A. Macro Fauna Species Diversity

Based on the observation there are 5 species of macro fauna at non-productive tea garden that are classified into ordo of Ophistopora, Coleoptera, Scolopendromorpha and Himenoptera. On manglid agroforestry land, those species increase up to 16 species from various ordo, i.e. Ophistopora, Haplotaxida, Tricladida, Isoptera, Coleoptera, Scolopendromorpha, Araneae, Orthoptera, Himenoptera, Diplura, Blattodea, and Isopoda. Those macro fauna functions are detritivore

Table 1. Macro fauna species on ex tea garden area and manglid agroforestry

No	Macro Fauna Species	Ordo	Family	Number of Macro Fauna		Role/ Function
				Ex-garden tea area	Manglid af	
1	*Pheretima* spp	Ophistopora	Megascolecidae	28	142	Detritivor
2	*Eisenia* sp	Haplotaxida	Lumbricidae	-	7	Detritivor
3	*Caenoplana* sp	Tricladida	Geoplanidae	-	1	Detritivor
4	*Macrotermes* sp	Isoptera	termitidae	-	1	Herbivore
5	*Oryctes* sp	Coleoptera	Scarabaeidae	1	1	Herbivore
6	*Scolopendra* sp	Scolopendromorpha	Scolopendridae	1	12	Predator
7	Laba-laba	Araneae	-	-	3	Predator
8	*Gryllus* sp	Orthoptera	Gryllidae	-	6	Herbivore
9	*Phyllophaga* sp	Coleoptera	Scarabaeidae	-	61	Herbivore
10	*Solenopsis* sp	Himenoptera	Formicidae	39	9	Predator
11	*Tenebrio* sp	Coleoptera	Tenebrionidae	7	-	Herbivore
12	*Gnathaphanus subolivaceus*	Coleoptera	Carabidae	-	10	Detritivor
13	*Agoponia* sp	Coleoptera	Scarabaeidae	-	4	Detritivor
14	*Campodea* sp	Diplura	Campdeidae	-	3	Detritivor
15	*Odontoponera* sp	Himenoptera	Formicidae	-	2	Detritivor
16	*Blatta* sp	Blattodea	Blattidae	-	1	Detritivor
17	*Altriniscus* sp	Isopoda	-	-	4	Detritivor
			Total	76	267	

Remark: af = agroforestry

Tabel 2. Diversity Index Number of Macro Fauna Species in Ex – Tea Garden and Manglid Agroforestry

Land	Family	Species	Population	H'	R'
Ex – tea garden	5	5	76	0.33	0.98
Manglid af	14	16	267	0.63	1.92

Remark: af = agroforestry

Table 3. Measurement on pH, Temperature, and Soil Moisture in Research Site

Parameter	Ex –tea Garden	Agroforestry of manglid
pH	4.9	6.6
Soil Temperature	29.5 ^{0}C	26.2 ^{0}C
Soil Moisture	0.5%	3.8%

Table 4. Result of Test of Correlation among pH, Temperature, and Soil Moisture on Shannon Diversity Index and Margalef Wealth Index for Macro Fauna Species

No	Environment Variables	Pearson Correlation Value	
		Shannon Index	Margalef Index
1	pH	1*	1*
2	Soil Temperature	-1*	-1*
3	Soil Moisture	1*	1*

Remark* = Very High Correlation

herbivore, and predator (Table 1). Formicidae family (insect class) is a family with the highest number of species on ex-tea garden land. The research is matching to the research of (Ernawati, 2008). She wrote that formicide family is the dominant family of the macro fauna that was found in ex gold mining area in Jampang, South Sukabumi. In manglid agroforestry, family with the highest number of species is from Megscolecidae family (Oligochaeta class). Based on Table 1, *Pheretima* sp is the most abundant number of soil macrofauna species. This is because *Pheretima* sp is able to adapt to low soil pH and low organic matter. Therefore, *Pheretima* sp can be found in post coal mining field in East Kalimantan (Nugroho, Widuri, & Sayektiningsih, 2018).

Species diversity index number and Margalef Wealth Index on ex – tea garden is lower (0.33 and 0.98) than diversity index after transforming into manglid agroforestry (0.63 and 1.92). However, its index is lower than agroforestry of sengon and pineapple (1.1) (Wulandari, Sugiyanto, & Wiryanto, 2007). It is because agroforestry of manglid and seasonal plants is young, still one year since it was planted. That makes the size of manglid tree is still small and land is covered by dominant seasonal plants. Meanwhile the agroforestry between sengon and pineapple has been applied longer than on the manglid. Diversity index of homogeneus tropical forest showed that wealth index of soil fauna is in the middle level (1.174 and 1.153) (Sari, 2014). Hilwan & Handayani (2013) said that land covering activity was correlated to time period. Therefore in the beginning of planting activity, generally, the diversity of macro fauna is low. It is similar to the ex-area that is beeing reclaimed, where the diversity index is low as well (1.15).

B. The influence of pH, Temperature, and Soil Moisture on Macro Fauna Diversity

Environment abiotic factor highly determines the structure of soil fauna community(Peritika, 2010a). pH, temperature, and soil moisture influence the diversity of soil fauna function (Bio Intelligence Service (BIS), 2010). Measurement results of pH, temperature, and soil moisture in the research site is shown in Table 3. Result of Pearson Test on correlation among pH, temperature, soil moisture on Shannon diversity index and Margalef Wealth diversity is shown in Table 4.

Table 4 shows a very high correlation (1 or -1) among pH, temperature, and soil moisture on diversity index and wealth index of macro fauna. The positive correlation shows that the increase and decrease of a variable will be followed by the increase or decrease of an other independent variables. On the contrary, the negative correlation shows that the increase of a variable will be followed by the decrease of the other variables (Peritika, 2010b).

The increased soil pH of the transformed land from ex – tea garden to manglid agroforestry causes the diversity and wealth of macro fauna species. Increase in soil pH due to fertilization in manglid agroforestry. Farmer added manure every planting crops. Worm likes to live inside neutral – basic soil (pH 6 – 7.2) because the soil nutrition is abudanly available in this soil (Maftu'ah & Susanti, 2009). Suheriyanto (2013) wrote that diversity index of fauna species in Bromo is the lowest. It is probably caused by the low soil pH. Meanwhile in the Pananjakan area the pH is higher, it has higher diversity of soil macro fauna than Bromo.

Soil temperature is one of the abiotic factors that influence the availability of soil fauna species. The increasing of soil temperature decreases the diversity and wealth of soil macro fauna species. Land with good vegetation canopy has low soil temperature and high soil moisture that has higher composition of soil macro fauna than the open space area (farm land area) (Qudratullah, Setyawati, & Yanti, 2013).

Correlation value of soil moisture between the diversity and wealth index of macro fauna species is positive. Higher moisture of soil will make higher index of diversity and wealth of macro fauna species. This is caused by the improvement of soil macro fauna activities that is caused by the soil moisture (Bio Intelligence Service (BIS), 2010). The organic fertilization and the litter of seasonal plants in manglid agroforestry increases the soil moisture. Lalthanzara, (2011) wrote that soil moisture is a factor that give the highest influence for the improvement of worm population. Therefore, more land canopy will increase macro fauna population.

C. Macro Fauna as Detritivore on Soil Fertility

Soil macro fauna is consisted of a huge number of different organisms that live on, in, and inside pores of soil surface. Macro fauna is found within 60 – 80 cm depth of soil. However most zoo mass is in the 0 – 30 cm of depth of humus (Bragina, 2016).

Macro fauna from Oligochaeta, i.e. *Pheretima* sp., *Eisenia* sp and *Caenoplana* sp. classes, and six species from *Gnathapanus subolivaceus*, *Agoponia* sp., *Campodea* sp., *Odontoponera* sp., *Blatta* sp. and *Altriniscus* sp. classes functioned as detritivore. Proportion from various tropical soil macro fauna is shown in Figure 1. On ex – tea garden, there are 20% macro fauna as detritivore, meanwhile on manglid agroforestry, macro fauna as detritivore is dominant (56.25%) than the others.

Worm is the main component of soil macro fauna community in most ecosystems and most macro fauna biomass. Worm has important function in organic material decomposition. Worm eats and destroys litter and other parts of dead plants. It improves soil nutritious cycle through a fast joining process from soil detrition into mineral soil. Beside, its mucus can improve the activity of other beneficial soil microorganisms. Then, organic production becomes a succeeded process. Therefore, in short term period, the significant effect is a huge concentration of soil nutrition (N, P, K, and Ca) that is easy to be assimilated by the plants. Worm is also known as an organism that can improved nitrogen mineralization through direct and indirect effect on microorganisms.

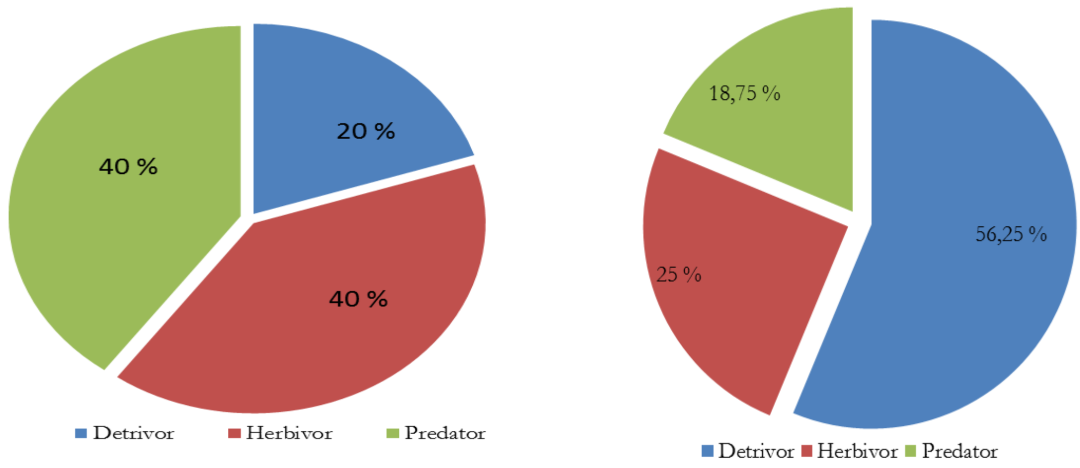

Figure 1. Structure of macro fauna on (a) Ex–tea garden and (b) Manglid agroforestry

The improve of organic C and N transfer becoming soil aggregate shows that worm potentially is able to facilitate soil organic material stabilization and its accumulation in farming system (Anwar, 2009; Bhadauria & Saxena, 2010). Worm is also effective in keeping the bio-geo-chemical process inside the soil and reducing bad nutrition (when it is in over dose), such as Fe, Al, Ms, Cu, and Zn (Anwar, 2009). Worm can improve plant's growth through mineralization improvement. There are various effects of worm in this plant's growth. It is depending on the soil characteristic, such as availability of nutrition, mineral, organic materials, and texture (Laossi et al., 2010).

Based on Table 1, worm population on manglid agroforestry is higher than in ex–tea garden, as written by Bhadauria & Saxena (2010) where the different land utilization can affect population and diversity of earthworm. The most ideal worm breeding process is on pH is 6 – 7.2 (Maftu'ah & Susanti, 2009). The pH 6.6 on manglid agroforestry land. It is an ideal condition for worm to breed. Considering the important role of worm as detritivore, then land utilization strategy has to promote the beneficial soil organisms, such as worm through the appropriate vegetation management to maximize its benefit for the whole agro-ecosystem (J, D, Quintero, Velásquez, & Lavelle, 2012).

Soil insect is insect that temporary or permanently live inside the soil. Insect has a function as a detritivore or an organism that can reorganize the available organic material for green plants, so it can return the soil fertility (Sari, 2015). Soil insect eats live or dead plant. Insect can accelerate the decomposition of organic material. Soil insect is highly dependent on availability of energy and source of food, such as organic materials and live biomass and all of them are related to carbon cycle inside the soil. The availability of energy and soil nutrition can keep the existence of soil insect, and it will make the activity of soil insect in sustainable (Ruslan, 2009).

Based on Table 1, detritivore insect on manglid agroforestry has more number than on ex–tea garden area. On manglid agroforestry land, number of vegetation and litter is also greater than on ex–tea garden. Therefore, there is more food for soil insects. The availability of fauna can be a parameter of soil quality. The soil fauna as bio-indicator of soil fertility must be in relatively abundant number (Ibrahim, 2014). In this research, number of macro fauna on manglid agroforestry is more than on ex–tea garden (276 species and 76 species).This shows that soil fertility on manglid agroforestry is better than on the ex–tea garden.

IV. CONCLUSION

Transformation of land utilization from tea monoculture to manglid agroforestry and seasonal plants causes change in the population of soil macro fauna. Manglid agroforestry pattern has higher value in Shannon Diversity Index and Margalef Wealth Index than the ex–tea garden. The influencing factors of the variety improvement of soil macro fauna is pH improvement, lower soil temperature, and higher soil moisture. Macro fauna as organic decomposer on agroforestry land is higher (56,25%) than on ex–tea garden (20%). This condition is expected to improve the soil fertility, in line with the improvement of soil macro fauna population.

ACKNOWLEDGEMENT

The authors want to say thank to the Agroforestry Research and Development Institute for giving us trust in doing this research that was also supported by the available facilities and fund. We also want to say thank to our technicians for helping us in collecting data and information and in managing research fund.

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STUDY ON PRIMING METHODS TO ENHANCE THE VIABILITY AND VIGOR OF TREMA (*Trema orientalis* LINN. BLUME) SEEDS

Naning Yuniarti*, Rina Kurniaty and Dida Syamsuwida

Forest Tree Seedling Research Institute
Jl. Pakuan, Ciheuleut, PO BOX 105, Bogor, West Java, Indonesia

Received: 21 September 2017, Revised: 10 April 2019, Accepted: 30 April 2019

STUDY ON PRIMING METHODS TO ENHANCE THE VIABILITY AND VIGOR OF TREMA (*Trema orientalis* LINN. BLUME) SEEDS. Trema is one of tropical forest trees that have many advantages such as wood for building, pulp and charcoal, leaves for medicine and bark for dye material. The constrain of the development of this species is the difficulties of the germination of the seeds and rapid seed deterioration after being stored. Therefore, there should be found a method to solve the problem. Objective of the research was to determine the proper method of priming to enhance the viability and vigor of Trema seeds after storage. Randomized Complete Design was employed in this trial by priming the seeds before and after storage. The treatments were priming methods including: control (no priming), matriconditioning with ash, osmoconditioning by soaking with 5% H_2O_2, humidify with water and hydrated-dehydrated process. The observed parameters were germination percentages, speed of germination, mean daily germination, germination value, and growth uniformity value. Results show the best treatment method for priming of seed of *Trema*, both before storage and after storage is the treatment of hydration-dehydration. All the observed parameters gave increased values after using such treatment. Before storage, it can increase the value of germination percentage and speed of germination by 15% and 0.9% $^{-etmal}$, respectively After the storage, treatment hydration-dehydration can increase the germination by 17% and the speed of germination by 1.25% $^{-etmal}$.

Keywords: Trema seed, priming, viability, vigor

PENENTUAN METODE PRIMING UNTUK PENINGKATAN VIABILITAS DAN VIGOR BENIH TREMA (Trema orientalis Linn. Blume. Trema adalah jenis tanaman yang termasuk tanaman serba guna. Kayunya digunakan untuk kayu pertukangan, industri kertas dan arang kayu. Daun dan batangnya dapat dijadikan obat herbal, dan kulit batangnya untuk bahan pewarna. Pengembangan jenis ini mempunyai permasalahan yaitu lamanya waktu berkecambah serta viabilitas dan vigor benihnya mengalami penurunan setelah penyimpanan. Sehingga diperlukan perlakuan yang dapat mempercepat perkecambahan dan meningkatkan viabilitas dan vigor, yaitu dengan metode priming. Tujuan penelitian ini adalah diperolehnya metode priming yang tepat untuk meningkatkan viabilitas dan vigor benih trema setelah penyimpanan. Benih trema yang digunakan dalam penelitian ini berasal dari Bali. Rancangan percobaan dalam penelitian ini menggunakan rancangan acak lengkap (RAL) dengan menggunakan perlakuan priming pada benih sebelum disimpan dan sesudah penyimpanan. Perlakuan priming yang digunakan terdiri dari: kontrol, matriconditioning abu gosok, Osmoconditioning dengan perendaman H_2O_2 *5%, perendaman/pelembaban dengan air, dan hidrasi-dehidrasi. Untuk perlakuan kontrol (tanpa perlakuan priming), benih langsung dikecambahkan. Parameter yang diamati yaitu daya berkecambah, kecepatan berkecambah, kecambah harian rata-rata. Nilai perkecambahan dan nilai keserampakan tumbuh. Hasil penelitian menunjukkan bahwa perlakuan metode priming terbaik, baik sebelum disimpan maupun sesudah penyimpanan yaitu perlakuan hidrasi dehidrasi. Semua parameter yang diamati memperlihatkan peningkatan setelah diperlakukan dengan metode priming tersebut. Sebelum disimpan, dapat meningkatkan nilai daya berkecambah dan kecepatan berkecambah masing-masing 15% dan 0,9%/etmal. Setelah penyimpanan, perlakuan hidrasi dehidrasi dapat meningkatkan daya berkecambah 17% dan kecepatan berkecambah 1,25%/etmal.*

Kata kunci: Benih, trema, priming, viabilitas, vigor

* Corresponding author: naningbtp@yahoo.co.id

 doi:10.20886/ijfr.2019.6.1.69-83

I. INTRODUCTION

The success of a plantation program is strongly dependent on its cultivation and the use of qualified seeds, which definitely have to be conditioned to achieve good seedlings that expected to give excellent stands. One of the prospective woody species to be developed in a plantation program is Trema (*Trema orientalis* Linn. Blume).

Trema is a multi-purpose species because all parts of the tree can be utilized for many purposes. The wood is flammable when dry and contains 4,576 cal/g of energy (Rostiwati et al., 2006). The wood can also be used for tools, construction, pulp and paper, veneers, matches and charcoal. The leaf is good for pharmaceuticals as herbal and it is useful as well for animal feeds (Kurniaty et al., 2015). However, the development of the species faces some problems concerning the viability of the seeds which takes long time to germinate and the rapid deterioration of the seeds after storage (Panjaitan, 2010). The seed of Trema is physiologically categorized as intermediate (Kurniaty et al. 2015). The quality of intermediate seeds will decrease gradually and this happens naturally. Seed quality is dependent upon initial seed quality, temperature, moisture content and mycoflora. Rapid deterioration occurs due to these environmental conditions which make it very difficult to keep the viability during storage (Jyoti & Malik, 2013). After storage, the metabolism activities in the seed will decline and the viability of the seeds will eventually diminish (Kurniaty et al., 2015).

To enhance the declining seed qualities and get high viability and vigor of the seeds after storage, priming is the solution (Moradi & Younesi, 2009). Priming is a pre-treatment that control the rate of water intake by the seed, augment the mitochondria activity through biosynthesis process and the defensive of cell ultra-structures that make the seeds more standed to the pressure and enable to stimulate the growth easily (Zanzibar, 2010). Priming the seeds can be carried out through hydropriming that is a way of soaking seed by using a specific solution (Halimursyadah & Murniati, 2008). Priming will function on seeds to increase uniformity of germination and emergence from the soil, and thus enhance stand establishment (Hill, 2018). Priming treatment can increase plant resistance to environmental stress, sub optimum, at low temperatures (Farooq et al., 2007), it is also effect on drought stress which was reported by Farooq et al. (2009).

One of the priming techniques is osmoconditioning (Rusmin, 2007). Osmoconditioning is a regular process of water absorption (imbibition) by the seed, using a solution that has a lower osmotic potential as a media of imbibition. Osmoconditioning aims to speed up germination time, synchronize germination and improve the percentage of normal germination (Yuanasari et al., 2015). To increase the ability of seed germination, the seeds can also be treated with low matrix potential media or matriconditioning media (Gholami et al, 2009; Mia et al., 2010).

Apart of increasing the physiological quality of seeds, the methods of priming will result a physically better performance of the seed, it will be more fresh and brighter in color. The priming technique is applicable and affordable that makes it suitable to be a standard in handling of forest tree seeds (Zanzibar, 2010). Priming treatments (seed hydration during a specific time followed by seed dehydration) could be an alternative germination pre-treatment to improve plant establishment. Natural priming (via seed burial) promotes rapid and synchronous germination as well as the mobilisation of storage reserves; consequently, it increases seedling vigor (Lopez, 2014).

Naturally, seed is deteriorating over time. Seed deterioration during a period of storage is a chronological decline in term of time and physiological decline due to various environmental factors. Seed deterioration is a decrease of seed viability caused by the overall changes of seed cells and tissues either physically, physiologically or chemically. Deterioration is characterized by the decline of seed germination, increase of abnormal germinated seedlings, decrease of field emergences, impaired growth and development of plants, increase of sensitivity towards extreme environment (Panjaitan, 2010). Priming is often used to re-increase the viability of seeds that have been reduced. Priming is also used for lengthening the storability of the seeds, thus it can maintain the viability and vigor of the seeds during storage (Utami et al., 2013).

The main purpose of the priming is to increase the viability and vigor of aging seeds, as well as to make seedlings more competitive and tolerant to sub-optimum conditions. This method is suitable to be applied to the seeds that have slow germination and rapid deterioration.

Seeds of Trema have a problem with their germination that takes long time to sprouts due to the dormant characteristic of the seeds (Yuniarti & Kurniaty, 2016). By using priming method, it is possible to speed up the time of seed germination and enhance the germination percentage. Hence the objective of the research was to determine the appropriate priming methods to enhance the viability and vigor of Trema (*Trema orientalis* Linn. Blume) seeds after storage.

II. MATERIAL AND METHOD

A. Location

The study was carried out in the laboratory and greenhouse of Forest Trees Seed Technology Research Centre in Bogor for four months from February to May 2015. The equipments included storage room at temperature of 27°C – 29°C, germination beds, media of sterilized soil and sand.

B. Fruit collection and seed extraction

Fruit of Trema was collected from Badung District, Bali Province in February, 2015. The materials for the trials were ash and H_2O_2 (Hydrogen Peroxide) (Zanzibar, 2010; Zanzibar, 2011). The fruits of Trema were collected by climbing the trees and cutting the fruit bearing branches using a pole with hooked pruner. Five sample trees were used to collect the fruits. Seeds were extracted by crushing the surface of the fruit with coarse sand, and washed under tap water, until the pulp and testa were removed. The cleaned seeds were then wind dried under shaded place.

C. Priming treatments (Zanzibar, 2010; Zanzibar, 2011)

There were two trials of treatments, i.e :

1) Priming before storage

The treatments used were matriconditioning with ash, soaking and/or moistening with water and hydrating-dehydrating. Seeds with no treatments were directly germinated.

Ash matriconditioning was carried out in a petri dish by placing a mixture of ash, seeds and water with a comparison of 4:1:1 (v/v). The mixtures were stirred evenly, then stored in an ambient room temperature (27°C – 29°C) for 3 x 24 hours and moistening with water every day.

Osmoconditioning with 5% H_2O_2 : seeds were put in a beaker glass filled with a solution of 5% H_2O_2 and water in a comparison of 3 : 1 (v/v). The mixtures were placed in an ambient room temperature (27°C–29°C) for 3 x 24 hours. Osmoconditioning by moistening the seeds: Seeds were arranged on a moist paper in a petri dish and placed in a germinator for 3 x 24 hours.

Hydration-dehydration : Seeds were put in a beaker glass, soaked with water for 24 hours, then wind dried at room temperature for 24 hours. The treatment was repeated 7 times, using fresh water in every treatment.

When all the priming treated seeds was done, the seeds were washed under tap water for 3 – 4 minutes and germinated in seed beds filled with a mixture media of soil and sand (1 : 1), then placed under greenhouse condition. The number of seeds for each treatment was 100 seeds with 4 replications.

The observation was carried out once the seedlings germinated, normally marked by the raising of a pair of leaves. The parameters observed were germination capacity, speed of germination, mean daily germination, germination value, and growth uniformity value.

2) Priming after storage

The fresh seeds were put in plastic containers stored under room temperature for one month. After being stored, the seeds were treated with priming methods as it was done above in point a). The trial was only conducted within 1 month storage due to the limitation of the seeds for research material. The parameters observed were germination capacity, speed of germination, mean daily germination, germination value, and growth uniformity value.

D. Design Experiment

Both trials were designed using Completely Randomized Design (Steel & Torrie, 1995) with priming methods as treatment factors, namely: matriconditioning with ash, soaking and/or moistening with water, and hydrating-dehydrating. Deuteronomy 4 times @ 100 seeds.

E. Data Analysis

A completely randomized design (CRD) with priming methods as treatment factors. Data were analyzed by using analysis of variance (ANOVA). If there was a significant effect that was followed by Least Significant Difference (LSD) test.

III. RESULTS AND DISCUSSION

1. The Germination Percentage

The result of variance analysis of the influence of priming before (0 month) and after storage (1 month) on the capacity of germination of Trema seeds is presented in Appendix 1 and Appendix 2.

Based on the analysis of variance, priming treatments before and after storage, influenced significantly the values of germination percentage of Trema seeds. The differences were tested by Duncan's (Figure 1).

Before and after storage treatments, the priming seeds of hydrated-dehydrated method resulted in the highest germination capacity of 89% for those seeds before storage and 78% for seeds after storage. Thus, it increases the germination capacity of about 15% before storage and 17% after storage compared to control (Figure 1).

For Trema seeds, hydro-priming is the most appropriate method to increase the germination capacity. Studies have shown that seed priming

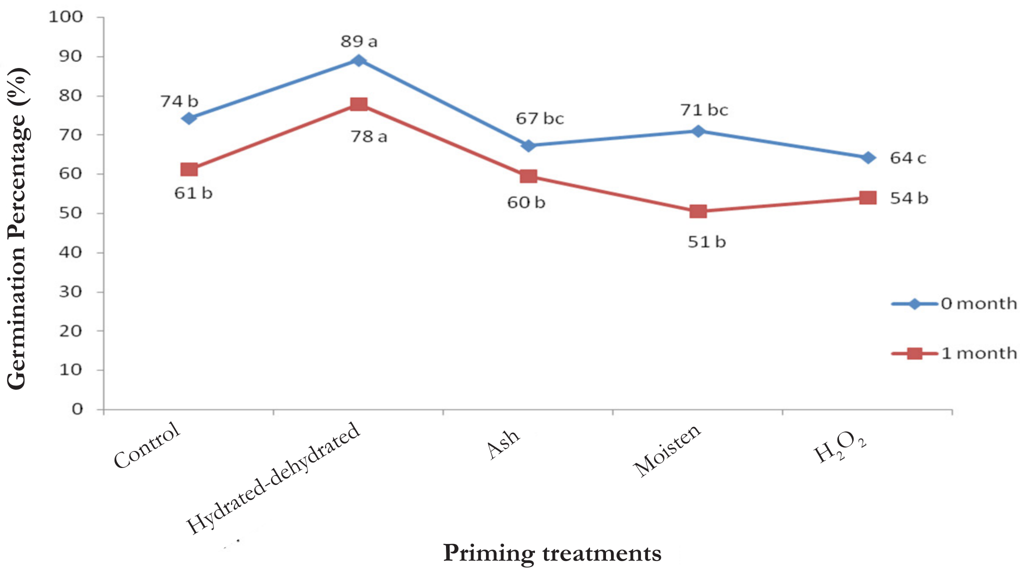

Figure1. Mean values of germination percentage of *Trema* seeds and their differences test in relation to the priming before and after storage

Remarks: values followed by the same letters are not significantly difference at a confidence level of 95%.

can be used to improve germination, accelerate seedling emergence time, as well as increase seed longevity during storage and yield (Khan, 1992). This is because hydro-priming increases the level of metabolites associated with the germination process and enzymes associated with the production of energy that allows the seeds to quickly reach a high level of moisture with a constant supply of oxygen (Duffus & Slaugther, 1985). However, according to Rodriguez et al. (2015) hydro-priming should be undertaken with care in case seeds are infected with pathogens. According to Hadinezhad et al. (2013) hydro-priming is used as a pre-sowing or mid-storage treatment for seeds that have lost their vigor due to improper storage conditions. In the case of Trema seeds, the hydration-dehydration treatment caused increased germination capacity for those seeds that have not been stored previously. It was observed that seeds of Pongamia pinnata had the highest germination, shoot length, root length, germination rate index and seedling dry weight after being hydrated for 16 hours (Ramensh (2007).

Figure 1 is also showing priming treatments of ash matriconditioning, osmoconditioning with 5% H_2O_2, and immersing and/or moisturizing with water, resulting in lower values of germination capacity than control. In this case, there might be some reasons to explain it. According to Ruliansyah (2011) the use of rubbing ash as a media of matriconditioning caused damage to the seed coat, as the media contains silica element that is sharp enough to injure the coat when ash, water and seeds were mixed. The damaged seed coat would eventually affect the germination process that decreasing the viability of the seeds. Zanzibar (2017) mentioned that the use of hydrogen peroxide (H_2O_2) at 5% concentration was adversely affecting the germination. In fact, the use of H_2O_2 can cause interference or damage to the seed embryo. Mostly, the method of seed testing using H_2O_2 uses a concentration of 1% to 3% and preferably in a stable form. Concentration above 1% of H_2O_2, usually may still adversely affect to the germination. In term of priming techniques using moist method, according to Zanzibar & Mokodompit (2007) the priming should consider the level of seed coat hardness. The hard seed coat of Trema is more suitable to use immersion than by moisturizing the seeds.

2. The Speed of Germination

The result of variance analysis of the influence of priming before (0 month) and after storage (1 month) on the speed of germination of Trema seeds is presented in Appendix 3 and Appendix 4.

Based on the analysis of variance, priming treatments before and after storage, influenced significantly the values of speed of germination of Trema seeds. The differences were tested by Duncan's (Figure 2).

Before storage, the priming method of hydrated-dehydrated was enable to increase the speed of germination by about 0,9 $\%^{-etmal}$ from control. The highest value of speed of germination rate (3.63 $\%^{-etmal}$ was those of fresh seeds treated by hydrated-dehydrated treatment. (Figure 2). Fujikura et al. (1993) demonstrated that hydropriming produced great improvement in the rate of germination, even more than osmo-priming, in cauliflower (*Brassica oleracea* L.). Contrary, Tian et al. (2014) mentioned that the seed of maize (*Zea mays* L) was reduced in germination rate after water priming compared to reagents priming of GA at 10 mg/L, NaCl at 50 mM, and PEG at 15%.

Deterioration of seed is impossible to stop but it can be delayed. One way to do such delay is through a hydration-dehydration (priming) treatment (Zanzibar & Mokodompit, 2007). In principle, priming activates the internal energy sources of the seed (viability and seed vigor) and external energy sources (optimum germination condition). A proper priming given to the seeds will stimulate the growth of sprouts, brake the dormancy and decrease the sprouts mortality (Zanzibar, 2010).

It was shown in Figure 1 and 2 that before being stored, the best priming for Trema

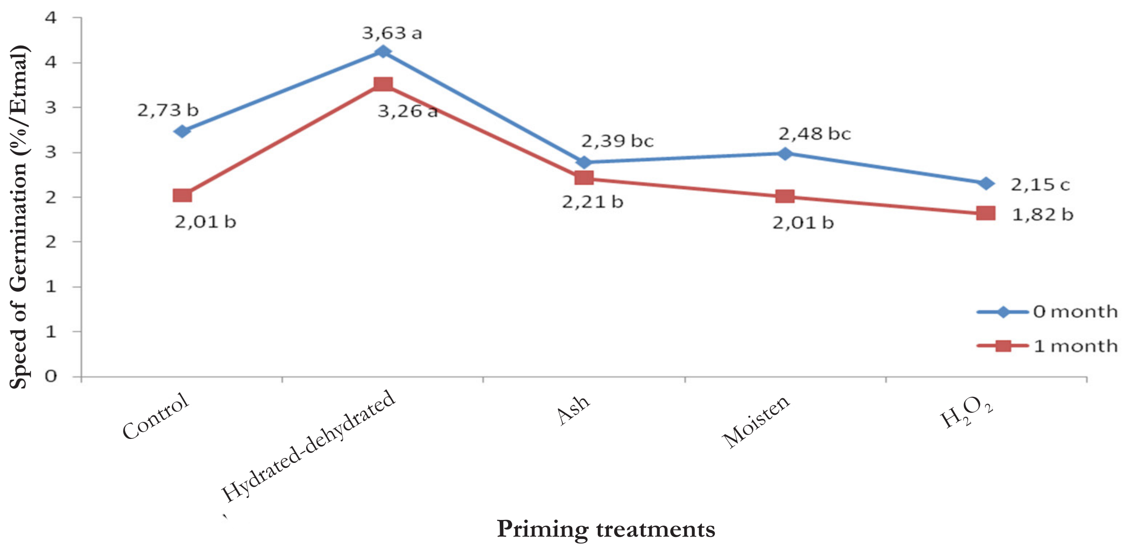

Figure 2. Mean values of speed of germination of *Trema* seeds and their differences test in relation to the priming before and after storage.

Remarks: values followed by the same letters are not significantly difference at a confidence level of 95%

seeds was hydrated-dehydrated treatment. The germination capacity and speed of germination was 89% and 3.63%$^{-etmal}$, respectively. Thus, priming method of hydrated-dehydrated would be able to enhance the capacity and speed of germination by up to 15% and 0.9%$^{-etmal}$ compared to control, respectively. Unlikely, hydrated followed by dehydrated in bean (*Phaseolus vulgaris*) seeds treatment was the possible cause of the decrease of germination rate (Abebe & Moddy, 2009).

After storage, the priming method of hydrated-dehydrated was enable to increase the speed of germination by about 1,25 %$^{-etmal}$ from control. The highest value of germination speed was those of fresh seeds treated by hydrated-dehydrated treatment. (Figure 2).

After storage, the priming method of hydrated-dehydrated was enable to increase the speed of germination for about 1,25 %$^{-etmal}$ increment from control. The highest value of speed germination was those fresh seeds treated by hydrated-dehydrated treatment . (Figure 2).

The storage was carried out for 1 month only because there was a limitation of the seeds for research material. After storage for one month, it was found that the best priming method was also the hydrated-dehydrated treatment that could increase the germination capacity up to 17% and speed of germination by 1.25%$^{-etmal}$ compared to control. Therefore, this method would be able to lengthen the storability of Trema seeds. Ibrahim et al. (2013) stated that upland rice (*Oryza sativa*) seeds can successfully be hydro primed for 12 hours and dehydrated the seeds by drying for 4 hours to get better germination and growth performance. Contrary to this finding, Abebe & Modi (2009) reported the failure of germination after hydrating the seeds of Phaseolus vulgaris for 4 and 8 hours. This might happen due to different characteristics of seed species, size of the seed, coat thicknesses that might get different cotyledonal cracking and higher leakage of nutrition (Mazibuko & Modi, 2005, Quan et al. 2004).

Hydrated-dehydrated treatment is capable to serve the requirement of optimum water from the time of imbibition to the end of activation process that is closed to the water potential at a room temperature. If the seeds were water saturated, then wind-dried, the seeds would release the water slowly and this condition was good for repairing deteriorated tissues.

The refinement mechanism of deteriorated tissues occur simultaneously of which the seeds achieve their water content balance. In this condition the seeds will be trying to heal themselves (Schmidt, 2000).

The priming is capable as well to break a dormancy. The circumstance condition of moist and dry surrounding the seeds will stimulate the embryo to continue their maturation (after ripening). This has been happening on kesambi (*Scheleria oleosa*) and teak (*Tectona grandis*) seeds (Zanzibar et al., 2008). According to Zanzibar (2010), the treatment of soaking was suitable for those seeds with a hard coat, meanwhile the treatments of hydrated-dehydrated and ash or sawdust matriconditioning were good for thin coat seeds.

Hydropriming, priming in $CaCl_2$, KNO_3, and ascorbic acid solution increased vigor index and speed of germination of long bean seeds. The advantages of these treatments could be maintained until 15 weeks of storage both in AC and ambient temperature. Hydropriming was the best choice for seed treatment before storage because it is cheap and easy to perform (Utami, et al.,2013).

The moist and dry treatment that was repeated several times will become a recovering mechanism of natural ageing and /or physical damage during seed handling. After controlling the rate of imbibition, priming will be activating the metabolism elements to start the process of germination. In addition, the radicle will be extending until the end of the activation phase. The treatment is discontinued before reaching the limit conditions of seed damage tolerance. Then, the priming seeds can be dried either to be stored, distributed or planted.

The use of hydrate-dehydrated technique is applicable on a large scale, because of being affordable and easy to be practiced. The proper priming will manage the requirement rate of seed water during germination and speed up the metabolism rate. This condition may cause the prolongation of the activity phase, giving physiological refinement to the seeds The priming will improve the activity of protease enzyme and the ability of embryo to synthesize protein and RNA, making it more resistant to unfavourable environmental condition. The priming can be done in two ways: osmoconditioning and matriconditioning. Mostly, forest tree seeds that have been deteriorating physiologically, their quality might be increased by using priming of osmocondition (moistening within a certain solution) or matricondition (moistening with ash or sawdust) (Zanzibar et al., 2011).

3. The Mean Daily Germination

The result of variance analysis of the influence of priming before (0 month) and after storage (1 month) on the mean daily germination of Trema seeds is presented in Appendix 5 and Appendix 6.

Based on the analysis of variance, priming treatments before storage influenced significantly, but after storage not significantly on the values of mean daily germination of Trema seeds. The differences were tested by Duncan's (Figure 3).

It was revealed that the seeds treated by priming with hydrated-dehydrated method before storage resulted in high value of mean daily germination (1.26%) and was significantly different compared to the other treatments. Meanwhile, treatments after storage showed that there was no difference of mean daily germination among treatments (Figure 3).

Mean daily germination is an average of germination percentage every day obtained from the value of germination percentage at the end of the observation divided by the number of testing day or the last germination day (Gairola, 2011). The mean daily germination indicates the ability of seeds to germinate at any day (Hidayat, 2007). This means that priming treatment of hydrated-dehydrated method is able to optimize the ability of seeds to germinate every day compared to the other treatments of priming.

4. The Germination Value

The result of variance analysis of the influence of priming before (0 month) and after storage (1 month) on the germination

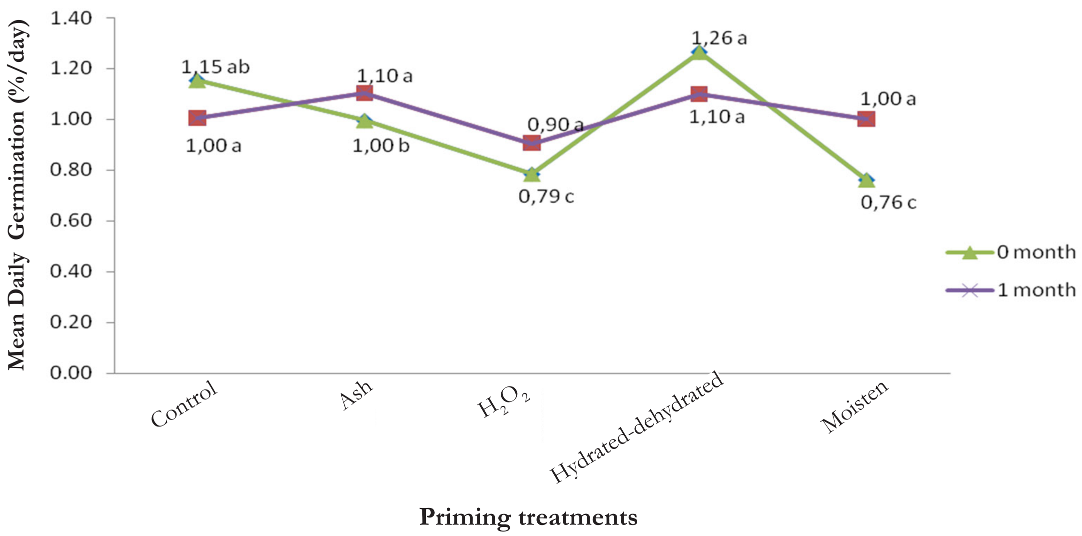

Figure 3. Mean values of the mean daily germination of *Trema* seeds and their differences test in relation to the priming before and after storage.

Remarks: values followed by the same letters are not significantly difference at a confidence level of 95%.

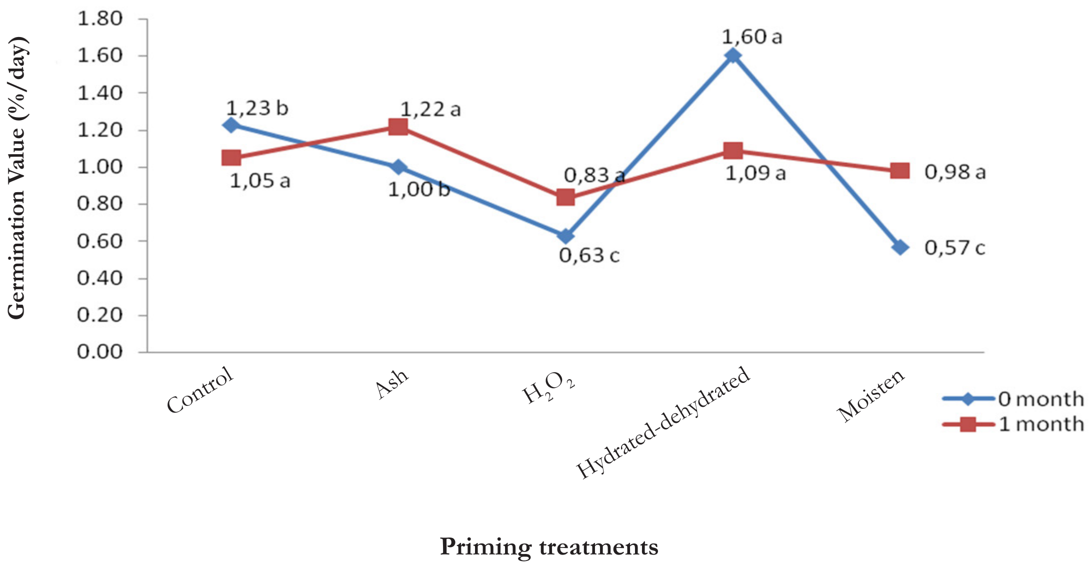

Figure 4. Mean values of the germination value of Trema seeds and their differences test in relation to the priming before and after storage.

Remarks: values followed by the same letters are not significantly difference at a confidence level of 95%.

value of Trema seeds is presented in Appendix 7 and Appendix 8.

Based on the analysis of variance, priming treatments before storage influenced significantly, but after storage not significantly on the germination value of Trema seeds. The differences were tested by Duncan's (Figure 4).

Before storage, seeds treated by hydrated-dehydrated priming gave the highest germination value (1.60%) which is significantly different with the others. After storage, the germination value did not give significant difference among all the treatments (Figure 4).

The germination value is obtained from the multiplication of germination peak value with mean daily germination. Germination peak value (the energy) is closely related to the germination percentage and germination rate values. The faster the germination rate, that accompanied by a high germination percentage, the higher the peak value. This is due to that peak value was achieved from the result of dividing the germination percentage by the number of days needed to reach such germination percentage. A high germination value indicates a good seed vigor which is showing perfection of seed viability. Germination peak value shows the energy (power) of maximum seed germination obtained in a quick certain time. Basically, germination power of a seed lot follows a normal curve pattern. At the first phase it will increase significantly up to reaching a maximum point, then it will decrease eventually (Hidayat, 2007).

5. The Growth Uniformity Value

The result of variance analysis of the influence of priming before (0 month) and after storage (1 month) on the growth uniformity value of trema seeds is presented in Appendix 9 and Appendix 10.

Based on the analysis of variance, priming treatments at before and after storage influenced significantly on the values of the growth uniformity value of trema seeds. The differences were tested by Duncan's (Figure 5).

In the treatments of before and after storages, it was known that the seeds treated by priming with hydrated-dehydrated method was able to produce a highest growth uniformity that is 74.75% (before storage) and 72% (after storage) compared to other treatments (Figure 5). So that, the treatment of hydrated-dehydrated was the best priming method to be used for trema seeds shown from all parameters measured.

Growth uniformity of germinating seeds is the ability of a seed lot to germinate simultaneously in a certain time. This parameter is one of vigour tests of seed germination capacity. The test gives a real percentage of seeds that capable to germinate normally in the field when the condition was optimum. The growth uniformity indicator identifies the seed vigour of lot seeds, although the growth

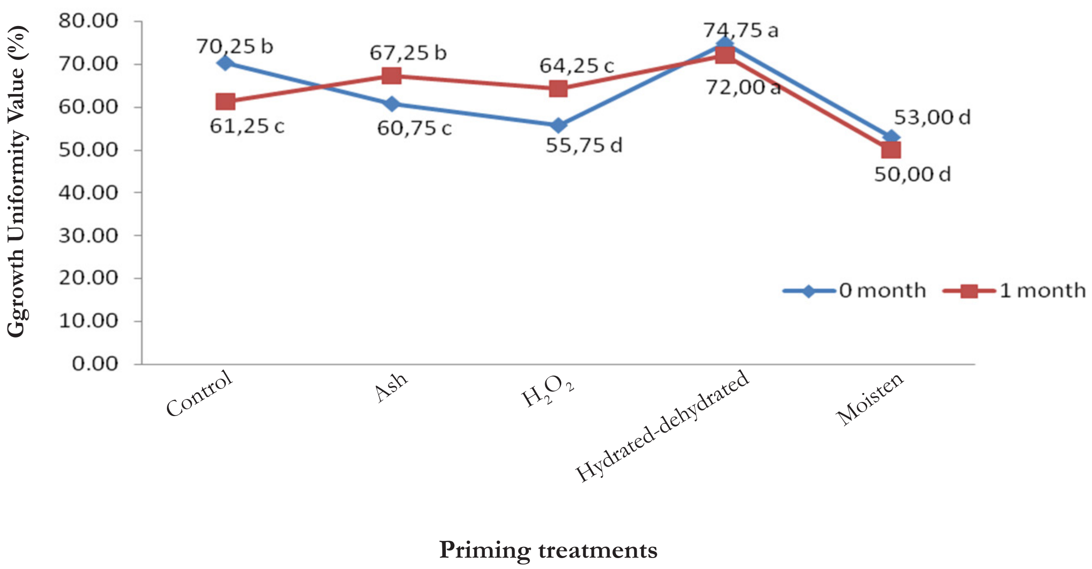

Figure 5. Mean values of the growth uniformity value of Trema seeds and their differences test in relation to the priming before and after storage.

Remarks: values followed by the same letters are not significantly difference at a confidence level of 95%.

rate is measured as the percentage of seedlings or normal germination toward all the seeds planted for the specified time (Damanik, 2010).

IV. CONCLUSION

The appropriate treatment method of priming to increase the viability and vigor of trema seeds, both before and after storage is the treatment of hydration-dehydration. Before storage, the treatment can increase the value of germination percentage and speed of germination, respectively of 15% and 0.9 $\%^{-etmal}$ of the control. After the storage, treatment hydration-dehydration is able to increase 17% germination percentage and 1.25$\%^{-etmal}$ of germination speed. High values of mean daily germination (1.26%) and germination value (1.60%) are achieved when the seeds have not been stored, whereas when the seeds have been stored there is no difference of both parameters among the treatments. In the treatments of before and after storages, it was known that the seeds treated by priming with hydrated-dehydrated method was able to produce a highest growth uniformity that is 74.75% (before storage) and 72% (after storage) compared to other treatments.

ACKNOWLEDGEMENT

The author would like to thank to Ateng Rahmat Hidayat, who had assisted us during the implementation of seed examination in the laboratory and greenhouse of Forest Tree Seed Technology Research and Development Centre.

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Appendix 1. The result of variance analysis of the influence of priming before storage on the capacity of germination of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	1484,30	371,08	9,94*	3,06
Residual	15	560,25	37,35		
Total	19	2044,55			

Remark: * = Significant at a confidence level of 95%

Appendix 2. The result of variance analysis of the influence of priming after storage on the capacity of germination of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	1765,30	441,33	6,08*	3,06
Residual	15	1089,50	72,63		
Total	19	2854,80			

Remark: * = Significant at a confidence level of 95%

Appendix 3. The result of variance analysis of the influence of priming before storage on the speed of germination of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	5,20	1,30	11,08*	3,06
Residual	15	1,76	0,12		
Total	19	6,96			

Remark: * = Significant at a confidence level of 95%

Appendix 4. The result of variance analysis of the influence of priming after storage on the capacity of germination of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	1765,30	441,33	6,08*	3,06
Residual	15	1089,50	72,63		
Total	19	2854,80			

Remark: * = Significant at a confidence level of 95%

Appendix 5. The result of variance analysis of the influence of priming before storage on the mean dailly germination of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	0,78	0,20	17,78*	3,06
Residual	15	0,16	0,01		
Total	19	0,95			

Remark: * = Significant at a confidence level of 95%

Appendix 6. The result of variance analysis of the influence of priming after storage on the mean dailly germination of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	0,11	0,03	1,62tn	3,06
Residual	15	0,25	0,02		
Total	19	0,36			

Remark: tn = Not Significant at a confidence level of 95%

Appendix 7. The result of variance analysis of the influence of priming before storage on the germination value of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	2,97	0,74	19,20*	3,06
Residual	15	0,58	0,04		
Total	19	3,55			

Remark: * = Significant at a confidence level of 95%

Appendix 8. The result of variance analysis of the influence of priming after storage on the germination value of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	0,32	0,08	0,96tn	3,06
Residual	15	1,26	0,08		
Total	19	1,58			

Remark: tn = Not Significant at a confidence level of 95%

Appendix 9. The result of variance analysis of the influence of priming before storage on the growth uniformity value of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	303,70	75,93	4,46*	3,06
Residual	15	255,50	17,03		
Total	19	559,20			

Remark: * = Significant at a confidence level of 95%

Appendix 10. The result of variance analysis of the influence of priming after storage on the growth uniformity value of trema seeds

Source of variation	Degree of Freedom	Sum of Square	Mean Square	F calculation	F table (5%)
Treatment	4	6108,30	1527,08	23,66*	3,06
Residual	15	968,25	64,55		
Total	19	7076,55			

Remark: * = Significant at a confidence level of 95%

GUIDELINE FOR AUTHORS

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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)

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