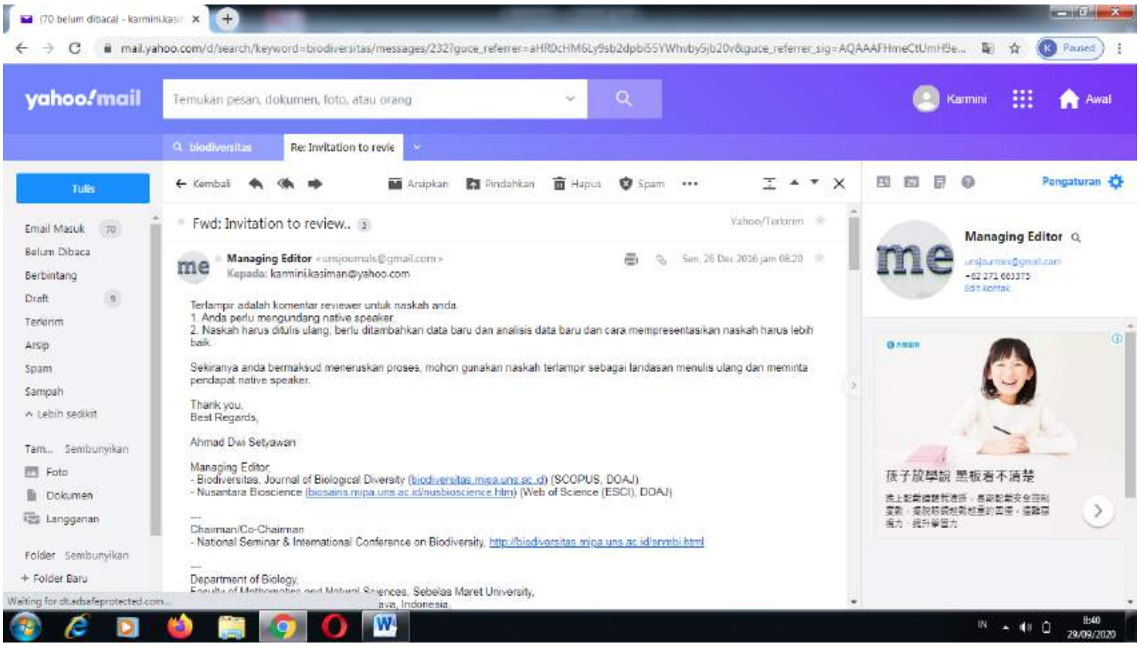
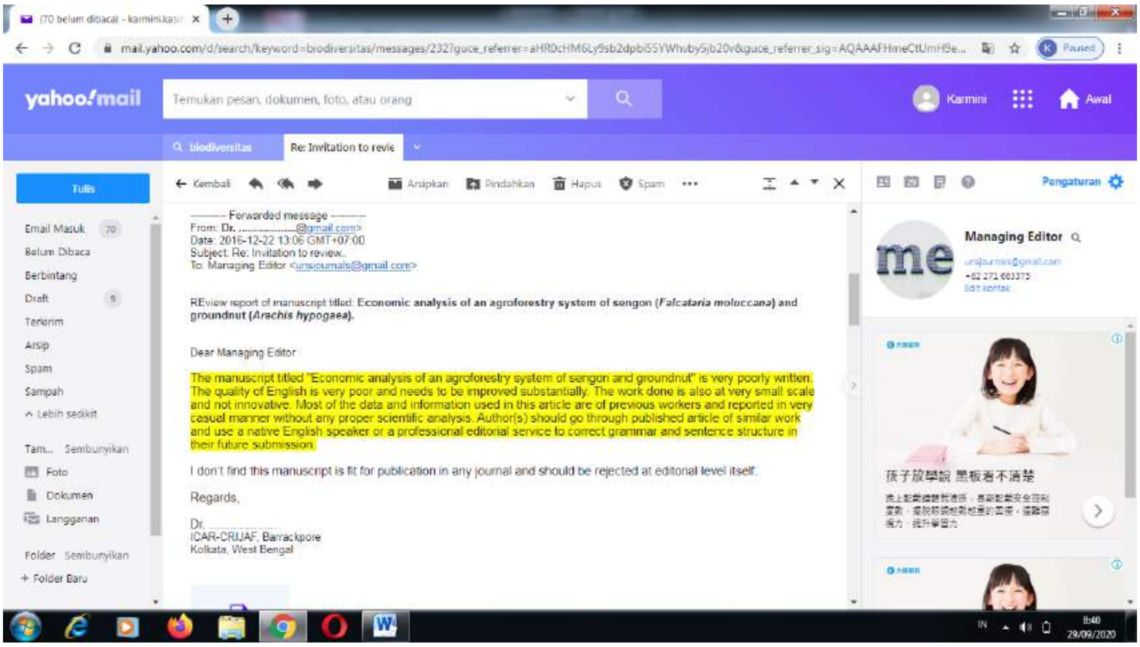
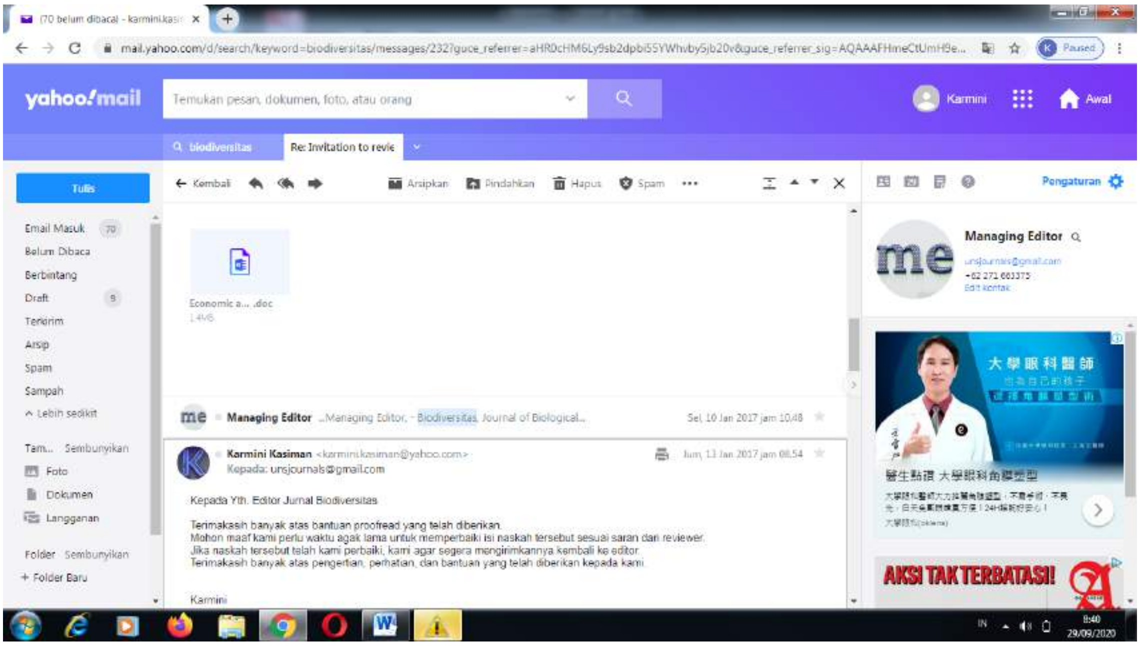
**BUKTI-BUKTI PROSES REVIEW (KORESPONDENSI)**

| | | |
|---|---|---|
| Judul | : | Economic Analysis of Groundnut (*Arachis hypogaea*) and Soybean (*Glycine max*) as Intercropping Plants in Two Agroforestry Systems |
| Penulis | : | Karmini, Sri Sarminah, dan Karyati |
| Nama Jurnal | : | Biodiversitas |
| Volume/Nomor/Tahun/Halaman | : | 18, 2, 2017, 483-493 |
| ISSN | : | 1412-033X/E-ISSN: 2085-4722 |
| Penerbit | : | Society for Indonesian Biodiversity |
| DOI | : | 10.13057/biodiv/d180206 |





Economic a... .doc
1.4MB

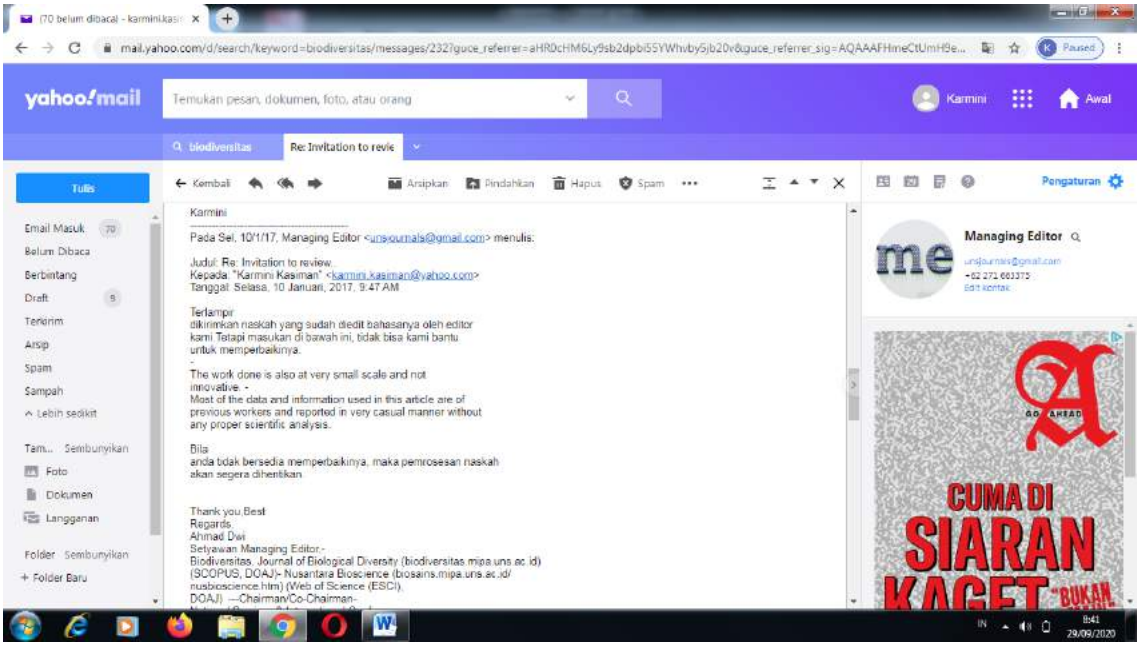
Managing Editor ...Managing Editor, - Biodiversitas, Journal of Biological... Sel, 10 Jan 2017 jam 10.48

Karmini Kasiman <karmini.kasiman@yahoo.com> Jum, 13 Jan 2017 jam 08.54
Kepada: unsjournals@gmail.com

Kepada Yth. Editor Jurnal Biodiversitas

Terimakasih banyak atas bantuan proofread yang telah diberikan.
Mohon maaf kami perlu waktu agak lama untuk memperbaiki isi naskah tersebut sesuai saran dari reviewer.
Jika naskah tersebut telah kami perbaiki, kami agar segera mengirimkannya kembali ke editor.
Terimakasih banyak atas pengertian, perhatian, dan bantuan yang telah diberikan kepada kami.

Karmini



Karmini

Pada Sel, 10/1/17, Managing Editor <unsjournals@gmail.com> menulis:

Judul: Re: Invitation to review
Kepada: "Karmini Kasiman" <karmini.kasiman@yahoo.com>
Tanggal: Selasa, 10 Januari, 2017, 9:47 AM

Terlampir
dikirimkan naskah yang sudah diedit bahasanya oleh editor
kami Tetapi masukan di bawah ini, tidak bisa kami bantu
untuk memperbaikinya.
-
The work done is also at very small scale and not
innovative. -
Most of the data and information used in this article are of
previous workers and reported in very casual manner without
any proper scientific analysis.

Bila
anda tidak bersedia memperbaikinya, maka pemrosesan naskah
akan segera dihentikan

Thank you,Best
Regards,
Ahmad Dwi
Setyawan Managing Editor,-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)
(SCOPUS, DOAJ)- Nusantara Bioscience (biosains.mipa.uns.ac.id/
nusbioscience.htm) (Web of Science (ESCI),
DOAJ) —Chairman/Co-Chairman-

biodiversitas | Re: Invitation to revie

2016-12-26 7:19 GMT+07:00
Managing Editor <unsjournals@gmail.com>
Terlampir adalah
komentar reviewer untuk naskah anda 1. Anda perlu
mengundang native speaker 2. Naskah harus ditulis
ulang, berlu ditambahkan data baru dan analisis data baru
dan cara mempresentasikan naskah harus lebih
baik.
Sekiranya anda
bermaksud meneruskan proses, mohon gunakan naskah terlampir
sebagai landasan menulis ulang dan meminta pendapat native
speaker.

Thank you.Best
Regards,
Ahmad Dwi
Setyawan Managing Editor.-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)
(SCOPUS, DOAJ)- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbi
oscience.htm) (Web of Science (ESCI),
DOAJ) ---Chairman/Co-Chairman-
National Seminar & International Conference on
Biodiversity. http://biodiversitas.mipa.uns.
ac.id/snmbi.html
---Department of
Biology,Faculty of Mathematics and Natural
Sciences, Sebelas Maret University,Jl. Ir. Sutami
36A Solo 57126, Central Java, Indonesia,Tel.
& Fax. +62-271-663375,e-mail: unsjournals@gmail.com

---------- Forwarded

Managing Editor
unsjournals@gmail.com
+62 271 663375

biodiversitas | Re: Invitation to revie

The manuscript
titled
"Economic analysis of an agroforestry system of sengon
and groundnut"
is very poorly written. The
quality of English is very poor and needs to be improved
substantially. The work done is
also at very small scale and not
innovative. Most of the data and information used in this
article are of previous workers and reported in very
casual manner without any proper scientific analysis.
Author(s)
should go through published article of similar work and use
a native English
speaker or a professional editorial service to correct
grammar and sentence
structure in their future submission.

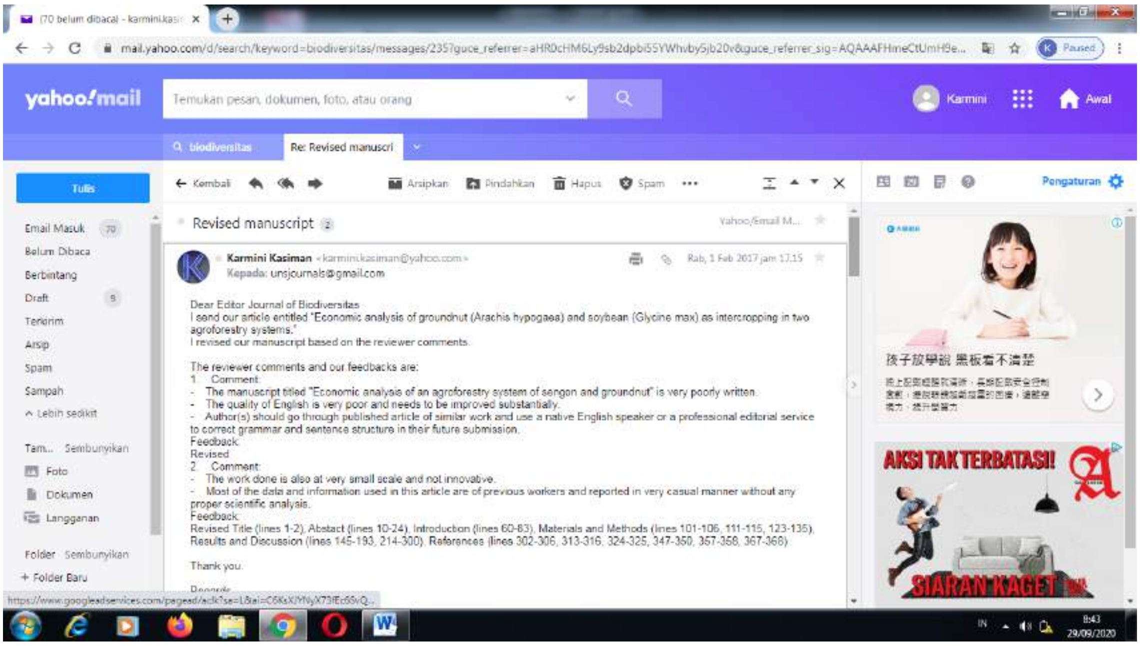
I don't find this
manuscript is fit for
publication in any journal and should be rejected at
editorial level itself.

Regards,

Dr.

ICAR-CRIJAF, Barrackpore
Kolkata, West
Bengal

Managing Editor
unsjournals@gmail.com
+62 271 663375



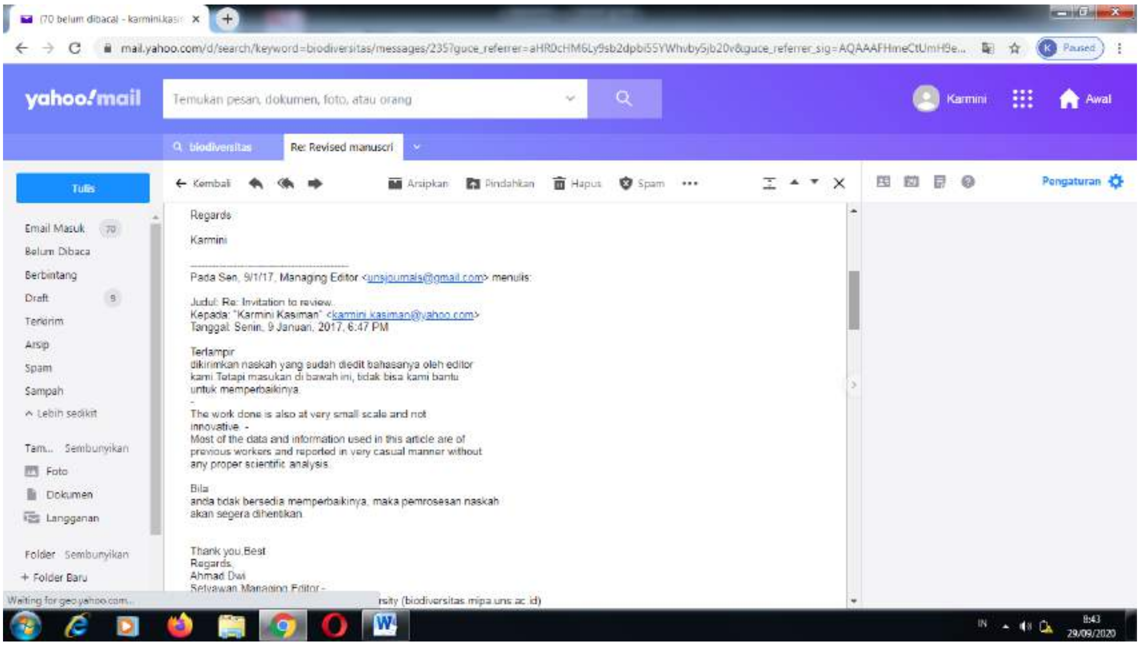
Revised manuscript

Karmini Kasiman <karminikasiman@yahoo.com>
Kepada: unsjournals@gmail.com
Rab, 1 Feb 2017 jam 17.15

Dear Editor Journal of Biodiversitas
I send our article entitled "Economic analysis of groundnut (Arachis hypogaea) and soybean (Glycine max) as intercropping in two agroforestry systems."
I revised our manuscript based on the reviewer comments.

The reviewer comments and our feedbacks are:
1. Comment:
- The manuscript titled "Economic analysis of an agroforestry system of sengon and groundnut" is very poorly written.
- The quality of English is very poor and needs to be improved substantially.
- Author(s) should go through published article of similar work and use a native English speaker or a professional editorial service to correct grammar and sentence structure in their future submission.
Feedback:
Revised
2. Comment:
- The work done is also at very small scale and not innovative.
- Most of the data and information used in this article are of previous workers and reported in very casual manner without any proper scientific analysis.
Feedback:
Revised Title (lines 1-2), Abstact (lines 10-24), Introduction (lines 60-83), Materials and Methods (lines 101-106, 111-115, 123-135), Results and Discussion (lines 145-193, 214-300). References (lines 302-306, 313-316, 324-325, 347-350, 357-358, 367-368).

Thank you.



Regards

Karmini

---

Pada Sen, 9/1/17, Managing Editor <unsjournals@gmail.com> menulis:

Judul: Re: Invitation to review
Kepada: "Karmini Kasiman" <karmini.kasiman@yahoo.com>
Tanggal: Senin, 9 Januari, 2017, 6:47 PM

Terlampir
dikirimkan naskah yang sudah diedit bahasanya oleh editor
kami. Tetapi masukan di bawah ini, tidak bisa kami bantu
untuk memperbaikinya.
-
The work done is also at very small scale and not
innovative. -
Most of the data and information used in this article are of
previous workers and reported in very casual manner without
any proper scientific analysis.

Bila
anda tidak bersedia memperbaikinya, maka pemrosesan naskah
akan segera dihentikan.

Thank you.Best
Regards,
Ahmad Dwi
Setyawan Managing Editor -
...rsity (biodiversitas.mipa.uns.ac.id)

Re: Revised manuscri

Thank you,Best
Regards,
Ahmad Dwi
Setyawan Managing Editor,-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)
(SCOPUS, DOAJ)- Nusantara Bioscience (biosains.mipa.uns.ac.id/
nusbioscience.htm) (Web of Science (ESCI),
DOAJ) ---Chairman/Co-Chairman-
National Seminar & International Conference on
Biodiversity, http://biodiversitas.mipa.uns.
ac.id/snmbi.html
---Department of
Biology,Faculty of Mathematics and Natural
Sciences, Sebelas Maret University Jl. Ir. Sutami
36A Solo 57126, Central Java, Indonesia.Tel.
& Fax. +62-271-663375,e-mail: unsjournals@gmail.com

2016-12-26 7:19 GMT+07:00
Managing Editor <unsjournals@gmail.com>:
Terlampir adalah
komentar reviewer untuk naskah anda.1. Anda perlu
mengundang native speaker 2. Naskah harus ditulis
ulang, berlu ditambahkan data baru dan analisis data baru
dan cara mempresentasikan naskah harus lebih
baik.
Sekiranya anda
bermaksud meneruskan proses, mohon gunakan naskah terlampir
sebagai landasan menulis ulang dan meminta pendapat native
speaker

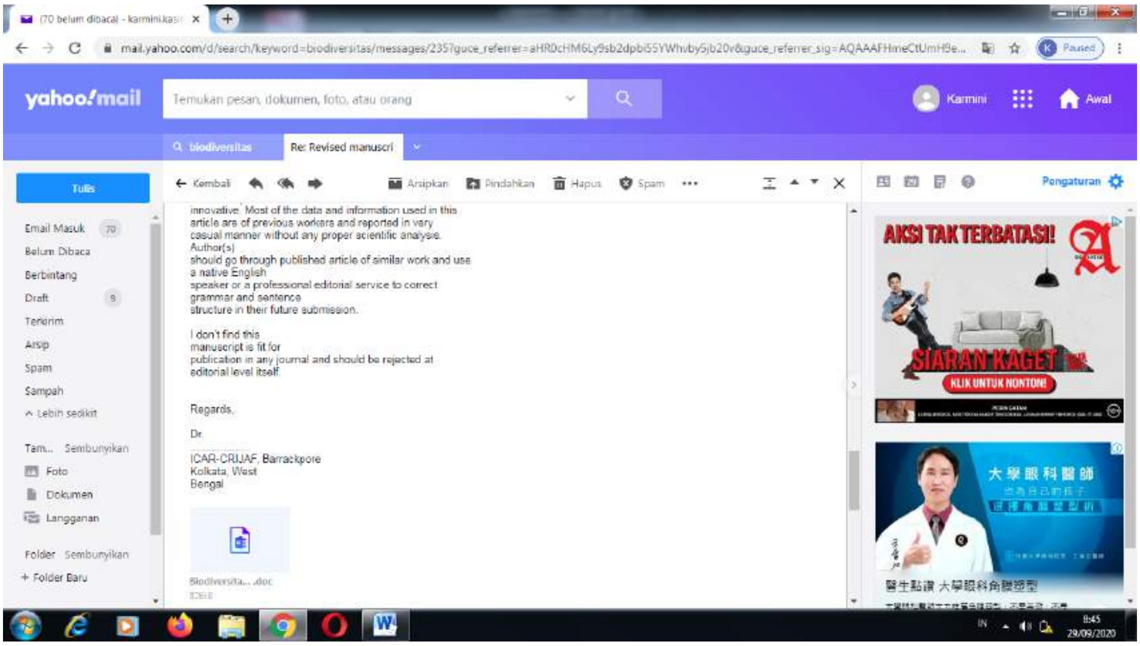
Re: Revised manuscri

---------- Forwarded
message ----------
From: Dr.
__________@gmail.com>
Date: 2016-12-22 13:06 GMT+07:00
Subject: Re: Invitation to review..
To: Managing Editor <unsjournals@gmail.com>

REview report of
manuscript titled: Economic
analysis of an agroforestry system of sengon (Falcataria
moluccana) and
groundnut (Arachis hypogaea).

Dear Managing Editor

The manuscript
titled
"Economic analysis of an agroforestry system of sengon
and groundnut"
is very poorly written. The
quality of English is very poor and needs to be improved
substantially. The work done is
also at very small scale and not
innovative. Most of the data and information used in this
article are of previous workers and reported in very
casual manner without any proper scientific analysis.
Author(s)
should go through published article of similar work and use
a native English
speaker or a professional editorial service to correct



innovative. Most of the data and information used in this
article are of previous workers and reported in very
casual manner without any proper scientific analysis.
Author(s)
should go through published article of similar work and use
a native English
speaker or a professional editorial service to correct
grammar and sentence
structure in their future submission.

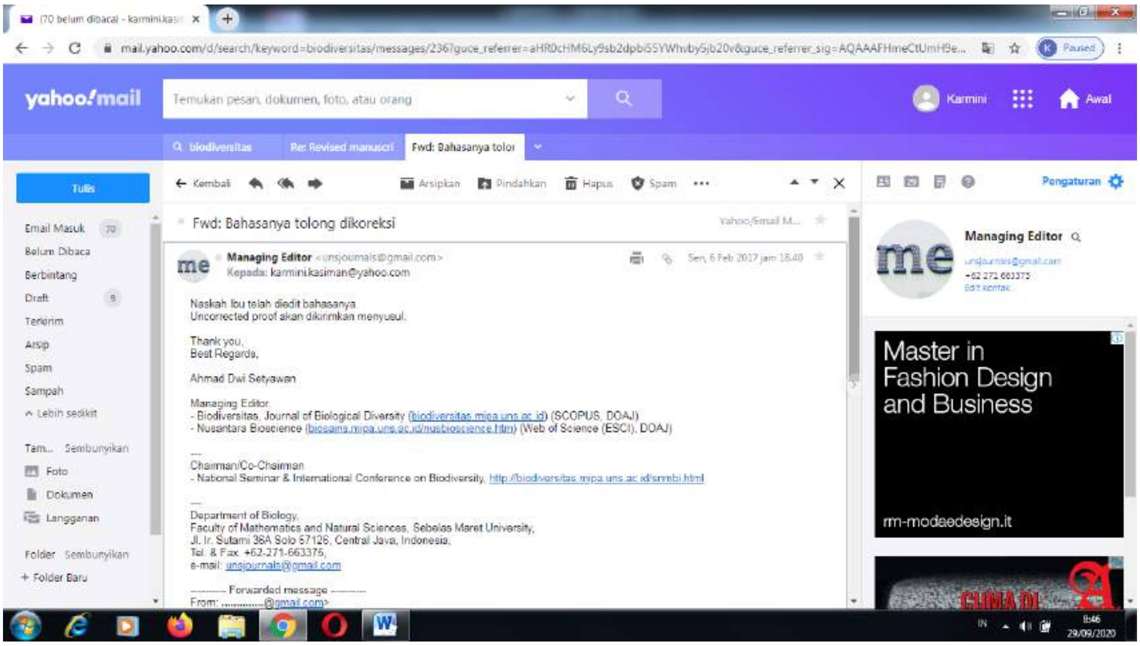
I don't find this
manuscript is fit for
publication in any journal and should be rejected at
editorial level itself.

Regards,

Dr.

ICAR-CRIJAF, Barrackpore
Kolkata, West
Bengal

Biodiversita... .doc



Fwd: Bahasanya tolong dikoreksi

**Managing Editor** <unsjournals@gmail.com>
Kepada: karmini.kasiman@yahoo.com
Sen, 6 Feb 2017 jam 18.40

Naskah Ibu telah diedit bahasanya.
Uncorrected proof akan dikirimkan menyusul.

Thank you,
Best Regards,

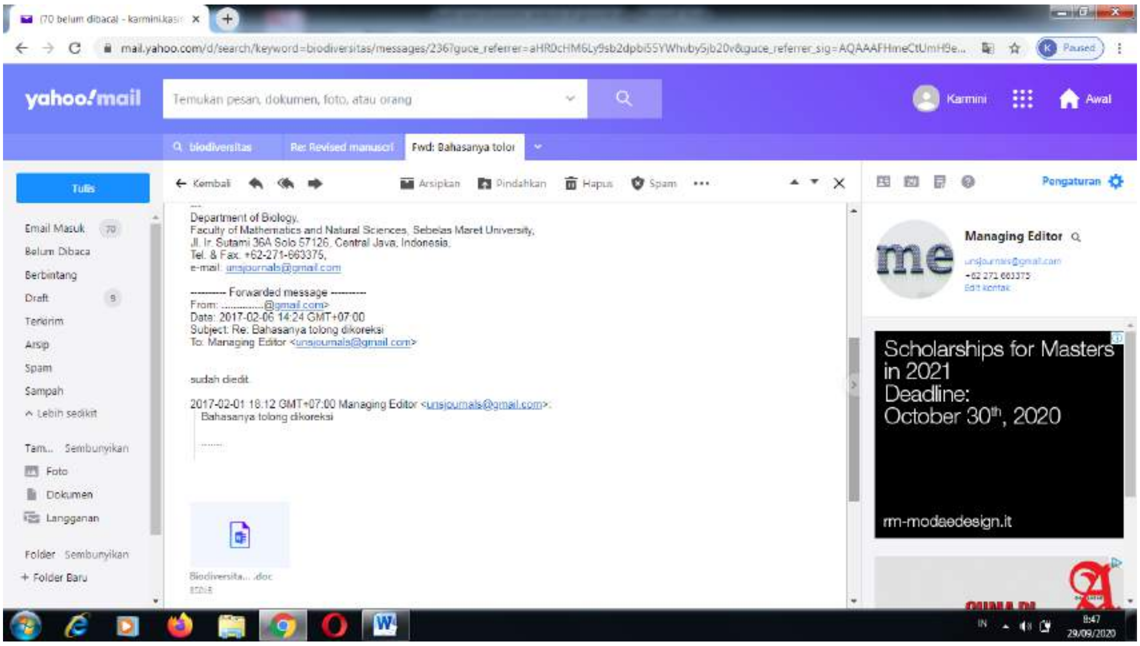
Ahmad Dwi Setyawan

Managing Editor,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbioscience.htm) (Web of Science (ESCI), DOAJ)

---
Chairman/Co-Chairman
- National Seminar & International Conference on Biodiversity, http://biodiversitas.mipa.uns.ac.id/snmbi.html

---
Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia,
Tel. & Fax. +62-271-663375,
e-mail: unsjournals@gmail.com

---------- Forwarded message ----------
From: ..............@gmail.com>



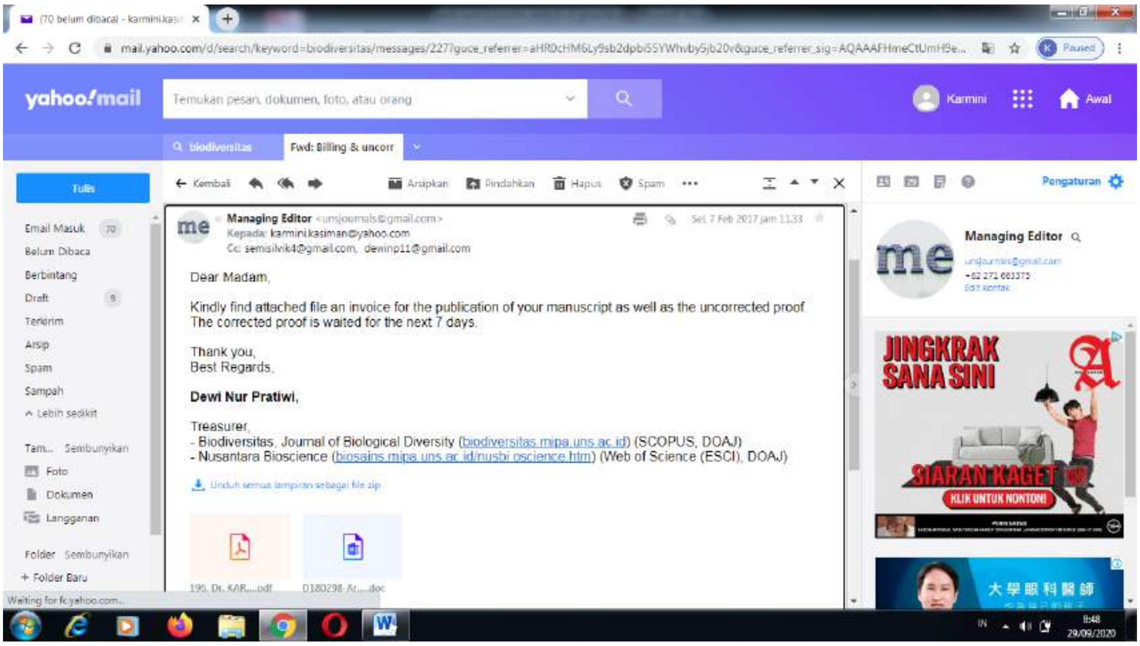
Fwd: Bahasanya tolon

Department of Biology,
Faculty of Mathematics and Natural Sciences, Sebelas Maret University,
Jl. Ir. Sutami 36A Solo 57126, Central Java, Indonesia,
Tel. & Fax. +62-271-663375,
e-mail: unsjournals@gmail.com

---------- Forwarded message ----------
From: ..............@gmail.com>
Date: 2017-02-06 14:24 GMT+07:00
Subject: Re: Bahasanya tolong dikoreksi
To: Managing Editor <unsjournals@gmail.com>

sudah diedit

2017-02-01 18:12 GMT+07:00 Managing Editor <unsjournals@gmail.com>:
Bahasanya tolong dikoreksi



Fwd: Billing & uncorr

Managing Editor <unsjournals@gmail.com> Sel, 7 Feb 2017 jam 11.33
Kepada: karmini.kasiman@yahoo.com
Cc: semisilvik4@gmail.com, dewinp11@gmail.com

Dear Madam,

Kindly find attached file an invoice for the publication of your manuscript as well as the uncorrected proof.
The corrected proof is waited for the next 7 days.

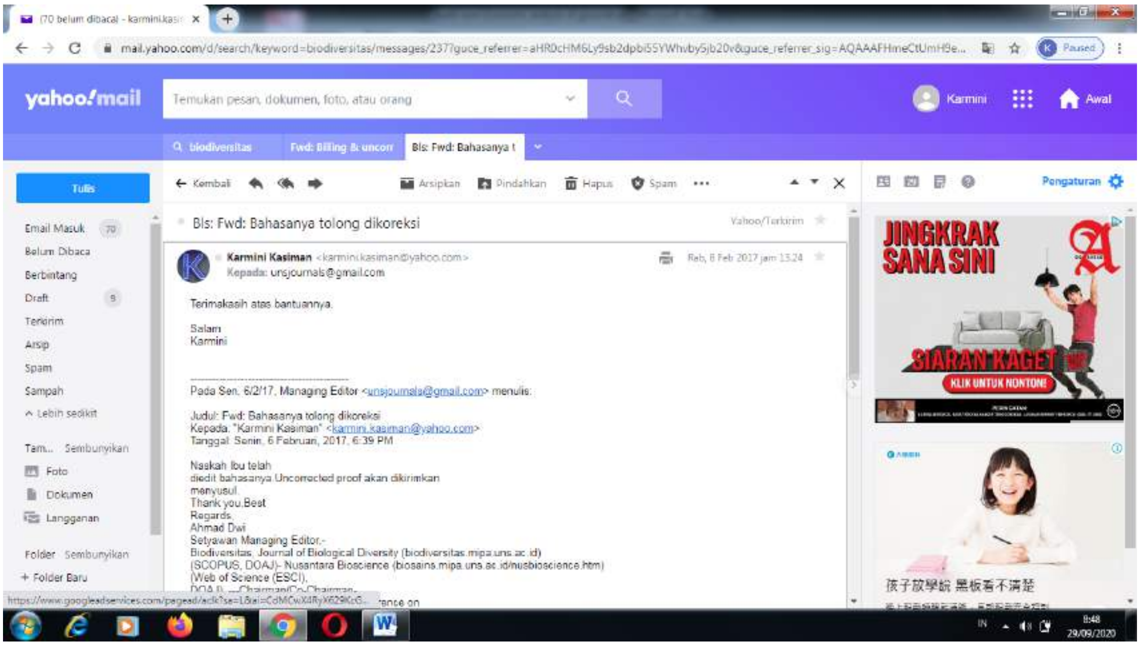
Thank you,
Best Regards,

**Dewi Nur Pratiwi,**

Treasurer,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbioscience.htm) (Web of Science (ESCI), DOAJ)

Unduh semua lampiran sebagai file zip

190. Dr. KAR....pdf
D180298-Ar....doc



Bls: Fwd: Bahasanya tolong dikoreksi

**Karmini Kasiman** <karmini.kasiman@yahoo.com>
Kepada: unsjournals@gmail.com
Rab, 8 Feb 2017 jam 13.24

Terimakasih atas bantuannya.

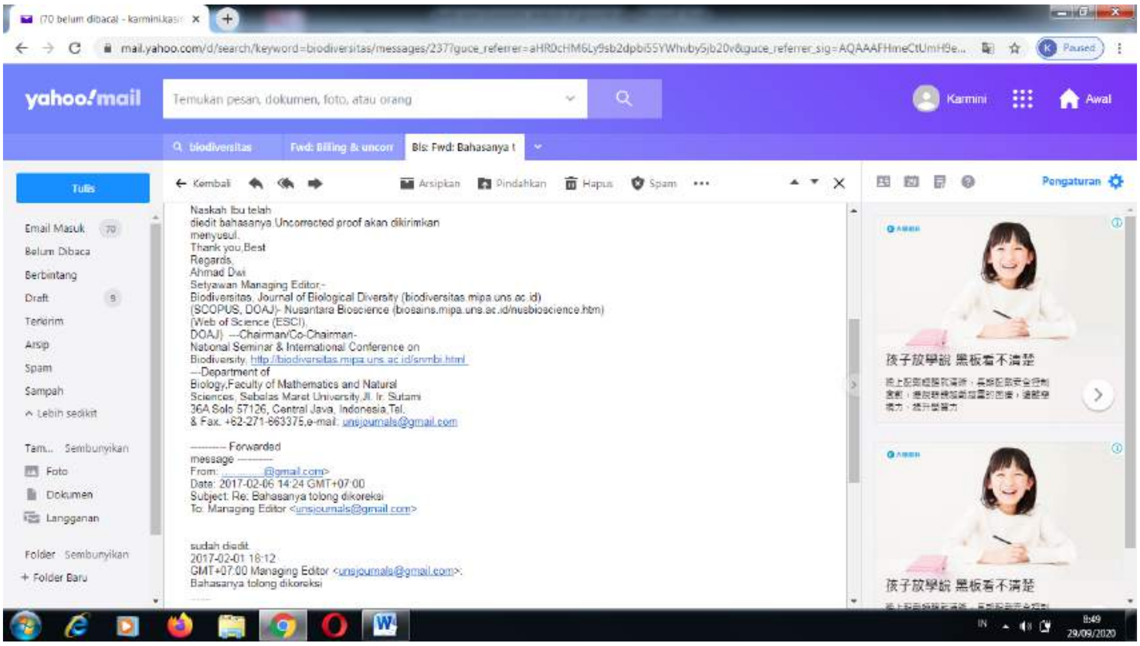
Salam
Karmini

---

Pada Sen, 6/2/17, Managing Editor <unsjournals@gmail.com> menulis:

Judul: Fwd: Bahasanya tolong dikoreksi
Kepada: "Karmini Kasiman" <karmini.kasiman@yahoo.com>
Tanggal: Senin, 6 Februari, 2017, 6:39 PM

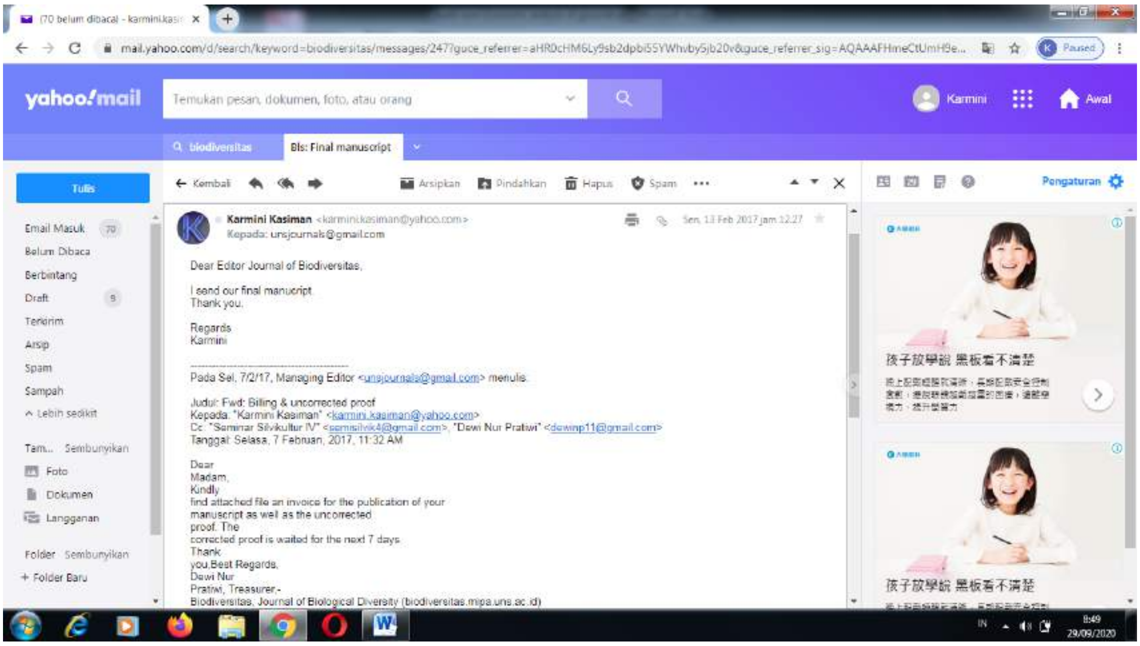
Naskah Ibu telah
diedit bahasanya.Uncorrected proof akan dikirimkan
menyusul.
Thank you,Best
Regards,
Ahmad Dwi
Setyawan Managing Editor,-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)
(SCOPUS, DOAJ)- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbioscience.htm)
(Web of Science (ESCI),



Naskah Ibu telah
diedit bahasanya.Uncorrected proof akan dikirimkan
menyusul.
Thank you,Best
Regards,
Ahmad Dwi
Setyawan Managing Editor,-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)
(SCOPUS, DOAJ)- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbioscience.htm)
(Web of Science (ESCI),
DOAJ) ---Chairman/Co-Chairman-
National Seminar & International Conference on
Biodiversity, http://biodiversitas.mipa.uns.ac.id/snmbi.html
---Department of
Biology,Faculty of Mathematics and Natural
Sciences, Sebelas Maret University,Jl. Ir. Sutami
36A Solo 57126, Central Java, Indonesia,Tel.
& Fax. +62-271-663375,e-mail: unsjournals@gmail.com

---------- Forwarded
message ----------
From: ..........@gmail.com>
Date: 2017-02-06 14:24 GMT+07:00
Subject: Re: Bahasanya tolong dikoreksi
To: Managing Editor <unsjournals@gmail.com>

sudah diedit
2017-02-01 18:12
GMT+07:00 Managing Editor <unsjournals@gmail.com>:
Bahasanya tolong dikoreksi



Bls: Final manuscript

Karmini Kasiman <karminikasiman@yahoo.com>
Kepada: unsjournals@gmail.com
Sen, 13 Feb 2017 jam 12.27

Dear Editor Journal of Biodiversitas,

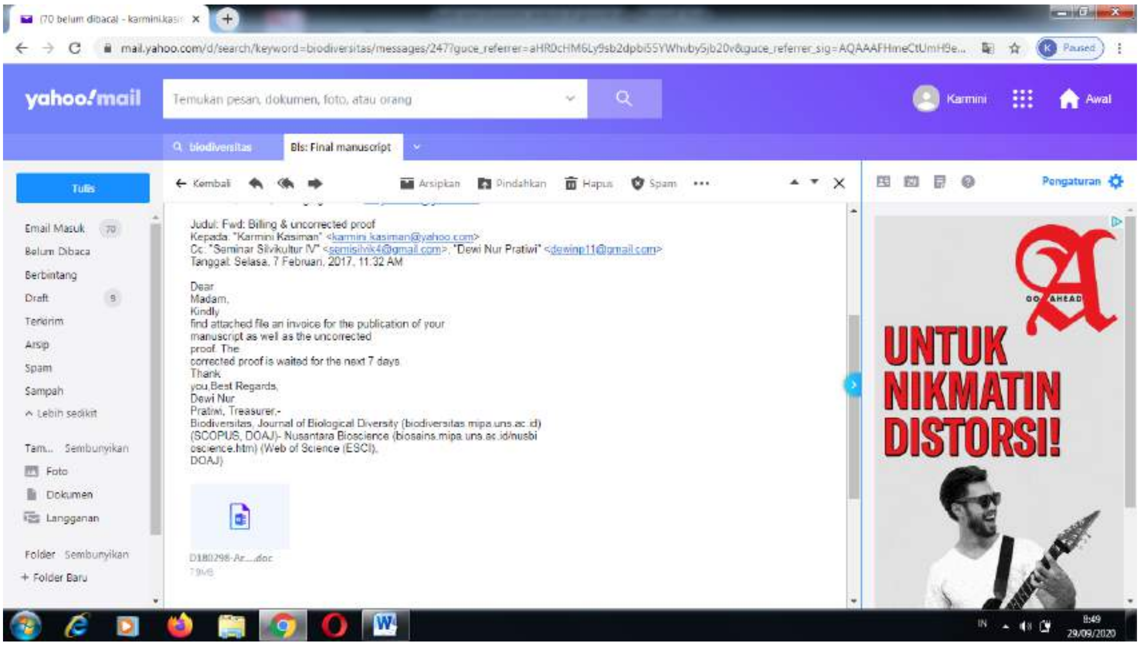
I send our final manucript
Thank you.

Regards
Karmini

Pada Sel, 7/2/17, Managing Editor <unsjournals@gmail.com> menulis:

Judul: Fwd: Billing & uncorrected proof
Kepada: "Karmini Kasiman" <karmini.kasiman@yahoo.com>
Cc: "Seminar Silvikultur IV" <semisilvik4@gmail.com>, "Dewi Nur Pratiwi" <dewinp11@gmail.com>
Tanggal: Selasa, 7 Februari, 2017, 11:32 AM

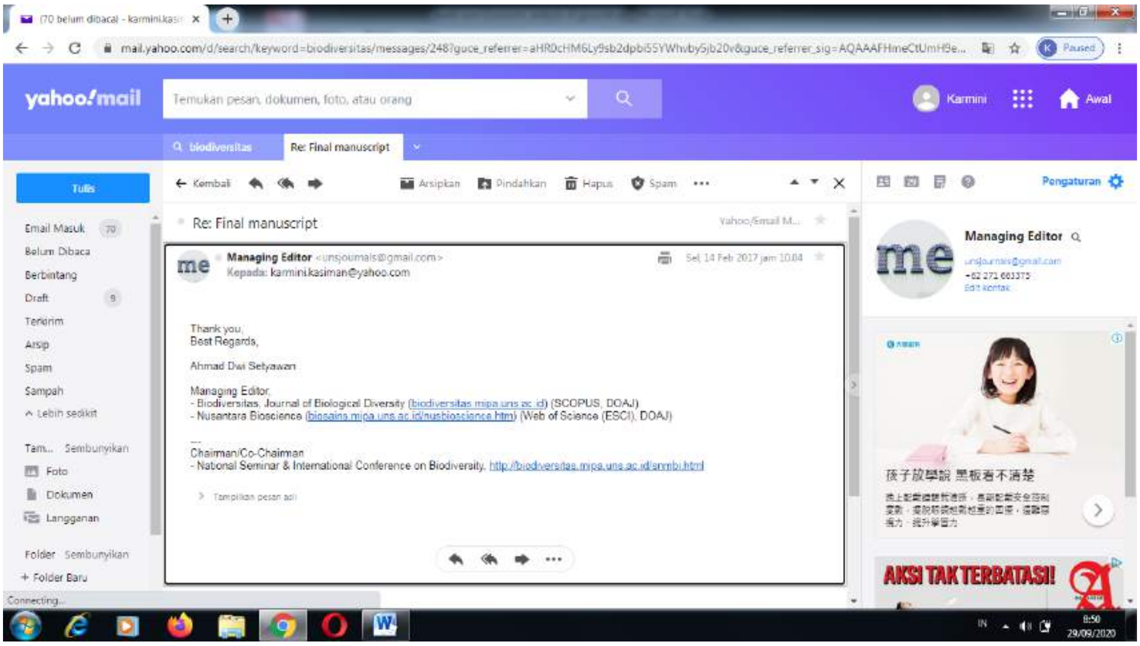
Dear
Madam,
Kindly
find attached file an invoice for the publication of your
manuscript as well as the uncorrected
proof. The
corrected proof is waited for the next 7 days.
Thank
you,Best Regards,
Dewi Nur
Pratiwi, Treasurer,-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)



Judul: Fwd: Billing & uncorrected proof
Kepada: "Karmini Kasiman" <karmini.kasiman@yahoo.com>
Cc: "Seminar Silvikultur IV" <semisilvik4@gmail.com>, "Dewi Nur Pratiwi" <dewinp11@gmail.com>
Tanggal: Selasa, 7 Februari, 2017, 11:32 AM

Dear
Madam,
Kindly
find attached file an invoice for the publication of your
manuscript as well as the uncorrected
proof. The
corrected proof is waited for the next 7 days.
Thank
you,Best Regards,
Dewi Nur
Pratiwi, Treasurer,-
Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id)
(SCOPUS, DOAJ)- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbi
oscience.htm) (Web of Science (ESCI),
DOAJ)

D180298-Ar....doc



Re: Final manuscript

**Managing Editor** <unsjournals@gmail.com>
Kepada: karmini.kasiman@yahoo.com
Sel, 14 Feb 2017 jam 10.04

Thank you,
Best Regards,

Ahmad Dwi Setyawan

Managing Editor,
- Biodiversitas, Journal of Biological Diversity (biodiversitas.mipa.uns.ac.id) (SCOPUS, DOAJ)
- Nusantara Bioscience (biosains.mipa.uns.ac.id/nusbioscience.htm) (Web of Science (ESCI), DOAJ)

---
Chairman/Co-Chairman
- National Seminar & International Conference on Biodiversity. http://biodiversitas.mipa.uns.ac.id/snmbi.html

Tampilkan pesan asli

# Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping plants in two agroforestry systems

**KARMINI[1♥], SRI SARMINAH[2], KARYATI[3]**

[1]Department of Agribusiness, Faculty of Agriculture, University of Mulawarman, Kampus Gunung Kelua, Jalan Pasir Balengkong, Kampus Gunung Kelua, PO Box 1040, Samarinda, Kalimantan Timur, Indonesia. ♥email: karmini.kasiman@yahoo.com
[2,3]Faculty of Forestry, University of Mulawarman, Kampus Gunung Kelua, Jalan Ki Hajar Dewantara, Kampus Gunung Kelua, PO Box 1013, Samarinda, Kalimantan Timur, Indonesia.

Manuscript received: 21-11-2016. Revision accepted: ................

## ABSTRACT

**Abstract.** *Karmini, Sri Sarminah, and Karyati. 2017. Economic analysis of groundnut (Arachis hypogaea) and soybean (Glycine max) as intercropping plants in two agroforestry systems. Biodiversitas* ..................... An agroforestry is a farming system combining forestry plant and agricultural plant. Two agroforestry systems of sengon (*Falcataria moluccana*) - groundnut (*Arachis hypogaea*) and jabon (*Anthocephalus cadamba)* - soybean (*Glycine max*) have been done and are proven to be successful. The objective of this study was to analyze the application of *A. hypogaea* and *G. max* as intercropping plants in two agroforestry systems from the aspect of economy. The study was conducted from January to May 2016 in Education Forest, Forestry Faculty, Mulawarman University, Samarinda City, East Kalimantan Province, Indonesia. Data analysis was done to calculate cost, revenue, and profit of the application of *A. hypogaea* and *G. max* as intercropping plants in two agroforestry systems. The results ~~of this study~~ indicate that two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max* are feasible and applicable to rehabilitate the critical lands. The application of *A. hypogaea* as intercropping plant in ~~an~~ the agroforestry system of *F. moluccana* and *A. hypogaea* expended total cost as much as Rp10,985,000.00 $ha^{-1}$ $cs^{-1}$, and it obtained total revenue as much as Rp14.000.000,00 $ha^{-1}$ $cs^{-1}$, ~~and~~ so it gave profit as much as Rp3,015,000.00 $ha^{-1}$ $cs^{-1}$. An agroforestry system of *F. moluccana* and *A. hypogaea* gives many benefits from the aspect of economy, social, ecology, and conservation. Total cost, total revenue, and profit of the application of *G. max* as intercropping plant in ~~an~~ the agroforestry system of *A. cadamba* and *G. max*, in the first year in the first cropping season, were Rp11,019,000.00 $ha^{-1}$ $cs^{-1}$; Rp3,500,000.00 $ha^{-1}$ $cs^{-1}$; and Rp-7,519,000.00 $ha^{-1}$ $cs^{-1}$. Although it was not profitable to do in ~~the~~ some critical lands, ~~however~~ it ~~gives~~ gave many benefits from the aspect of ecology and conservation.

**Key words:** Agroforestry, *Arachis hypogaea*, economic analysis, *Glycine max*.

**Abbreviations**: Hectare (ha), kilogram (kg), cropping season (cs), Rupiah (Rp).

**Running title:** Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping plants in two agroforestry systems.

## INTRODUCTION

Agroforesty is a system of farm activities which combines plant or other kinds of forestry plant with agricultural plant. Agroforestry activity could be done at farm area, ~~even~~ inside or outside of forest area. Agroforestry system could be applied at critical land or degraded land. According to Sudomo (2007), an agroforestry is a model of community forest or social forestry which is expected to enable the increase of land productivity per wide area and, in future, it ~~could~~ can increase community welfare. Besides, agroforestry is expected to have positive function in land and in water conservation, since it is applied mostly in degraded areas as an effort to rehabilitate the land.

Agroforestry system uses combination of many kinds of forestry plants with agricultural plants. The ~~Tree~~ tree raises positive effect on the supply of ground water for the intercrops that grow among trees. Besides, shelter gives buffer effect to anticipate the temperature fluctuation and extreme temperature of both ground temperature and atmosphere temperature ~~above~~ of the land (Hamid, 2008). Some previous researches (Barneby and J.W. Grimes) chose sengon (*Falcataria moluccana* (Miq.) ~~Barneby and J.W. Grimes)~~ as ~~a~~ forestry plant in agroforestry system, and combined it with other agricultural plants. The combination of sengon with other plants were ~~such~~ as follows: sengon - nilam (Sudomo 2007), sengon - maize - chili - stick nut (Hamid 2008), sengon - coffee - cacao - gliricidia - maize - ginger - stick nut (Mindawati et al. 2013), groundnut - sengon - manglid (Swestiani and Purwaningsih 2013), sengon - paddy (Wahyudi and Panjaitan 2013), and sengon - groundnut (Widiyanto and Sudomo 2014).

Sudomo (2007) stated that most people like to cultivate *F. moluccana* because it was fast-growing ~~tree~~ and easy breeding, and its timber could be used to make many products such as furniture and firewood, and its leaf could be used as cattle provisions and as compost material. Moreover, *F. moluccana* and nilam are proven to have potential to be cultivated in agroforestry system at Sukamulih Village, Sariwangi Subdistrict, Tasikmalaya District. Meanwhile, the study result of Wahyudi and Panjaitan (2013) indicated superiority of agroforestry system that uses combination of *F. moluccana* and upland paddy. That system becomes the best choice in the development of Industrial Plantation Forest of PT Gunung Meranti, because it gives the best yield rate of *F. moluccana* and upland paddy, creates job opportunities, increases income of local community, grows own feeling on natural resources, creates positive perception to develop the plantation forest and agroforestry, guards the forest security, and decreases the degradation rate of forest. The fact in field shows that most land is in critical and damage condition because ~~in~~ of the continuous effort to fulfill the economic need.~~,~~ To fulfill this need, ~~p~~People ~~has~~ have to contact with nature, so the activity to rehabilitate forest and its surrounding area has potential conflict (Nasution 2010).

According to Sembiring et al. (2014), groundnut (*Arachis hypogaea* L.) is a food commodity that has high economic value. *A. hypogaea* has high nutrition ingredient especially protein and grease. *A. hypogaea* is mostly used as food-stuff and industrial material (Raja et al. 2013). Researches on *A. hypogaea* farming have been done by some researchers such as Hidayat et al. (2004), Muklis et al. (2012), Raja et al. (2013), Riska (2014), Sembiring et al. (2014), and Boekoesoe and Saleh (2015).

Jabon (*Anthocephalus cadamba* (Roxb.) Miq.) is a tropical tree species that is native to South Asia and Southeast Asia, including Indonesia (Krisnawati et al. 2011b). *A. cadamba* is preferred by the local community because it is a fast-growing tree species and has good adaptability to drought and waterlogging stresses (Hadi et al. 2015; Seo et al. 2015; Sudrajat et al. 2015). *A. cadamba* is used in community forests and greening activities such as reforestation programmes, afforestation programmes, rehabilitation activities of waterlogged marginal sites, and replanting the dryer marginal sites. *A. cadamba* has wood for multiple end uses such as plywood, light construction materials, flooring, beams and rafters, boxes and crates, tea-chests, packing cases, shuttering, ceiling boards, toys, wooden shoes, bobbins, yokes, carvings, matches, chopsticks, pencils, canoes, and inexpensive furniture. The pulp of *A. cadamba* for medium quality paper and the fresh leaves are used as ~~fodder~~ cattle fodder or as plates and serviettes (Soerianegara and Lemmens 1993).

Soybean (*Glycine max* (L.) Merrill) is valued as a productive and adaptable crops which fits well into the cropping patterns of varying agro-climatic conditions (Amusat and Ademola 2013). For a long time, ~~Soybean~~ soybean has been a part of traditional food for human population which comes in various forms such as tofu, soy-milk, green vegetable soybeans, tempeh, and soybean oil, and ~~. Also~~also, in its second generation of soy-foods such as soy-nuts, ~~cheese~~ alternatives cheese, and soymilk yogurt. According to Agroudy et al. (2011), the soy oil is one of the ~~most~~ widest spreaded vegetable oils.~~ spread,~~ It ~~where~~ is used directly in food to prevent its consumers from having blood pressure and arteriosclerosis; moreover seeds of soybean contain the highest number of ~~most~~ vitamins that are essential for the body.

The establishment of two agroforestry systems ~~by~~ using *F. moluccana* and *A. cadamba* as forestry plants and *A. hypogaea* and *G. max* as agricultural plants is important to apply because it has high economic potential. The aim of this study was to analyze the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems from the aspect of economy. The result of this study are expected to give~~s~~ information ~~for~~ to businessman, government, stakeholders, and other researchers about cost expenditure, potential revenue, and profit estimation that could be obtained from the application of *A. hypogaea* and *G. max* as intercropping in the two agroforestry systems. Those information are useful to determine ~~how much~~ the capital ~~should be prepared~~ needed to start an ~~begin that~~ agro-business. This study compared two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max* to offer the best agroforestry system that could be applied in the critical lands.

The sections of this study are organized in the following sequence. First, Materials and methods section explaining~~s~~ the study area, materials and equipments, procedures, and data analysis. The ~~following~~ next section presents the results and includes some discussions.~~ Finally~~The last section is ~~,~~ the conclusion that summarizes findings and offers recommendations.

## MATERIALS AND METHODS

**Study area**

This study was conducted for 4 months from January to May 2016. The experiment was done in Forest Education, Forestry Faculty, Mulawarman University. Experimental plots were located in Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia (Figure 1). There are many previous researches on agroforestry systems in some locations in Indonesia. Some of them did the research on *F. moluccana* in Tasikmalaya District, West Java Province (Sudomo 2007), in East Java Province (Hamid 2008; Mindawati et al. 2013), and in Ciamis District, West Java Province (Sudomo 2013; Swestiani and Purwaningsih 2013; Widiyanto and Sudomo 2014). The study on *A. hypogaea* had been done by some researchers in several provinces in Indonesia. Several *A. hypogaea* studies were located in West Java Province (Hidayat et al. 2004), in Purworejo District, Central Java Province (Muklis et al. 2012), in Medan City, North Sumatera Province (Raja et al. 2013), in Sigi District, Central Sulawesi Province (Riska 2014), in Deli Serdang District, North Sumatera Province (Sembiring et al. 2014), and in West Gorontalo District, Gorontalo Province (Boekoesoe and Saleh 2015). However, the publication of researches about two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max* in East Kalimantan Province is still limited.

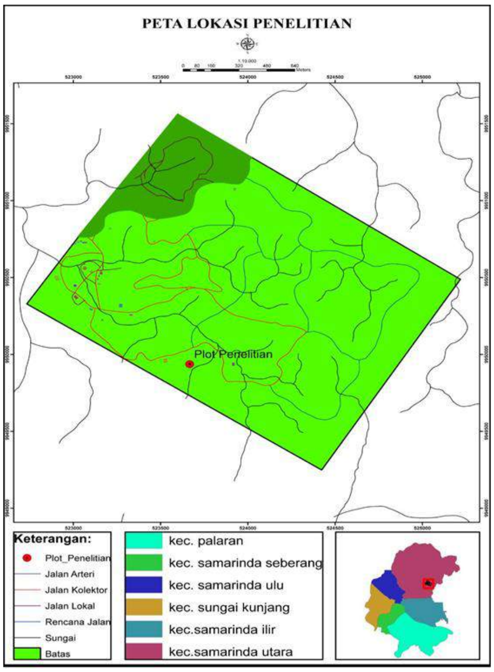



Figure 1. Study location.

**Materials and Equipments**

Some materials were used in this study such as *F. moluccana* seedling, *A. cadamba* seedling, *A. hypogaea* seed, *G. max* seed, NPK fertilizer, pesticide, plastic strings, gunny sack, and other materials. Several equipments were needed to cultivate *F. moluccana, A. hypogaea, A. cadamba,* and *G. max* such as hoe, chopper, sickle, sprayer, and other equipments.

**Procedures**

Some researchers collected primary data through survey to a number of farmers as respondents to reach their ~~researches~~ aims of research. Siregar et al. (2007) surveyed 40 respondents to analyze the economic value of some agroforestry systems. Asnah and Natal (2009) surveyed 45 respondents to calculate the profit of *A. hypogaea* farm. Others researcher, Muklis et al. (2012), surveyed 26 respondents to analyze the profit of *A. hypogaea* farm. Amusat and Ademola (2013) collected primary data using interview schedules from the 130 selected *G. max* farmers, but only 123 of the schedules were found to be useable. Dogbe et al. (2013) determined 140 *G. max* farmers as enumerators for their study. In addition, Riska (2014) surveyed 30 respondents to analyze the production and profit of *A. hypogaea* farm. Zoundji et al. (2015) selected 324 soybean producers as respondents.

This study was different from those studies above in which primary data for the analysis of economy were collected from on-farm experimental plot established to study two agroforestry systems of *F. moluccana - A. hypogaea* and *A. cadamba - G. max*. Experimental researches related to agroforestry had been done by some researchers with different kinds of plant combination. For example, tree - maize (Bertomeu 2006), sengon - nilam (Sudomo 2007), sengon - maize - chili - stick nut (Hamid 2008), sengon - coffee - cacao - gliricidia - maize - ginger - stick nut (Mindawati et al. 2013), groundnut - manglid (Sudomo 2013), groundnut - sengon - manglid (Swestiani and Purwaningsih 2013), sengon - paddy (Wahyudi and Panjaitan 2013), and sengon - groundnut (Widiyanto and Sudomo 2014).

In this study, experimental plot (Figure 2) of *F. moluccana* and *A. hypogaea* had size of 10 m × 10 m per plot with 2 replications or as many as 2 plots. Similar to *F. moluccana* and *A. hypogaea*, experimental plot of *A. cadamba* and *G. max* had the same of size and replication. *F. moluccana* and *A. cadamba* were cultivated with distance of 3 m × 3 m. *A. hypogaea* crops were cultivated among *F. moluccana* trees as intercropping with size of 20 cm x 20 cm. *G. max* crops were also cultivated among *A. cadamba* trees as intercropping with size of 20 cm x 20 cm. The cultivation activities included land preparation, planting, crop maintenance (weeding, fertilizing, and control of pests and diseases), and harvesting. Harvesting activity was only done to gather *A. hypogaea* and *G. max* yields, but no timber harvesting of *F. moluccana* and *A. cadamba* trees.

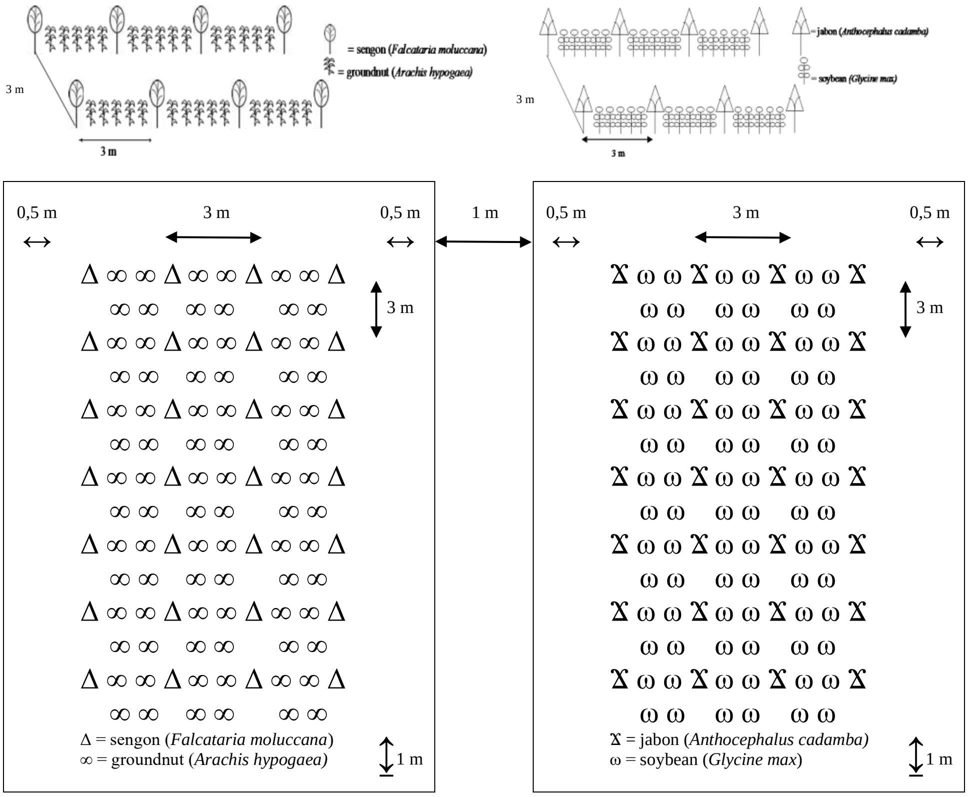



Figure 2. Layout of experimental plots in two agroforestry systems of *Falcataria moluccana - Arachis hypogaea* and *Anthocephalus cadamba - Glycine max.*

**Data analysis**

This study was different from previous study by Bertomeu (2006) which also made experimental plot to collect primary data. Bertomeu (2006) collected primary data to study the financial evaluation of agroforestry systems of tree and maize. However, this study collected primary data to analyze the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems from the aspect of economy. In this study, data were analyzed to calculate cost, revenue, and profit from the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems. Cost is calculated from price and quantity of inputs, thus revenue is price of production yield, and meanwhile profit is revenue minus cost (Slavin 2009). Besides primary data, this study also collected secondary data from the results of previous studies.

## RESULTS AND DISCUSSION

The application of an agroforestry system needs the cost expenditure to buy materials, depreciation of equipment, and wage of labor. Besides cost expenditure, the application of an agroforestry system results revenue and profit. Table 1 shows economic analysis of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* (Figure 3) and *A. hypogaea* (Figure 4) during 4 months in East Kalimantan in the 2016 cropping season. Meanwhile, ~~economic~~ economic analysis of *G. max* as intercropping in an agroforestry system of *A. cadamba* (Figure 5) and *G. max* (Figure 6) during 4 months in East Kalimantan in the 2016 cropping season is presented in Table 2.

Table 1. Economic analysis of *Arachis hypogaea* as intercropping in an agroforestry system of *Falcataria moluccana* and *Arachis hypogaea* during 4 months in East Kalimantan in the 2016 cropping season

| No. | Cost | Quantity | | Price | | | Total (Rp $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|---|---|
| PRODUCTION COST | | | | | | | |
| Material cost | | | | | | | |
| 1. | *F. moluccana* seedling | 800.00 | units $ha^{-1}$ | Rp | 3,000.00 | $unit^{-1}$ | 2,400,000.00 |
| 2. | *A. hypogaea* seed | 150.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp | 20,000.00 | $kg^{-1}$ | 3,000,000.00 |
| 3. | NPK fertilizer | 100.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp | 15,000.00 | $kg^{-1}$ | 1,500,000.00 |
| 4. | Pesticide | 25.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp | 30,000.00 | $kg^{-1}$ | 750,000.00 |
| 5. | Plastic strings | 1.00 | unit $ha^{-1}$ $cs^{-1}$ | Rp | 30,000.00 | $unit^{-1}$ | 30,000.00 |
| 6. | Gunny sack | 20.00 | units $ha^{-1}$ $cs^{-1}$ | Rp | 2,000.00 | $unit^{-1}$ | 40,000.00 |
| Subtotal | | | | | | | 7,720,000.00 |
| Depreciation cost | | | | | | | |
| 7. | Hoe | 2.00 | units $ha^{-1}$ | Rp | 125,000.00 | $unit^{-1}$ | 20,833.33 |
| 8. | Chopper | 2.00 | units $ha^{-1}$ | Rp | 100,000.00 | $unit^{-1}$ | 16,666.67 |
| 9. | Sickle | 2.00 | units $ha^{-1}$ | Rp | 60,000.00 | $unit^{-1}$ | 10,000.00 |
| 10. | Sprayer | 1.00 | unit $ha^{-1}$ | Rp | 350,000.00 | $unit^{-1}$ | 17,500.00 |
| Subtotal | | | | | | | 65,000.00 |
| Labor cost | | | | | | | |
| 11. | Land preparation | 7.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 700,000.00 |
| 12. | Planting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 600,000.00 |
| 13. | Crop maintenance: | | | | | | |
| | a. Fertilizing | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 400,000.00 |
| | b. Weeding | 5.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 500,000.00 |
| | c. ~~Control p~~Pests and diseases controlling | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 400,000.00 |
| 14. | Harvesting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 600,000.00 |
| Subtotal | | | | | | | 3,200,000.00 |
| TOTAL COST | | | | | | | 10,985,000.00 |
| TOTAL REVENUE | | | | | | | |
| | *A. hypogaea* yield | 1,000.00 | kg $ha^{-1}$ | Rp | 14,000.00 | $kg^{-1}$ | 14,000,000.00 |
| PROFIT | | | | | | | 3,015,000.00 |

Source: Primary data (analyzed).

Figure 3. *Falcataria moluccana.*

Figure 4. *Arachis hypogaea.*

Table 2. Economic analysis of *Glycine max* as intercropping in an agroforestry system of *Anthocephalus cadamba* and *Glycine max* during 4 months in East Kalimantan in the 2016 cropping season

| No. | Cost | Quantity | | Price | | | Total (Rp $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|---|---|
| PRODUCTION COST | | | | | | | |
| Material cost | | | | | | | |
| 1. | *A. cadamba* seedling | 800.00 | units $ha^{-1}$ | Rp | 4,000.00 | $unit^{-1}$ | 3,200,000.00 |
| 2. | *G. max* seed | 150.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp | 15,000.00 | $kg^{-1}$ | 2,250,000.00 |
| 3. | NPK fertilizer | 100.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp | 15,000.00 | $kg^{-1}$ | 1,500,000.00 |
| 4. | Pesticide | 25.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp | 30,000.00 | $kg^{-1}$ | 750,000.00 |
| 5. | Plastic strings | 1.00 | unit $ha^{-1}$ $cs^{-1}$ | Rp | 30,000.00 | $unit^{-1}$ | 30,000.00 |
| 6. | Gunny sack | 12.00 | units $ha^{-1}$ $cs^{-1}$ | Rp | 2,000.00 | $unit^{-1}$ | 24,000.00 |
| Subtotal | | | | | | | 7,754,000.00 |
| Depreciation cost | | | | | | | |
| 7. | Hoe | 2.00 | units $ha^{-1}$ | Rp | 125,000.00 | $unit^{-1}$ | 20,833.33 |
| 8. | Chopper | 2.00 | units $ha^{-1}$ | Rp | 100,000.00 | $unit^{-1}$ | 16,666.67 |
| 9. | Sickle | 2.00 | units $ha^{-1}$ | Rp | 60,000.00 | $unit^{-1}$ | 10,000.00 |
| 10. | Sprayer | 1.00 | unit $ha^{-1}$ | Rp | 350,000.00 | $unit^{-1}$ | 17,500.00 |
| Subtotal | | | | | | | 65,000.00 |
| Labor cost | | | | | | | |
| 11. | Land preparation | 7.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 700,000.00 |
| 12. | Planting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 600,000.00 |
| 13. | Crop maintenance: | | | | | | |
| | a. Fertilizing | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 400,000.00 |
| | b. Weeding | 5.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 500,000.00 |
| | c. ~~Control p~~Pests and diseases controlling | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 400,000.00 |
| 14. | Harvesting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp | 100,000.00 | $day^{-1}$ | 600,000.00 |
| Subtotal | | | | | | | 3,200,000.00 |
| TOTAL COST | | | | | | | 11,019,000.00 |
| TOTAL REVENUE | | | | | | | |
| | *G. max* yield | 500.00 | kg $ha^{-1}$ | Rp | 7.000.00 | $kg^{-1}$ | 3,500,000.00 |
| PROFIT | | | | | | | -7,519,000.00 |

Source: Primary data (analyzed).

Figure 5. *Anthocephalus cadamba*.

Figure 6. *Glycine max*.

Material cost was expended on buying *F. moluccana* seedling, *A. hypogaea* seed, *A. cadamba* seedling, *G. max* seed, and NPK fertilizer. Fertilizer is given to increase soil fertility. In this study, pesticide, plastic strings, and gunny sack were also bought. Material cost for the application of an agroforestry system of *A. cadamba* and *G. max* (Rp7,754,000.00 $ha^{-1}$ $cs^{-1}$) was bigger than that of *F. mollucana* and *A. hypogaea* (Rp7,720,000.00 $ha^{-1}$ $cs^{-1}$). Material cost was difference between the application of an agroforestry system of *F. mollucana* - *A. hypogaea* and *A. cadamba* - *G. max* because of some reasons. Price of *A. cadamba* seedling was more expensive than that of *F. mollucana* seedling, however price of *A. hypogaea* seed was more expensive than that of *G. max.* That two agroforestry systems need gunny sack in different number depends on its yield.

There was no difference between depreciation cost for the application of an agroforestry system of *F. mollucana* - *A. hypogaea* and that of *A. cadamba* - *G. max* because the kind, quantity, and price of equipment were same. There were many kinds of equipment needed to support farm activity. The equipments were hoe, chopper, sickle, and sprayer. The ~~Equipment~~ price of these equipments ~~are~~ was different and it depend~~ed~~s on the material and the quality of the equipment. Technical duration of a equipment is commonly 3 years, however sprayer can be used until 5 years. Depreciation cost in the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems was lower than material cost and labor cost.

The application of that two agroforestry systems expended labor cost in same numbers because those applications are done in the same critical land which have similar soil properties. Many kinds of activities are done in the application of two agroforestry systems of *F. mollucana* - *A. hypogaea* and that of *A. cadamba* - *G. max.* Those activities are land preparation, planting, crop maintenance, and harvesting. Land preparation expended more ~~cost~~ money than the planting activity. Activities of crop maintenance included fertilizing, weeding, and ~~control~~ pests and diseases controlling. Weed control methods significantly affected *A. hypogaea* yield both on the Samnut 10 and MK 373 varieties (Olayinka and Etejere 2015). Crop maintenance needed more cost than harvesting activity because it involved more labor.

Total cost ~~for~~ of the application ~~of an agroforestry system is~~ was ~~for buying~~ material buying, depreciation cost, and labor cost. Total cost for the application of an agroforestry system of *F. mollucana* and *A. hypogaea* (Rp10,985,000.00 $ha^{-1}$ $cs^{-1}$) was smaller than that of *A. cadamba* and *G. max* (Rp11,019,000.00 $ha^{-1}$ $cs^{-1}$). Material cost was different between an agroforestry system of *F. mollucana* - *A. hypogaea* and that of *A. cadamba* - *G. max*, however, depreciation cost and labor cost were same.

In an agroforestry system of *F. moluccana* and *A. hypogaea*, there was no harvesting of *F. moluccana* yield in the first year because the aim of *F. mollucana* planting was ~~aim~~ to rehabilitate the critical lands. Crop maintenance of *F. mollucana* ~~is~~ was done in the ~~next~~ following year~~s~~. There is a possibility ~~if~~ that the harvesting activity is ~~done~~ only to take the economic value of *F. moluccana* timbers. ~~Producer~~ Farmers ~~will~~ can obtain revenue from selling the *F. moluccana* timbers, so ~~if~~ when there is no harvesting, it ~~will~~ means no revenue. Economic potential of *F. moluccana* trees is very high from the aspect of tree growth level.

There were several prior researches measuring the growth level of diameter and height of *F. moluccana* in some plantation systems (Table 3). Sudomo (2007) investigated an agroforestry system of *F. moluccana* and nilam and found that the growth of *F. moluccana* on loamy sand soil is good enough. It was proven by the increasing of height and diameter at 18 months and 24 months. Meanwhile, two best agroforestry systems that could be applied widely in Blitar, East Java Province, are sengon - gliricidia - cassava - stick nut and sengon - coffee - cacao - gliricidia - ginger - stick nut because those systems gave the best sengon diameter growth (Mindawati et al. 2013). The result of study by Swestiani and Purwaningsih (2013) and Wahyudi and Panjaitan (2013) showed that Mean Annual Increment (MAI) of *F. moluccana's* diameter in agroforestry system is wider than in monoculture system. The study by Krisnawati et al. (2011a) in smallholder plantations in Ciamis (West Java Province) recorded the mean diameter and height of *F. moluccana* trees which were younger than 4 years old, older than 5 years (but less than 10 years), and 12 years old of stands. The wide variations in mean diameter and height are probably due to differences in growing conditions, including site quality, altitude, slope, and silvicultural management.

Table 3. An average diameter, a mean height, and Mean Annual Increment (MAI) of *Falcataria moluccana* in some plantation systems

| Researcher (year) | Important findings |
|---|---|
| Sudomo (2007) | Agroforestry system of *F. moluccana* - nilam.<br>*F. moluccana* diameter:<br>- 18 months: 6.85 cm;<br>- 24 months: 9.48 cm.<br>*F. moluccana* height:<br>- 18 months: 5.59 m;<br>- 24 months: 7,28 m. |
| Krisnawati et al. (2011a) | Monoculture system of *F. moluccana*<br>*F. moluccana* diameter:<br>- < 4 years: 3.4 - 16.7 cm;<br>- 5 - 10 years: 8.7 - 40.1 cm;<br>- 12 years: 24.6 - 74 cm.<br>*F. moluccana* height:<br>- < 4 years: 3.9 - 19.6 m;<br>- 5 - 10 years: 9.9 - 27.9 m;<br>- 12 years: 15.3 - 36.2 m. |
| Mindawati et al. (2013) | Agroforestry system of sengon - coffee - gliricidia - cassava - stick nut and sengon - coffee - cacao - gliricidia - ginger - stick nut.<br>*F. moluccana* diameter: 17.2 - 28.6 cm. |
| Swestiani and Purwaningsih (2013) | MAI *F. moluccana* in agroforestry system: 5.25 cm $year^{-1}$. |

**Formatted:** Not Highlight

**Formatted:** Not Highlight

| | |
|---|---|
| | MAI *F. moluccana* in monoculture system: 3,2 cm year$^{-1}$. |
| Wahyudi and Panjaitan (2013) | *F. moluccana* diameter:<br>- Agroforestry system: 3.45 cm year$^{-1}$;<br>- Intensive monoculture system: 3.21 cm year$^{-1}$;<br>- Conventional monoculture system: 1.99 cm year$^{-1}$. |

*A. hypogaea* matures at 90 and 95 days (Najiyati and Danarti 2000) or at between 98 and 105 days (Olayinka and Etejere 2015). There ~~was~~ were differences in *A. hypogaea* yield that obtained in monoculture system in some farm areas, as shown in Table 4. In United States of Amerika, *A. hypogaea* yield is higher than the average yield in tropical Africa. *A. hypogaea* yield of Macan variety in monoculture system is between 1,200 and 1,800 kg ha$^{-1}$ (Najiyati and Danarti 2000). According to Asnah and Natal (2009), *A. hypogaea* farmers in Tagawiti Village, Ile Ape Subdistrict, Lembata District, who own land more than 0.5 ha have bigger profit than those who own land less than 0.5 ha.

Table 4. *Arachis hypogaea* yield of monoculture and agroforestry systems

| Researcher (year) | Farming system | *Arachis hypogaea* yield | Location |
|---|---|---|---|
| Akobundu (1987) | Monoculture system of *A. hypogaea* | 3,000 kg ha$^{-1}$<br>800 kg ha$^{-1}$ | United States of Amerika<br>Africa |
| Najiyati and Danarti (2000) | Monoculture system of *A. hypogaea* | 1,200 - 1,800 kg ha$^{-1}$ | |
| Swestiani and Purwaningsih (2013) | Monoculture system of *A. hypogaea*<br>Agroforestry system of *F. moluccana* and *A. hypogaea* | 1.01 ton ha$^{-1}$<br>0.83 ton ha$^{-1}$ | Ciamis District, West Java Province, Indonesia. |
| Riska (2014) | Monoculture system of *A. hypogaea* | 1,003.96 kg ha$^{-1}$ | Boya Baliase Village, Marawola Subdistrict, Sigi District, Central Sulawesi Province, Indonesia. |
| Widiyanto and Sudomo (2014) | Monoculture system of *A. hypogaea*<br>Agroforestry system of *F. moluccana* and *A. hypogaea* | 1,349.4 kg ha$^{-1}$<br>861 kg ha$^{-1}$ | Raksabaya Village, Cimaragas Subdistrict, Ciamis District, West Java Province, Indonesia. |
| This study (2016) | Agroforestry system of *F. moluccana* and *A. hypogaea* | 1,000.00 kg ha$^{-1}$ | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. |

There were differences in *A. hypogaea* yield in agroforestry system in some locations. In this study, *A. hypogaea* as intercropping in an agroforestry system of *F. mollucana* and *A. hypogaea* could produce yield as much as 1,000.00 kg ha$^{-1}$. The result of this study which was conducted in Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province was higher than the result of studies by Swestiani and Purwaningsih (2013) in Ciamis District, West Java Province and Widiyanto and Sudomo (2014) in Raksabaya Village, Cimaragas Subdistrict, Ciamis District, West Java Province. When the price of *A. hypogaea* yield was Rp14.000,00 kg$^{-1}$, the ~~producer~~ farmer could get potential revenue as much as Rp14,000,000.00 ha$^{-1}$ cs$^{-1}$.

Sudomo (2013) reported that *A. hypogaea* yield decreases in an agroforestry system of *A. hypogaea* and manglid (19.63%) compared to *A. hypogaea* in monoculture system. Similar to Sudomo's study (2013), Swestiani and Purwaningsih (2013), and Widiyanto and Sudomo (2014) also found that *A. hypogaea* yield in monoculture system was higher than that in an agroforestry system of *F. moluccana* and *A. hypogaea*. It was happened ~~because of~~due to the shade of *F. moluccana*~~'s~~ ~~shelter~~ over *A. hypogaea* and ~~there was a~~ the competition ~~between~~ of *F. moluccana* ~~and~~ with *A. hypogaea* in water and nutrition absorption (Widiyanto and Sudomo, 2014). According to Swestiani and Purwaningsih (2013), *F. moluccana*, manglid, and *A. hypogaea* will grow optimally ~~if~~ when the environment factors (duration of sunshine, water, nutrition, $CO_2$, and growth space) are available adequately. The strategy to increase *A. hypogaea* yield is ~~to~~ by ~~increase~~ increasing the ~~wide~~ area width for a ~~*A. hypogaea* farming~~ more intensive~~ly~~ farming and by ~~to~~ expanding the planting area through the arrangement of planting pattern, the use of hybrid varieties, the use of appropriate machines and equipments, and the adequate supply of water (Agriculture Departement 2001 as citied by Hidayat et al. 2004).

Similar to an agroforestry system of *F. moluccana* and *A. hypogaea*, there was no harvesting of *A. cadamba* yield in the first year. However, crop maintenance is continued to be done to rehabilitate the critical lands in the ~~next~~ following years. Reports by Sudarmo (1957) and Lemmens (1993) show an average diameter, a mean height, MAI, and wood production of *A. cadamba* (Tabel 5). The growth rates of both diameter and height of *A. cadamba* in Java are higher than

**Formatted:** Not Highlight

those in South Kalimantan. The wide variations in mean diameter and height are probably due to differences in site quality and owners management practices (Krisnawati et al. 2011b).

Table 5. An average diameter, a mean height, Mean Annual Increment (MAI), and wood production of *Anthocephalus cadamba*

| Researcher (year) | Important findings |
|---|---|
| Sudarmo (1957) | MAI *A. cadamba*:<br>- Age of 9 years in good-quality sites: 20 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 183 $m^3$ $ha^{-1}$;<br>- Age of 9 years in medium-quality sites: 16 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 145 $m^3$ $ha^{-1}$;<br>- Age of 9 years in poor-quality site: 15 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 105 $m^3$ $ha^{-1}$. |
| Lemmens (1993) | *A cadamba*: an average diameter of 65 cm, a mean height of 39 m, wood production 350 $m^3$ $ha^{-1}$. |
| Krisnawati et al. (2011b) | *A. cadamba* diameter at breast height (DBH) < 5 years old: 8 - 18 cm.<br>*A. cadamba* growth > 5 years:<br>- Java: diameter 1.2 - 11.6 cm $year^{-1}$, height 0.8 - 7.9 m $year^{-1}$.<br>- South Kalimantan: diameter 1.2 - 4.8 cm $year^{-1}$, height 0.8 - 3.7 m $year^{-1}$.<br>*A. cadamba* height:<br>- < 10 years old: 19.6 m;<br>- > 10 years old: 17.3 - 30 m. |

The result of study by Dogbe et al. (2013) showed monoculture system of *G. max* produces 509 - 642 kg $ha^{-1}$ yield in Saboba and Chereponi Districts, Northern Region of Ghana. Meanwhile, Zoundji et al. (2015) found that 60.5%, 28.1%, and 11.4% of the soybean ~~producers~~ farmers in Benin had low (< 700 kg $ha^{-1}$), medium (between 700 and 1,000 kg $ha^{-1}$), and high ( > 1,000 kg $ha^{-1}$) yield level, respectively (Table 6). The soybean grain yields obtained after harvest are inferior to 1,000 kg $ha^{-1}$ for the majority of respondents. In this study, the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max* could produce yield as much as 500.00 kg $ha^{-1}$. The selling price of *G. max* yield was Rp7,000.00 $kg^{-1}$, therefore ~~producer~~ the farmers owned revenue of Rp3,500,000.00 $ha^{-1}$ $cs^{-1}$ in the first cropping season. The revenue level is determined by yield quantity and selling price.

Table 6. *Glycine max* yield ~~of~~ on monoculture and agroforestry systems

| Researcher (year) | Plantation system | *Glycine max* yield | Location |
|---|---|---|---|
| Dogbe et al. (2013) | Monoculture system of *G. max* | 509 - 642 kg $ha^{-1}$ | Saboba and Chereponi Districts, Northern Region of Ghana |
| Zoundji et al. (2015) | Monoculture system of *G. max* | 1,000 kg $ha^{-1}$ | Benin |
| This study (2016) | Agroforestry system of *A. cadamba* and *G. max* | 500 kg $ha^{-1}$ | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. |

There are some factors influencinge the level of *G. max* yield such as characteristic of land, quality and quantity of inputs (material, equipment, and labor), cropping practice, climate condition, environment condition, and other factors. Dogbe et al. (2013) explained several factors could account for the low levels of productivity of *G. max* ~~farmers~~ including poor soil health, pest and diseases, unfavourable weather conditions, inadequate and untimely access to agroinputs, equipments, and labor. According to Zoundji et al. (2015), yield level is significantly determined by gender issues. Technical factors such as the use of improved *G. max* varieties, the use of fertilizers, the plant density, and the practice of fallow in the cropping system have significantly and positively determined the level of yields. Constrains to soybean production include mainly inadequate cropping practices.

The application of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* and *A. hypogaea* gave profit as much as Rp3,015,000.00 $ha^{-1}$ $cs^{-1}$. That profit could be increased ~~if~~ when *A. hypogaea* yield is ~~bigger~~ higher than the yield result in the time of the study. That profit was ~~bigger~~ higher than the profit of monoculture system of *A. hypogaea* in Central Java Province, but it was smaller than the profit of that in Gorontalo Province and in Central Sulawesi Province (Table 7). The difference of total cost could be happened because of the difference in input usage and input price. The ~~N~~number and the price of outputs are the determining factors affecting revenue. Meanwhile, profit is determined by total revenue and total cost.

Table 7. Total cost, revenue, and profit of monoculture and agroforestry system of *Arachis hypogaea*

| Researcher (year) | Plantation system | Research location | Total cost (Rp $ha^{-1}$ $cs^{-1}$) | Total revenue (Rp $ha^{-1}$ $cs^{-1}$) | Profit (Rp $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Muklis et al. (2012) | Monoculture system of *A. hypogaea* | Pasar Anom Village, Grabag Subdistrict, Purworejo District, Central Java Province, Indonesia. | 7,402,092 | 9,562,860 | 2,160,769 |
| Riska (2014) | Monoculture system of *A. hypogaea* | Boya Baliase Village, Marawola Subdistrict, Sigi District, Central Sulawesi Province, Indonesia. | 3,688,412 | 15,069,434 | 11,371,022 |
| Boekoesoe and Saleh (2015) | Monoculture system of *A. hypogaea* | Pulahenti Village, Sumalata Subdistrict, West Gorontalo District, Gorontalo Province, Indonesia. | 4,049,003 | 7,600,242 | 3,551,238 |
| This study (2016) | Agroforestry system of *F. moluccana* and *A. hypogaea* | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. | 10,985,000 | 14,000,000 | 3,015,000 |

The ~~Income~~ income from ~~of~~ the application of an agroforestry system of *F. moluccana* and *A. hypogaea* during four months comes only from the selling of *A. hypogaea* yield. However, ~~producer~~ farmer can achieve other income from harvesting ~~of~~ the trees in the ~~next fiveth~~ fifth year. According to Widiyanto and Sudomo (2014), *F. moluccana* has short harvest cycle from 5 to 7 years. The result of study by Siregar et al. (2007) in East Java Province showed that *F. moluccana* is usually harvested after 10 years; however there is a tendency to shorten the harvesting time to 8 years. ~~The bigger *F. moluccana* diameter, the higher *F. moluccana* growth, the bigger income will come.~~The higher income will come as *F. moluccana* grows taller and its stalk diameter gets bigger.

In the first cropping season in the first year, ~~The~~ the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max*~~,~~ ~~in the first year in the first cropping season~~, ~~was not give~~ gives no profit whereas ~~producer~~ the farmer has ~~loss~~ spent as much as Rp7,519,000.00 ha$^{-1}$ cs$^{-1}$. The small revenue and the big cost cause little motivation for farmer to do this system~~the big loss~~. In the first cropping season, the big portion of capital is to buy *A. cadamba* seedling. In the following cropping season, it is not need to buy *A. cadamba* seedling therefore production cost will decrease. ~~If~~ When there ~~is~~ are adequate cropping practices, the *G. max* production will increase.~~,~~ It~~it~~ ~~impacts~~ affects ~~to~~ the increase of the revenue, and there is opportunity to reach the higher profit. The result of this study is similar to the result of the study of Dogbe et al. (2013) ~~study~~ that found the soybean production in Chereponi District, Northern Region of Ghana is not profitable even though it is done by female who are relatively better~~-off~~ than male farmers. On the other hand, ~~Soybean~~ soybean production is ~~however~~ profitable ~~for male farmers~~ in Saboba District which is done by male farmers. ~~but not female farmers.~~

The application of an agroforestry system of *A. cadamba* and *G. max* during four months ~~results~~ gives income only from the selling of *G. max* yield. ~~If~~ When the trees have the best growth of diameter and height, producer could harvest ~~trees~~ them and collects higher income. Logs from tree plantations of *A cadamba* are mostly from young trees with the age of~~d~~ 5-8 years (Hadi et al. 2015). Similar to ~~an~~ the agroforestry system of *F. moluccana* and *A. hypogaea*, this agroforestry system ~~has~~ gives more than a source of income for ~~producer~~ farmers.

The result indicates two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max* are feasible and applicable to rehabilitate the critical lands. Both agroforestry systems give many benefits from the aspect of economy, social, ecology, and conservation. The owner has possibility to manage their small forest more flexibly and effectively especially in yield arrangement and control (Muliawati 2006). Moreover, if both agroforestry systems are reckoned from social aspect, it supplies timber product, provides food-stuff, and creates job opportunities for community. According to Bertomeu (2006), agroforestry systems with wide-spaced trees have the potential of diversifying farm production. The establishment of agroforestry aims to develop the community forest. The application of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* and *A. hypogaea* is profitable in the critical lands. From the aspect of economy, agroforestry system has important role for community life as a source of income (Senoaji 2012), it produces higher economic returns, and it provides other economic profit (Bertomeu 2006).

In the critical land, ~~The~~ the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max*~~,~~ in the first year in the first cropping season~~,~~ is not profitable based on economic analysis~~ in the critical lands~~. However, from the aspect of ecology, agroforestry system ~~could~~ can increase land fertility and environment protection (Senoaji 2012). From the aspect of conservation, both agroforestry systems ~~could~~ can rehabilitate critical land. Another study showed that agroforestry systems with wide-spaced trees have environmental benefits derived from tree planting, including erosion control, soil fertility improvement, and windbreaks (Bertomeu 2006). Conservation benefit is also reported by Labata et al. (2012) who found that the agroforestry systems (mixed multistorey system, taungya agroforestry system, and falcata-coffee multistorey system) have the capacity to store carbon in trees, herbaceous vegetation, litter, and soil. According to their study ~~result~~ in Bukidnon, Philippines, agroforestry systems can store 92 MgC ha$^{-1}$ to 174 MgC ha$^{-1}$ of carbon.

## REFERENCES


Agroudy NE, Mokhtar S, Zaghlol EA, Gebaly ME. 2011. An economic study of the production of soybean in Egypt. Agric. Biol. J. N. Am. 2(2): 221-225.

Akobundu IO. 1987. Weed Science in Tropics, Principles and Practices. Wiley, New York.

Amusat AS, Ademola AO. 2013. Utilisation of soybean in Oniyo community of Oyo State, Nigeria. Global Journal of Science Frontier Research Agriculture and Veterinary 13(7): 6-14.

Asnah, Natal V. 2009. Profit of groundnut farming in Tagawiti Village, Ile Ape Subdistrict, Lembata District. Buana Sains 9(1): 25-30. [Indonesian]

Bertomeu M. 2006. Financial evaluation of smallholder timber-based agroforestry systems in Claveria, Northern Mindanao, the Philippines. Small-scale Forest Economics, Management and Policy 5(1): 57-82.

Boekoesoe Y, Saleh Y. 2015. Cost structure and profitability of groundnut farming in Pulahenti Village, Sumalata Subdistrict, West Gorontalo District. Perspektif Pembiayaan dan Pembangunan Daerah 3(1): 19-26. [Indonesian]

Dogbe W, Etwire PM, Martey E, Etwire JC, Baba IIY, Siise A. 2013. Economics of soybean production: Evidence from Saboba and Chereponi Districts of Northern Region of Ghana. Agricultural Science 5(12): 38-46.

Hadi YS, Rahayu IS, Danu S. 2015. Termite resistance of jabon wood impregnated with methyl methacrylate. Tropical Forest Science 27(1): 25-29.

Hamid A. 2008. The effect of sengon tree pruning to diversity intercrop in agroforestry system of sengon. Buana Sains 8(2): 189-202. [Indonesian]

Hidayat A, Adiningsih ES, Setiawan P. 2004. Analysis of land development for groundnut plant in West Java from landsat data with geografic information system. Penginderaan Jauh dan Pengolahan Data Citra Digital 1(1): 46-50. [Indonesian]

Krisnawati H, Varis E, Kallio M, Kanninen M. 2011a. *Paraserianthes falcataria* (L.) Nielsen. Ecology, Silviculture and Productivity. Center for International Forestry Research (CIFOR), Bogor.

Krisnawati H, Kallio M, Kanninen M. 2011b. *Anthocephalus cadamba* Miq. Ecology, Silviculture and Productivity. Center for International Forestry Research (CIFOR), Bogor.

Labata MM, Aranico EC, Tabaranza ACE, Patricio JHPP, Amparado RF. 2012. Carbon stock assessment of three selected agroforestry systems in Bukidnon, Philippines. Advances in Environmental Sciences 4(1): 5-11.

Mindawati N, Kosasih AS, Bustomi S, Sitompul SM, Tyasmoro SY. 2013. Agroforestry system to increase ecology and agroeconomic functions of social forest. Proceeding of National Seminary on Agroforestry. 189-196. [Indonesian]

Muklis I, Wicaksono IA, Hasanah U. 2012. Analysis of groundnut farming (*Arachis hypogaea* L.) in Pasar Anom Village, Grabag Subdistrict, Purworejo District. Surya Agritama 1(2): 46-56. [Indonesian]

Muliawati A. 2006. Model and Scenario of Sengon Forest Management (*Paraserianthes falcataria* (L.) Nielsen) Small Scale in Pasir Ipis Village, Surade Subdistrict, Sukabumi District. Institut Pertanian Bogor, Bogor. [Indonesian]

Najiyati, Danarti. 2000. Food Crops. Cultivation and Farm Analysis. Penebar Swadaya, Jakarta. [Indonesian]

Nasution K. 2010. Economic analysis of community and forest sustainability in national movement of forest and land rehabilitations in Karo District. Abdi Ilmu 3(2): 415-416. [Indonesian]

Olayinka BU, Etejere EO. 2015. Growth analysis and yield of two varieties of groundnut (*Arachis hypogaea* L.) as influenced by different weed control methods. Ind J Plant Physiol. 20(2): 130-136.

Raja BSL, Damani BSJ, Ginting. 2013. Respon of growth and production groundnuts to organic material *Tithonia diversifolia* and fertilizer SP-36. Agroekoteknologi 1(3): 725-731. [Indonesian]

Riska. 2014. Analysis of production and profit of groundnut farming in Boya Baliase Village, Marawola Subdistrict, Sigi District. Agroland 21(1): 49-54. [Indonesian]

Sembiring M, Sipayung R, Sitepu FE. 2014. Growth and production of groundnuts by giving compost of palm oil bunch at different pile up frequency. Agroekoteknologi 2(2): 598-607. [Indonesian]

Senoaji G. 2012. Land management with agroforestry system by Baduy community in South Banten. Bumi Lestari 12(2): 283-293. [Indonesian]

Seo JW, Kim H, Chun JH, Mansur I, Lee CB. 2015. Silvicultural practice and growth of the jabon tree (*Anthocephalus cadamba* Miq.) in community forests of West Java, Indonesia. Agriculture and Life Science 49(4): 81-93.

Soerianegara I and Lemmens RHMJ. 1993. Plant Resources of South-East Asia 5(1): Timber Trees: Major Commercial Timbers. Pudoc Scientific Publishers, Wageningen, Netherlands.

Sudarmo MK. 1957. Tabel Hasil Sementara *Anthocephalus cadamba* Mig. (jabon). Pengumunan No. 59. Lembaga Penelitian Kehutanan, Bogor, Indonesia.

Sudomo A. 2007. The influence of loamy sand soil on growth of sengon and nilam in agroforestry system. Pemuliaan Tanaman Hutan 1(2): 1-8. [Indonesian]

Sudomo A. 2013. Productivity of groundnut (*Arachis hypogeae* L.) under manglid plantation in agroforestry system. Prosiding Seminar Nasional Agroforestri. 215-221. [Indonesian]

Sudrajat DJ, Siregar IZ, Khumaida N, Siregar UJ, Mansur I. 2015. Adaptability of white jabon (*Anthocephalus cadamba* Miq.) seedling from 12 populations to drought and waterlogging. Agrivita 37(2): 130-143.

Slavin SL. 2009. Economics. McGraw-Hill Irwin, New York.

Swestiani D, Purwaningsih S. 2013. Production of groundnut (*Arachis hypogaea* L.) in agroforestry based sengon and manglid timbers. Agroforestry 1(2): 71-82.

Wahyudi, Panjaitan S. 2013. The comparison of agroforestry system, intensive monoculture, and conventional monoculture in the development of sengon plantation forest. Prosiding Seminar Nasional Agroforestri 165-171. [Indonesian]

Widiyanto A, Sudomo A. 2014. The influence of sengon litter giving (*Paraserianthes falcataria* (L.) Nielsen) to groundnut productivity (*Arachis hypogeae* L.) in agroforestry system. Agroforestry 2(1): 1-12. [Indonesian]

Zoundji CC, Houngnandan P, Dedehouanou H, Toukourou F. 2015. Determinants of soybean [*Glycine max* (L.) Merrill] production system in Benin. Experimental Biology and Agricultural Sciences 3(V): 430-439.

## SUBMISSION CHECKLIST

Ensure that the following items are present:

| The first corresponding author must be accompanied with contact details: | **Give mark (X)** |
|---|---|
| • E-mail address | X |
| • Full postal address (incl street name and number (location), city, postal code, state/province, country) | X |
| • Phone and facsimile numbers (incl country phone code) | X |

All necessary files have been uploaded, and contain:

| | |
|---|---|
| • Keywords | X |
| • Running titles | X |
| • All figure captions | X |
| • All tables (incl title and note/description) | X |

Further considerations

| | |
|---|---|
| • Manuscript has been "spell & grammar-checked" Better, if it is revised by a professional science editor or a native English speaker | X |
| • References are in the correct format for this journal | X |
| • All references mentioned in the Reference list are cited in the text, and vice versa | X |
| • Colored figures are only used if the information in the text may be losing without those images | X |
| • Charts (graphs and diagrams) are drawn in black and white images; use shading to differentiate | X |

## COVERING LETTER

Dear **Editor-in-Chief,**

I herewith enclosed a research article,

**Title:**

Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping in two agroforestry systems

**Author(s) name:**

Karmini, Sri Sarminah, dan Karyati

**Address**

(Fill in your institution's name and address, your personal cellular phone and email)

Department of Agribusiness, Faculty of Agriculture, University of Mulawarman.
Jln. Pasir Balengkong, Kampus Gunung Kelua.
Samarinda, East Kalimantan, Indonesia. 75119.
Hp: 081258194386
email: karmini.kasiman@yahoo.com.

**For possibility publication on the journal:**

(fill in *Biodiversitas* or *Nusantara Bioscience*)

Biodiversitas

**Novelty:**

(state your claimed novelty of the findings versus current knowledge)

This study offers an agroforestry system from economic aspect.

**Statements:**

This manuscript has not been published and is not under consideration for publication to any other journal or any other type of publication (including web hosting) either by me or any of my co-authors.
Author(s) has been read and agree to the Ethical Guidelines.

**List of five potential reviewers**

(Fill in names of five potential reviewers and their **email** address. He/she should have Scopus ID and come from different institution with the authors)

**Place and date:**

Samarinda, 21 November 2016

**Sincerely yours,**

(fill in your name, no need scanned autograph)

KARMINI

# Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping plants in two agroforestry systems

**KARMINI[1♥], SRI SARMINAH[2], KARYATI[3]**

[1]Department of Agribusiness, Faculty of Agriculture, University of Mulawarman, Kampus Gunung Kelua, Jalan Pasir Balengkong, Kampus Gunung Kelua, PO Box 1040, Samarinda, Kalimantan Timur, Indonesia. [♥]email: karmini.kasiman@yahoo.com
[2,3]Faculty of Forestry, University of Mulawarman, Kampus Gunung Kelua, Jalan Ki Hajar Dewantara, Kampus Gunung Kelua, PO Box 1013, Samarinda, Kalimantan Timur, Indonesia.

Manuscript received: 21-11-2016. Revision accepted: ................

## ABSTRACT

**Abstract.** *Karmini, Sri Sarminah, and Karyati. 2017. Economic analysis of groundnut (Arachis hypogaea) and soybean (Glycine max) as intercropping plants in two agroforestry systems. Biodiversitas* .................... An agroforestry is a farming system combining forestry plant and agricultural plant. Two agroforestry systems of sengon (*Falcataria moluccana*) - groundnut (*Arachis hypogaea*) and jabon (*Anthocephalus cadamba)* - soybean (*Glycine max*) have been done and are proven to be successful. The objective of this study was to analyze the application of *A. hypogaea* and *G. max* as intercropping plants in two agroforestry systems from the aspect of economy. The study was conducted from January to May 2016 in Education Forest, Forestry Faculty, Mulawarman University, Samarinda City, East Kalimantan Province, Indonesia. Data analysis was done to calculate cost, revenue, and profit of the application of *A. hypogaea* and *G. max* as intercropping plants in two agroforestry systems. The results ~~of this study~~ indicate that two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max* are feasible and applicable to rehabilitate the critical lands. The application of *A. hypogaea* as intercropping plant in ~~an~~ the agroforestry system of *F. moluccana* and *A. hypogaea* expended total cost as much as Rp10,985,000.00 ha$^{-1}$ cs$^{-1}$, and it obtained total revenue as much as Rp14.000.000,00 ha$^{-1}$ cs$^{-1}$, ~~and~~ so it gave profit as much as Rp3,015,000.00 ha$^{-1}$ cs$^{-1}$. An agroforestry system of *F. moluccana* and *A. hypogaea* gives many benefits from the aspect of economy, social, ecology, and conservation. Total cost, total revenue, and profit of the application of *G. max* as intercropping plant in ~~an~~ the agroforestry system of *A. cadamba* and *G. max*, in the first year in the first cropping season, were Rp11,019,000.00 ha$^{-1}$ cs$^{-1}$; Rp3,500,000.00 ha$^{-1}$ cs$^{-1}$; and Rp-7,519,000.00 ha$^{-1}$ cs$^{-1}$. Although it was not profitable to do in ~~the~~ some critical lands, ~~however~~ it ~~gives~~ gave many benefits from the aspect of ecology and conservation.

**Key words:** Agroforestry, *Arachis hypogaea*, economic analysis, *Glycine max*.

**Abbreviations**: Hectare (ha), kilogram (kg), cropping season (cs), Rupiah (Rp).

**Running title:** Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping plants in two agroforestry systems.

## INTRODUCTION

Agroforesty is a system of farm activities which combines plant or other kinds of forestry plant with agricultural plant. Agroforestry activity could be done at farm area, ~~even~~ inside or outside of forest area. Agroforestry system could be applied at critical land or degraded land. According to Sudomo (2007), an agroforestry is a model of community forest or social forestry which is expected to enable the increase of land productivity per wide area and, in future, it ~~could~~ can increase community welfare. Besides, agroforestry is expected to have positive function in land and in water conservation, since it is applied mostly in degraded areas as an effort to rehabilitate the land.

Agroforestry system uses combination of many kinds of forestry plants with agricultural plants. The ~~Tree~~ tree raises positive effect on the supply of ground water for the intercrops that grow among trees. Besides, shelter gives buffer effect to anticipate the temperature fluctuation and extreme temperature of both ground temperature and atmosphere temperature ~~above~~ of the land (Hamid, 2008). Some previous researches (Barneby and J.W. Grimes) chose sengon (*Falcataria moluccana* (Miq.) ~~Barneby and J.W. Grimes)~~ as ~~a~~ forestry plant in agroforestry system, and combined it with other agricultural plants. The combination of sengon with other plants were ~~such~~ as follows: sengon - nilam (Sudomo 2007), sengon - maize - chili - stick nut (Hamid 2008), sengon - coffee - cacao - gliricidia - maize - ginger - stick nut (Mindawati et al. 2013), groundnut - sengon - manglid (Swestiani and Purwaningsih 2013), sengon - paddy (Wahyudi and Panjaitan 2013), and sengon - groundnut (Widiyanto and Sudomo 2014).

Sudomo (2007) stated that most people like to cultivate *F. moluccana* because it was fast-growing ~~tree~~ and easy breeding, and its timber could be used to make many products such as furniture and firewood, and its leaf could be used as cattle provisions and as compost material. Moreover, *F. moluccana* and nilam are proven to have potential to be cultivated in agroforestry system at Sukamulih Village, Sariwangi Subdistrict, Tasikmalaya District. Meanwhile, the study result of Wahyudi and Panjaitan (2013) indicated superiority of agroforestry system that uses combination of *F. moluccana* and upland paddy. That system becomes the best choice in the development of Industrial Plantation Forest of PT Gunung Meranti, because it gives the best yield rate of *F. moluccana* and upland paddy, creates job opportunities, increases income of local community, grows own feeling on natural resources, creates positive perception to develop the plantation forest and agroforestry, guards the forest security, and decreases the degradation rate of forest. The fact in field shows that most land is in critical and damage condition because ~~in~~ of the continuous effort to fulfill the economic need.~~,~~ To fulfill this need, ~~p~~People ~~has~~ have to contact with nature, so the activity to rehabilitate forest and its surrounding area has potential conflict (Nasution 2010).

According to Sembiring et al. (2014), groundnut (*Arachis hypogaea* L.) is a food commodity that has high economic value. *A. hypogaea* has high nutrition ingredient especially protein and grease. *A. hypogaea* is mostly used as food-stuff and industrial material (Raja et al. 2013). Researches on *A. hypogaea* farming have been done by some researchers such as Hidayat et al. (2004), Muklis et al. (2012), Raja et al. (2013), Riska (2014), Sembiring et al. (2014), and Boekoesoe and Saleh (2015).

Jabon (*Anthocephalus cadamba* (Roxb.) Miq.) is a tropical tree species that is native to South Asia and Southeast Asia, including Indonesia (Krisnawati et al. 2011b). *A. cadamba* is preferred by the local community because it is a fast-growing tree species and has good adaptability to drought and waterlogging stresses (Hadi et al. 2015; Seo et al. 2015; Sudrajat et al. 2015). *A. cadamba* is used in community forests and greening activities such as reforestation programmes, afforestation programmes, rehabilitation activities of waterlogged marginal sites, and replanting the dryer marginal sites. *A. cadamba* has wood for multiple end uses such as plywood, light construction materials, flooring, beams and rafters, boxes and crates, tea-chests, packing cases, shuttering, ceiling boards, toys, wooden shoes, bobbins, yokes, carvings, matches, chopsticks, pencils, canoes, and inexpensive furniture. The pulp of *A. cadamba* for medium quality paper and the fresh leaves are used as ~~fodder~~ cattle fodder or as plates and serviettes (Soerianegara and Lemmens 1993).

Soybean (*Glycine max* (L.) Merrill) is valued as a productive and adaptable crops which fits well into the cropping patterns of varying agro-climatic conditions (Amusat and Ademola 2013). For a long time, ~~Soybean~~ soybean has been a part of traditional food for human population which comes in various forms such as tofu, soy-milk, green vegetable soybeans, tempeh, and soybean oil, and ~~. Also~~also, in its second generation of soy-foods such as soy-nuts, ~~cheese~~ alternatives cheese, and soymilk yogurt. According to Agroudy et al. (2011), the soy oil is one of the ~~most~~ widest spreaded vegetable oils. ~~spread,~~ It ~~where~~ is used directly in food to prevent its consumers from having blood pressure and arteriosclerosis; moreover seeds of soybean contain the highest number of ~~most~~ vitamins that are essential for the body.

The establishment of two agroforestry systems ~~by~~ using *F. moluccana* and *A. cadamba* as forestry plants and *A. hypogaea* and *G. max* as agricultural plants is important to apply because it has high economic potential. The aim of this study was to analyze the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems from the aspect of economy. The result of this study are expected to give~~s~~ information ~~for~~ to businessman, government, stakeholders, and other researchers about cost expenditure, potential revenue, and profit estimation that could be obtained from the application of *A. hypogaea* and *G. max* as intercropping in the two agroforestry systems. Those information are useful to determine ~~how much~~ the capital ~~should be prepared~~ needed to start an ~~begin that~~ agro-business. This study compared two agroforestry systems of *F. moluccana - A. hypogaea* and *A. cadamba - G. max* to offer the best agroforestry system that could be applied in the critical lands.

The sections of this study are organized in the following sequence. First, Materials and methods section explaining~~s~~ the study area, materials and equipments, procedures, and data analysis. The ~~following~~ next section presents the results and includes some discussions. ~~Finally~~The last section is ~~,~~ the conclusion that summarizes findings and offers recommendations.

## MATERIALS AND METHODS

**Study area**

This study was conducted for 4 months from January to May 2016. The experiment was done in Forest Education, Forestry Faculty, Mulawarman University. Experimental plots were located in Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia (Figure 1). There are many previous researches on agroforestry systems in some locations in Indonesia. Some of them did the research on *F. moluccana* in Tasikmalaya District, West Java Province (Sudomo 2007), in East Java Province (Hamid 2008; Mindawati et al. 2013), and in Ciamis District, West Java Province (Sudomo 2013; Swestiani and Purwaningsih 2013; Widiyanto and Sudomo 2014). The study on *A. hypogaea* had been done by some researchers in several provinces in Indonesia. Several *A. hypogaea* studies were located in West Java Province (Hidayat et al. 2004), in Purworejo District, Central Java Province (Muklis et al. 2012), in Medan City, North Sumatera Province (Raja et al. 2013), in Sigi District, Central Sulawesi Province (Riska 2014), in Deli Serdang District, North Sumatera Province (Sembiring et al. 2014), and in West Gorontalo District, Gorontalo Province (Boekoesoe and Saleh 2015). However, the publication of researches about two agroforestry systems of *F. moluccana - A. hypogaea* and *A. cadamba - G. max* in East Kalimantan Province is still limited.

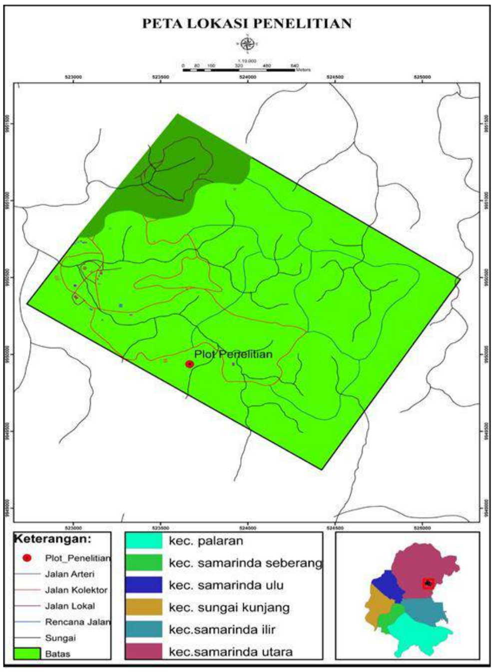



Figure 1. Study location.

**Materials and Equipments**

Some materials were used in this study such as *F. moluccana* seedling, *A. cadamba* seedling, *A. hypogaea* seed, *G. max* seed, NPK fertilizer, pesticide, plastic strings, gunny sack, and other materials. Several equipments were needed to cultivate *F. moluccana*, *A. hypogaea*, *A. cadamba*, and *G. max* such as hoe, chopper, sickle, sprayer, and other equipments.

**Procedures**

Some researchers collected primary data through survey to a number of farmers as respondents to reach their ~~researches~~ aims of research. Siregar et al. (2007) surveyed 40 respondents to analyze the economic value of some agroforestry systems. Asnah and Natal (2009) surveyed 45 respondents to calculate the profit of *A. hypogaea* farm. Others researcher, Muklis et al. (2012), surveyed 26 respondents to analyze the profit of *A. hypogaea* farm. Amusat and Ademola (2013) collected primary data using interview schedules from the 130 selected *G. max* farmers, but only 123 of the schedules were found to be useable. Dogbe et al. (2013) determined 140 *G. max* farmers as enumerators for their study. In addition, Riska (2014) surveyed 30 respondents to analyze the production and profit of *A. hypogaea* farm. Zoundji et al. (2015) selected 324 soybean producers as respondents.

This study was different from those studies above in which primary data for the analysis of economy were collected from on-farm experimental plot established to study two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max*. Experimental researches related to agroforestry had been done by some researchers with different kinds of plant combination. For example, tree - maize (Bertomeu 2006), sengon - nilam (Sudomo 2007), sengon - maize - chili - stick nut (Hamid 2008), sengon - coffee - cacao - gliricidia - maize - ginger - stick nut (Mindawati et al. 2013), groundnut - manglid (Sudomo 2013), groundnut - sengon - manglid (Swestiani and Purwaningsih 2013), sengon - paddy (Wahyudi and Panjaitan 2013), and sengon - groundnut (Widiyanto and Sudomo 2014).

In this study, experimental plot (Figure 2) of *F. moluccana* and *A. hypogaea* had size of 10 m × 10 m per plot with 2 replications or as many as 2 plots. Similar to *F. moluccana* and *A. hypogaea*, experimental plot of *A. cadamba* and *G. max* had the same of size and replication. *F. moluccana* and *A. cadamba* were cultivated with distance of 3 m × 3 m. *A. hypogaea* crops were cultivated among *F. moluccana* trees as intercropping with size of 20 cm x 20 cm. *G. max* crops were also cultivated among *A. cadamba* trees as intercropping with size of 20 cm x 20 cm. The cultivation activities included land preparation, planting, crop maintenance (weeding, fertilizing, and control of pests and diseases), and harvesting. Harvesting activity was only done to gather *A. hypogaea* and *G. max* yields, but no timber harvesting of *F. moluccana* and *A. cadamba* trees.

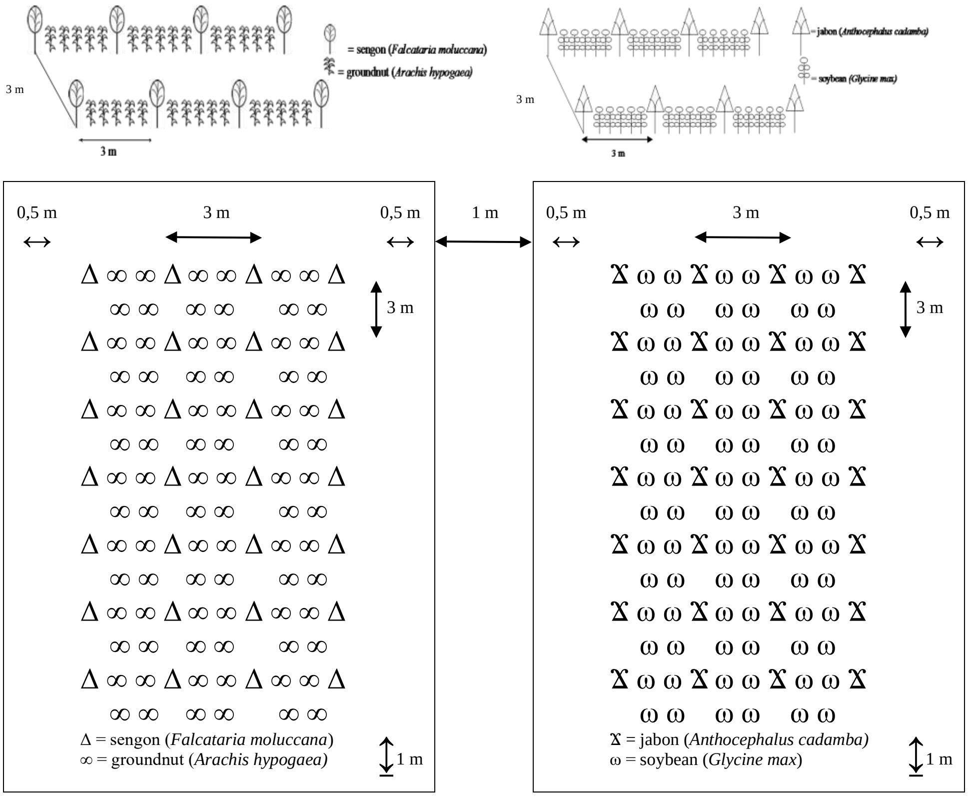



Figure 2. Layout of experimental plots in two agroforestry systems of *Falcataria moluccana - Arachis hypogaea* and *Anthocephalus cadamba - Glycine max.*

**Data analysis**

This study was different from previous study by Bertomeu (2006) which also made experimental plot to collect primary data. Bertomeu (2006) collected primary data to study the financial evaluation of agroforestry systems of tree and maize. However, this study collected primary data to analyze the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems from the aspect of economy. In this study, data were analyzed to calculate cost, revenue, and profit from the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems. Cost is calculated from price and quantity of inputs, thus revenue is price of production yield, and meanwhile profit is revenue minus cost (Slavin 2009). Besides primary data, this study also collected secondary data from the results of previous studies.

## RESULTS AND DISCUSSION

The application of an agroforestry system needs the cost expenditure to buy materials, depreciation of equipment, and wage of labor. Besides cost expenditure, the application of an agroforestry system results revenue and profit. Table 1 shows economic analysis of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* (Figure 3) and *A. hypogaea* (Figure 4) during 4 months in East Kalimantan in the 2016 cropping season. Meanwhile, ~~economic~~ economic analysis of *G. max* as intercropping in an agroforestry system of *A. cadamba* (Figure 5) and *G. max* (Figure 6) during 4 months in East Kalimantan in the 2016 cropping season is presented in Table 2.

Table 1. Economic analysis of *Arachis hypogaea* as intercropping in an agroforestry system of *Falcataria moluccana* and *Arachis hypogaea* during 4 months in East Kalimantan in the 2016 cropping season

| No. | Cost | Quantity | | | Price | | Total (Rp ha$^{-1}$ cs$^{-1}$) |
|---|---|---|---|---|---|---|---|
| PRODUCTION COST | | | | | | | |
| Material cost | | | | | | | |
| 1. | *F. moluccana* seedling | 800.00 | units ha$^{-1}$ | Rp | 3,000.00 | unit$^{-1}$ | 2,400,000.00 |
| 2. | *A. hypogaea* seed | 150.00 | kg ha$^{-1}$ cs$^{-1}$ | Rp | 20,000.00 | kg$^{-1}$ | 3,000,000.00 |
| 3. | NPK fertilizer | 100.00 | kg ha$^{-1}$ cs$^{-1}$ | Rp | 15,000.00 | kg$^{-1}$ | 1,500,000.00 |
| 4. | Pesticide | 25.00 | kg ha$^{-1}$ cs$^{-1}$ | Rp | 30,000.00 | kg$^{-1}$ | 750,000.00 |
| 5. | Plastic strings | 1.00 | unit ha$^{-1}$ cs$^{-1}$ | Rp | 30,000.00 | unit$^{-1}$ | 30,000.00 |
| 6. | Gunny sack | 20.00 | units ha$^{-1}$ cs$^{-1}$ | Rp | 2,000.00 | unit$^{-1}$ | 40,000.00 |
| Subtotal | | | | | | | 7,720,000.00 |
| Depreciation cost | | | | | | | |
| 7. | Hoe | 2.00 | units ha$^{-1}$ | Rp | 125,000.00 | unit$^{-1}$ | 20,833.33 |
| 8. | Chopper | 2.00 | units ha$^{-1}$ | Rp | 100,000.00 | unit$^{-1}$ | 16,666.67 |
| 9. | Sickle | 2.00 | units ha$^{-1}$ | Rp | 60,000.00 | unit$^{-1}$ | 10,000.00 |
| 10. | Sprayer | 1.00 | unit ha$^{-1}$ | Rp | 350,000.00 | unit$^{-1}$ | 17,500.00 |
| Subtotal | | | | | | | 65,000.00 |
| Labor cost | | | | | | | |
| 11. | Land preparation | 7.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 700,000.00 |
| 12. | Planting | 6.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 600,000.00 |
| 13. | Crop maintenance: | | | | | | |
| | a. Fertilizing | 4.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 400,000.00 |
| | b. Weeding | 5.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 500,000.00 |
| | c. ~~Control p~~Pests and diseases controlling | 4.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 400,000.00 |
| 14. | Harvesting | 6.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 600,000.00 |
| Subtotal | | | | | | | 3,200,000.00 |
| TOTAL COST | | | | | | | 10,985,000.00 |
| TOTAL REVENUE | | | | | | | |
| | *A. hypogaea* yield | 1,000.00 | kg ha$^{-1}$ | Rp | 14,000.00 | kg$^{-1}$ | 14,000,000.00 |
| PROFIT | | | | | | | 3,015,000.00 |

Source: Primary data (analyzed).

Figure 3. *Falcataria moluccana.*

Figure 4. *Arachis hypogaea.*

Table 2. Economic analysis of *Glycine max* as intercropping in an agroforestry system of *Anthocephalus cadamba* and *Glycine max* during 4 months in East Kalimantan in the 2016 cropping season

| No. | Cost | Quantity | | Price | | | Total (Rp ha$^{-1}$ cs$^{-1}$) |
|---|---|---|---|---|---|---|---|
| PRODUCTION COST | | | | | | | |
| Material cost | | | | | | | |
| 1. | *A. cadamba* seedling | 800.00 | units ha$^{-1}$ | Rp | 4,000.00 | unit$^{-1}$ | 3,200,000.00 |
| 2. | *G. max* seed | 150.00 | kg ha$^{-1}$ cs$^{-1}$ | Rp | 15,000.00 | kg$^{-1}$ | 2,250,000.00 |
| 3. | NPK fertilizer | 100.00 | kg ha$^{-1}$ cs$^{-1}$ | Rp | 15,000.00 | kg$^{-1}$ | 1,500,000.00 |
| 4. | Pesticide | 25.00 | kg ha$^{-1}$ cs$^{-1}$ | Rp | 30,000.00 | kg$^{-1}$ | 750,000.00 |
| 5. | Plastic strings | 1.00 | unit ha$^{-1}$ cs$^{-1}$ | Rp | 30,000.00 | unit$^{-1}$ | 30,000.00 |
| 6. | Gunny sack | 12.00 | units ha$^{-1}$ cs$^{-1}$ | Rp | 2,000.00 | unit$^{-1}$ | 24,000.00 |
| Subtotal | | | | | | | 7,754,000.00 |
| Depreciation cost | | | | | | | |
| 7. | Hoe | 2.00 | units ha$^{-1}$ | Rp | 125,000.00 | unit$^{-1}$ | 20,833.33 |
| 8. | Chopper | 2.00 | units ha$^{-1}$ | Rp | 100,000.00 | unit$^{-1}$ | 16,666.67 |
| 9. | Sickle | 2.00 | units ha$^{-1}$ | Rp | 60,000.00 | unit$^{-1}$ | 10,000.00 |
| 10. | Sprayer | 1.00 | unit ha$^{-1}$ | Rp | 350,000.00 | unit$^{-1}$ | 17,500.00 |
| Subtotal | | | | | | | 65,000.00 |
| Labor cost | | | | | | | |
| 11. | Land preparation | 7.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 700,000.00 |
| 12. | Planting | 6.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 600,000.00 |
| 13. | Crop maintenance: | | | | | | |
| | a. Fertilizing | 4.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 400,000.00 |
| | b. Weeding | 5.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 500,000.00 |
| | c. ~~Control p~~Pests and diseases controlling | 4.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 400,000.00 |
| 14. | Harvesting | 6.00 | days ha$^{-1}$ cs$^{-1}$ | Rp | 100,000.00 | day$^{-1}$ | 600,000.00 |
| Subtotal | | | | | | | 3,200,000.00 |
| TOTAL COST | | | | | | | 11,019,000.00 |
| TOTAL REVENUE | | | | | | | |
| | *G. max* yield | 500.00 | kg ha$^{-1}$ | Rp | 7.000.00 | kg$^{-1}$ | 3,500,000.00 |
| PROFIT | | | | | | | -7,519,000.00 |

Source: Primary data (analyzed).

Figure 5. *Anthocephalus cadamba*.

Figure 6. *Glycine max*.

Material cost was expended on buying *F. moluccana* seedling, *A. hypogaea* seed, *A. cadamba* seedling, *G. max* seed, and NPK fertilizer. Fertilizer is given to increase soil fertility. In this study, pesticide, plastic strings, and gunny sack were also bought. Material cost for the application of an agroforestry system of *A. cadamba* and *G. max* (Rp7,754,000.00 ha$^{-1}$ cs$^{-1}$) was bigger than that of *F. mollucana* and *A. hypogaea* (Rp7,720,000.00 ha$^{-1}$ cs$^{-1}$). Material cost was difference between the application of an agroforestry system of *F. mollucana* - *A. hypogaea* and *A. cadamba* - *G. max* because of some reasons. Price of *A. cadamba* seedling was more expensive than that of *F. mollucana* seedling, however price of *A. hypogaea* seed was more expensive than that of *G. max.* That two agroforestry systems need gunny sack in different number depends on its yield.

There was no difference between depreciation cost for the application of an agroforestry system of *F. mollucana* - *A. hypogaea* and that of *A. cadamba* - *G. max* because the kind, quantity, and price of equipment were same. There were many kinds of equipment needed to support farm activity. The equipments were hoe, chopper, sickle, and sprayer. The ~~Equipment~~ price of these equipments ~~are~~ was different and it depended~~s~~ on the material and the quality of the equipment. Technical duration of a equipment is commonly 3 years, however sprayer can be used until 5 years. Depreciation cost in the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems was lower than material cost and labor cost.

The application of that two agroforestry systems expended labor cost in same numbers because those applications are done in the same critical land which have similar soil properties. Many kinds of activities are done in the application of two agroforestry systems of *F. mollucana* - *A. hypogaea* and that of *A. cadamba* - *G. max.* Those activities are land preparation, planting, crop maintenance, and harvesting. Land preparation expended more ~~cost~~ money than the planting activity. Activities of crop maintenance included fertilizing, weeding, and ~~control~~ pests and diseases controlling. Weed control methods significantly affected *A. hypogaea* yield both on the Samnut 10 and MK 373 varieties (Olayinka and Etejere 2015). Crop maintenance needed more cost than harvesting activity because it involved more labor.

Total cost ~~for~~ of the application ~~of an agroforestry system is~~ was ~~for buying~~ material buying, depreciation cost, and labor cost. Total cost for the application of an agroforestry system of *F. mollucana* and *A. hypogaea* (Rp10,985,000.00 ha$^{-1}$ cs$^{-1}$) was smaller than that of *A. cadamba* and *G. max* (Rp11,019,000.00 ha$^{-1}$ cs$^{-1}$). Material cost was different between an agroforestry system of *F. mollucana* - *A. hypogaea* and that of *A. cadamba* - *G. max*, however, depreciation cost and labor cost were same.

In an agroforestry system of *F. moluccana* and *A. hypogaea*, there was no harvesting of *F. moluccana* yield in the first year because the aim of *F. mollucana* planting was ~~aim~~ to rehabilitate the critical lands. Crop maintenance of *F. mollucana* ~~is~~ was done in the ~~next~~ following year~~s~~. There is a possibility ~~if~~ that the harvesting activity is ~~done~~ only to take the economic value of *F. moluccana* timbers. ~~Producer~~ Farmers ~~will~~ can obtain revenue from selling the *F. moluccana* timbers, so ~~if~~ when there is no harvesting, it ~~will~~ means no revenue. Economic potential of *F. moluccana* trees is very high from the aspect of tree growth level.

There were several prior researches measuring the growth level of diameter and height of *F. moluccana* in some plantation systems (Table 3). Sudomo (2007) investigated an agroforestry system of *F. moluccana* and nilam and found that the growth of *F. moluccana* on loamy sand soil is good enough. It was proven by the increasing of height and diameter at 18 months and 24 months. Meanwhile, two best agroforestry systems that could be applied widely in Blitar, East Java Province, are sengon - coffee - gliricidia - cassava - stick nut and sengon - coffee - cacao - gliricidia - ginger - stick nut because those systems gave the best sengon diameter growth (Mindawati et al. 2013). The result of study by Swestiani and Purwaningsih (2013) and Wahyudi and Panjaitan (2013) showed that Mean Annual Increment (MAI) of *F. moluccana's* diameter in agroforestry system is wider than in monoculture system. The study by Krisnawati et al. (2011a) in smallholder plantations in Ciamis (West Java Province) recorded the mean diameter and height of *F. moluccana* trees which were younger than 4 years old, older than 5 years (but less than 10 years), and 12 years old of stands. The wide variations in mean diameter and height are probably due to differences in growing conditions, including site quality, altitude, slope, and silvicultural management.

Table 3. An average diameter, a mean height, and Mean Annual Increment (MAI) of *Falcataria moluccana* in some plantation systems

| Researcher (year) | Important findings |
|---|---|
| Sudomo (2007) | Agroforestry system of *F. moluccana* - nilam.<br>*F. moluccana* diameter:<br>- 18 months: 6.85 cm;<br>- 24 months: 9.48 cm.<br>*F. moluccana* height:<br>- 18 months: 5.59 m;<br>- 24 months: 7,28 m. |
| Krisnawati et al. (2011a) | Monoculture system of *F. moluccana*<br>*F. moluccana* diameter:<br>- < 4 years: 3.4 - 16.7 cm;<br>- 5 - 10 years: 8.7 - 40.1 cm;<br>- 12 years: 24.6 - 74 cm.<br>*F. moluccana* height:<br>- < 4 years: 3.9 - 19.6 m;<br>- 5 - 10 years: 9.9 - 27.9 m;<br>- 12 years: 15.3 - 36.2 m. |
| Mindawati et al. (2013) | Agroforestry system of sengon - coffee - gliricidia - cassava - stick nut and sengon - coffee - cacao - gliricidia - ginger - stick nut.<br>*F. moluccana* diameter: 17.2 - 28.6 cm. |
| Swestiani and Purwaningsih (2013) | MAI *F. moluccana* in agroforestry system: 5.25 cm year$^{-1}$. |

**Formatted:** Not Highlight

**Formatted:** Not Highlight

| | |
|---|---|
| | MAI *F. moluccana* in monoculture system: 3,2 cm year$^{-1}$. |
| Wahyudi and Panjaitan (2013) | *F. moluccana* diameter:<br>- Agroforestry system: 3.45 cm year$^{-1}$;<br>- Intensive monoculture system: 3.21 cm year$^{-1}$;<br>- Conventional monoculture system: 1.99 cm year$^{-1}$. |

*A. hypogaea* matures at 90 and 95 days (Najiyati and Danarti 2000) or at between 98 and 105 days (Olayinka and Etejere 2015). There ~~was~~ were differences in *A. hypogaea* yield that obtained in monoculture system in some farm areas, as shown in Table 4. In United States of Amerika, *A. hypogaea* yield is higher than the average yield in tropical Africa. *A. hypogaea* yield of Macan variety in monoculture system is between 1,200 and 1,800 kg ha$^{-1}$ (Najiyati and Danarti 2000). According to Asnah and Natal (2009), *A. hypogaea* farmers in Tagawiti Village, Ile Ape Subdistrict, Lembata District, who own land more than 0.5 ha have bigger profit than those who own land less than 0.5 ha.

Table 4. *Arachis hypogaea* yield of monoculture and agroforestry systems

| Researcher (year) | Farming system | *Arachis hypogaea* yield | Location |
|---|---|---|---|
| Akobundu (1987) | Monoculture system of *A. hypogaea* | 3,000 kg ha$^{-1}$<br>800 kg ha$^{-1}$ | United States of Amerika<br>Africa |
| Najiyati and Danarti (2000) | Monoculture system of *A. hypogaea* | 1,200 - 1,800 kg ha$^{-1}$ | |
| Swestiani and Purwaningsih (2013) | Monoculture system of *A. hypogaea*<br>Agroforestry system of *F. moluccana* and *A. hypogaea* | 1.01 ton ha$^{-1}$<br>0.83 ton ha$^{-1}$ | Ciamis District, West Java Province, Indonesia. |
| Riska (2014) | Monoculture system of *A. hypogaea* | 1,003.96 kg ha$^{-1}$ | Boya Baliase Village, Marawola Subdistrict, Sigi District, Central Sulawesi Province, Indonesia. |
| Widiyanto and Sudomo (2014) | Monoculture system of *A. hypogaea*<br>Agroforestry system of *F. moluccana* and *A. hypogaea* | 1,349.4 kg ha$^{-1}$<br>861 kg ha$^{-1}$ | Raksabaya Village, Cimaragas Subdistrict, Ciamis District, West Java Province, Indonesia. |
| This study (2016) | Agroforestry system of *F. moluccana* and *A. hypogaea* | 1,000.00 kg ha$^{-1}$ | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. |

There were differences in *A. hypogaea* yield in agroforestry system in some locations. In this study, *A. hypogaea* as intercropping in an agroforestry system of *F. mollucana* and *A. hypogaea* could produce yield as much as 1,000.00 kg ha$^{-1}$. The result of this study which was conducted in Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province was higher than the result of studies by Swestiani and Purwaningsih (2013) in Ciamis District, West Java Province and Widiyanto and Sudomo (2014) in Raksabaya Village, Cimaragas Subdistrict, Ciamis District, West Java Province. When the price of *A. hypogaea* yield was Rp14.000,00 kg$^{-1}$, the ~~producer~~ farmer could get potential revenue as much as Rp14,000,000.00 ha$^{-1}$ cs$^{-1}$.

Sudomo (2013) reported that *A. hypogaea* yield decreases in an agroforestry system of *A. hypogaea* and manglid (19.63%) compared to *A. hypogaea* in monoculture system. Similar to Sudomo's study (2013), Swestiani and Purwaningsih (2013), and Widiyanto and Sudomo (2014) also found that *A. hypogaea* yield in monoculture system was higher than that in an agroforestry system of *F. moluccana* and *A. hypogaea*. It was happened ~~because of~~due to the shade of *F. moluccana*~~'s~~ ~~shelter~~ over *A. hypogaea* and ~~there was a~~ the competition ~~between~~ of *F. moluccana* ~~and~~ with *A. hypogaea* in water and nutrition absorption (Widiyanto and Sudomo, 2014). According to Swestiani and Purwaningsih (2013), *F. moluccana*, manglid, and *A. hypogaea* will grow optimally ~~if~~ when the environment factors (duration of sunshine, water, nutrition, $CO_2$, and growth space) are available adequately. The strategy to increase *A. hypogaea* yield is ~~to~~ by ~~increase~~ increasing the ~~wide~~ area width for a ~~*A. hypogaea* farming~~ more intensive~~ly~~ farming and by ~~to~~ expanding the planting area through the arrangement of planting pattern, the use of hybrid varieties, the use of appropriate machines and equipments, and the adequate supply of water (Agriculture Departement 2001 as citied by Hidayat et al. 2004).

Similar to an agroforestry system of *F. moluccana* and *A. hypogaea*, there was no harvesting of *A. cadamba* yield in the first year. However, crop maintenance is continued to be done to rehabilitate the critical lands in the ~~next~~ following years. Reports by Sudarmo (1957) and Lemmens (1993) show an average diameter, a mean height, MAI, and wood production of *A. cadamba* (Tabel 5). The growth rates of both diameter and height of *A. cadamba* in Java are higher than

**Formatted:** Not Highlight

those in South Kalimantan. The wide variations in mean diameter and height are probably due to differences in site quality and owners management practices (Krisnawati et al. 2011b).

Table 5. An average diameter, a mean height, Mean Annual Increment (MAI), and wood production of *Anthocephalus cadamba*

| Researcher (year) | Important findings |
|---|---|
| Sudarmo (1957) | MAI *A. cadamba*:<br>- Age of 9 years in good-quality sites: 20 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 183 $m^3$ $ha^{-1}$;<br>- Age of 9 years in medium-quality sites: 16 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 145 $m^3$ $ha^{-1}$;<br>- Age of 9 years in poor-quality site: 15 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 105 $m^3$ $ha^{-1}$. |
| Lemmens (1993) | *A cadamba*: an average diameter of 65 cm, a mean height of 39 m, wood production 350 $m^3$ $ha^{-1}$. |
| Krisnawati et al. (2011b) | *A. cadamba* diameter at breast height (DBH) < 5 years old: 8 - 18 cm.<br>*A. cadamba* growth > 5 years:<br>- Java: diameter 1.2 - 11.6 cm $year^{-1}$, height 0.8 - 7.9 m $year^{-1}$.<br>- South Kalimantan: diameter 1.2 - 4.8 cm $year^{-1}$, height 0.8 - 3.7 m $year^{-1}$.<br>*A. cadamba* height:<br>- < 10 years old: 19.6 m;<br>- > 10 years old: 17.3 - 30 m. |

The result of study by Dogbe et al. (2013) showed monoculture system of *G. max* produces 509 - 642 kg $ha^{-1}$ yield in Saboba and Chereponi Districts, Northern Region of Ghana. Meanwhile, Zoundji et al. (2015) found that 60.5%, 28.1%, and 11.4% of the soybean ~~producers~~ farmers in Benin had low (< 700 kg $ha^{-1}$), medium (between 700 and 1,000 kg $ha^{-1}$), and high ( > 1,000 kg $ha^{-1}$) yield level, respectively (Table 6). The soybean grain yields obtained after harvest are inferior to 1,000 kg $ha^{-1}$ for the majority of respondents. In this study, the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max* could produce yield as much as 500.00 kg $ha^{-1}$. The selling price of *G. max* yield was Rp7,000.00 $kg^{-1}$, therefore ~~producer~~ the farmers owned revenue of Rp3,500,000.00 $ha^{-1}$ $cs^{-1}$ in the first cropping season. The revenue level is determined by yield quantity and selling price.

Table 6. *Glycine max* yield ~~of~~ on monoculture and agroforestry systems

| Researcher (year) | Plantation system | *Glycine max* yield | Location |
|---|---|---|---|
| Dogbe et al. (2013) | Monoculture system of *G. max* | 509 - 642 kg $ha^{-1}$ | Saboba and Chereponi Districts, Northern Region of Ghana |
| Zoundji et al. (2015) | Monoculture system of *G. max* | 1,000 kg $ha^{-1}$ | Benin |
| This study (2016) | Agroforestry system of *A. cadamba* and *G. max* | 500 kg $ha^{-1}$ | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. |

There are some factors influencinge the level of *G. max* yield such as characteristic of land, quality and quantity of inputs (material, equipment, and labor), cropping practice, climate condition, environment condition, and other factors. Dogbe et al. (2013) explained several factors could account for the low levels of productivity of *G. max* ~~farmers~~ including poor soil health, pest and diseases, unfavourable weather conditions, inadequate and untimely access to agroinputs, equipments, and labor. According to Zoundji et al. (2015), yield level is significantly determined by gender issues. Technical factors such as the use of improved *G. max* varieties, the use of fertilizers, the plant density, and the practice of fallow in the cropping system have significantly and positively determined the level of yields. Constrains to soybean production include mainly inadequate cropping practices.

The application of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* and *A. hypogaea* gave profit as much as Rp3,015,000.00 $ha^{-1}$ $cs^{-1}$. That profit could be increased ~~if~~ when *A. hypogaea* yield is ~~bigger~~ higher than the yield result in the time of the study. That profit was ~~bigger~~ higher than the profit of monoculture system of *A. hypogaea* in Central Java Province, but it was smaller than the profit of that in Gorontalo Province and in Central Sulawesi Province (Table 7). The difference of total cost could be happened because of the difference in input usage and input price. The ~~N~~number and the price of outputs are the determining factors affecting revenue. Meanwhile, profit is determined by total revenue and total cost.

Table 7. Total cost, revenue, and profit of monoculture and agroforestry system of *Arachis hypogaea*

| Researcher (year) | Plantation system | Research location | Total cost (Rp $ha^{-1}$ $cs^{-1}$) | Total revenue (Rp $ha^{-1}$ $cs^{-1}$) | Profit (Rp $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Muklis et al. (2012) | Monoculture system of *A. hypogaea* | Pasar Anom Village, Grabag Subdistrict, Purworejo District, Central Java Province, Indonesia. | 7,402,092 | 9,562,860 | 2,160,769 |
| Riska (2014) | Monoculture system of *A. hypogaea* | Boya Baliase Village, Marawola Subdistrict, Sigi District, Central Sulawesi Province, Indonesia. | 3,688,412 | 15,069,434 | 11,371,022 |
| Boekoesoe and Saleh (2015) | Monoculture system of *A. hypogaea* | Pulahenti Village, Sumalata Subdistrict, West Gorontalo District, Gorontalo Province, Indonesia. | 4,049,003 | 7,600,242 | 3,551,238 |
| This study (2016) | Agroforestry system of *F. moluccana* and *A. hypogaea* | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. | 10,985,000 | 14,000,000 | 3,015,000 |

The ~~Income~~ income from ~~of~~ the application of an agroforestry system of *F. moluccana* and *A. hypogaea* during four months comes only from the selling of *A. hypogaea* yield. However, ~~producer~~ farmer can achieve other income from harvesting ~~of~~ the trees in the ~~next fiveth~~ fifth year. According to Widiyanto and Sudomo (2014), *F. moluccana* has short harvest cycle from 5 to 7 years. The result of study by Siregar et al. (2007) in East Java Province showed that *F. moluccana* is usually harvested after 10 years; however there is a tendency to shorten the harvesting time to 8 years. ~~The bigger *F. moluccana* diameter, the higher *F. moluccana* growth, the bigger income will come.~~The higher income will come as *F. moluccana* grows taller and its stalk diameter gets bigger.

In the first cropping season in the first year, ~~The~~ the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max*~~,~~ ~~in the first year in the first cropping season~~, ~~was not give~~ gives no profit whereas ~~producer~~ the farmer has ~~loss~~ spent as much as Rp7,519,000.00 ha$^{-1}$ cs$^{-1}$. The small revenue and the big cost cause little motivation for farmer to do this system~~the big loss~~. In the first cropping season, the big portion of capital is to buy *A. cadamba* seedling. In the following cropping season, it is not need to buy *A. cadamba* seedling therefore production cost will decrease. ~~If~~ When there ~~is~~ are adequate cropping practices, the *G. max* production will increase.~~,~~ It~~it~~ ~~impacts~~ affects ~~to~~ the increase of the revenue, and there is opportunity to reach the higher profit. The result of this study is similar to the result of the study of Dogbe et al. (2013) ~~study~~ that found the soybean production in Chereponi District, Northern Region of Ghana is not profitable even though it is done by female who are relatively better~~-off~~ than male farmers. On the other hand, ~~Soybean~~ soybean production is ~~however~~ profitable ~~for male farmers~~ in Saboba District which is done by male farmers. ~~but not female farmers.~~

The application of an agroforestry system of *A. cadamba* and *G. max* during four months ~~results~~ gives income only from the selling of *G. max* yield. ~~If~~ When the trees have the best growth of diameter and height, producer could harvest ~~trees~~ them and collects higher income. Logs from tree plantations of *A cadamba* are mostly from young trees with the age of~~d~~ 5-8 years (Hadi et al. 2015). Similar to ~~an~~ the agroforestry system of *F. moluccana* and *A. hypogaea*, this agroforestry system ~~has~~ gives more than a source of income for~~producer~~ farmers.

The result indicates two agroforestry systems of *F. moluccana* - *A. hypogaea* and *A. cadamba* - *G. max* are feasible and applicable to rehabilitate the critical lands. Both agroforestry systems give many benefits from the aspect of economy, social, ecology, and conservation. The owner has possibility to manage their small forest more flexibly and effectively especially in yield arrangement and control (Muliawati 2006). Moreover, if both agroforestry systems are reckoned from social aspect, it supplies timber product, provides food-stuff, and creates job opportunities for community. According to Bertomeu (2006), agroforestry systems with wide-spaced trees have the potential of diversifying farm production. The establishment of agroforestry aims to develop the community forest. The application of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* and *A. hypogaea* is profitable in the critical lands. From the aspect of economy, agroforestry system has important role for community life as a source of income (Senoaji 2012), it produces higher economic returns, and it provides other economic profit (Bertomeu 2006).

In the critical land, ~~The~~ the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max*~~,~~ in the first year in the first cropping season~~,~~ is not profitable based on economic analysis~~ in the critical lands~~. However, from the aspect of ecology, agroforestry system ~~could~~ can increase land fertility and environment protection (Senoaji 2012). From the aspect of conservation, both agroforestry systems ~~could~~ can rehabilitate critical land. Another study showed that agroforestry systems with wide-spaced trees have environmental benefits derived from tree planting, including erosion control, soil fertility improvement, and windbreaks (Bertomeu 2006). Conservation benefit is also reported by Labata et al. (2012) who found that the agroforestry systems (mixed multistorey system, taungya agroforestry system, and falcata-coffee multistorey system) have the capacity to store carbon in trees, herbaceous vegetation, litter, and soil. According to their study ~~result~~ in Bukidnon, Philippines, agroforestry systems can store 92 MgC $ha^{-1}$ to 174 MgC $ha^{-1}$ of carbon.

## REFERENCES


Agroudy NE, Mokhtar S, Zaghlol EA, Gebaly ME. 2011. An economic study of the production of soybean in Egypt. Agric. Biol. J. N. Am. 2(2): 221-225.

Akobundu IO. 1987. Weed Science in Tropics, Principles and Practices. Wiley, New York.

Amusat AS, Ademola AO. 2013. Utilisation of soybean in Oniyo community of Oyo State, Nigeria. Global Journal of Science Frontier Research Agriculture and Veterinary 13(7): 6-14.

Asnah, Natal V. 2009. Profit of groundnut farming in Tagawiti Village, Ile Ape Subdistrict, Lembata District. Buana Sains 9(1): 25-30. [Indonesian]

Bertomeu M. 2006. Financial evaluation of smallholder timber-based agroforestry systems in Claveria, Northern Mindanao, the Philippines. Small-scale Forest Economics, Management and Policy 5(1): 57-82.

Boekoesoe Y, Saleh Y. 2015. Cost structure and profitability of groundnut farming in Pulahenti Village, Sumalata Subdistrict, West Gorontalo District. Perspektif Pembiayaan dan Pembangunan Daerah 3(1): 19-26. [Indonesian]

Dogbe W, Etwire PM, Martey E, Etwire JC, Baba IIY, Siise A. 2013. Economics of soybean production: Evidence from Saboba and Chereponi Districts of Northern Region of Ghana. Agricultural Science 5(12): 38-46.

Hadi YS, Rahayu IS, Danu S. 2015. Termite resistance of jabon wood impregnated with methyl methacrylate. Tropical Forest Science 27(1): 25-29.

Hamid A. 2008. The effect of sengon tree pruning to diversity intercrop in agroforestry system of sengon. Buana Sains 8(2): 189-202. [Indonesian]

Hidayat A, Adiningsih ES, Setiawan P. 2004. Analysis of land development for groundnut plant in West Java from landsat data with geografic information system. Penginderaan Jauh dan Pengolahan Data Citra Digital 1(1): 46-50. [Indonesian]

Krisnawati H, Varis E, Kallio M, Kanninen M. 2011a. *Paraserianthes falcataria* (L.) Nielsen. Ecology, Silviculture and Productivity. Center for International Forestry Research (CIFOR), Bogor.

Krisnawati H, Kallio M, Kanninen M. 2011b. *Anthocephalus cadamba* Miq. Ecology, Silviculture and Productivity. Center for International Forestry Research (CIFOR), Bogor.

Labata MM, Aranico EC, Tabaranza ACE, Patricio JHPP, Amparado RF. 2012. Carbon stock assessment of three selected agroforestry systems in Bukidnon, Philippines. Advances in Environmental Sciences 4(1): 5-11.

Mindawati N, Kosasih AS, Bustomi S, Sitompul SM, Tyasmoro SY. 2013. Agroforestry system to increase ecology and agroeconomic functions of social forest. Proceeding of National Seminary on Agroforestry. 189-196. [Indonesian]

Muklis I, Wicaksono IA, Hasanah U. 2012. Analysis of groundnut farming (*Arachis hypogaea* L.) in Pasar Anom Village, Grabag Subdistrict, Purworejo District. Surya Agritama 1(2): 46-56. [Indonesian]

Muliawati A. 2006. Model and Scenario of Sengon Forest Management (*Paraserianthes falcataria* (L.) Nielsen) Small Scale in Pasir Ipis Village, Surade Subdistrict, Sukabumi District. Institut Pertanian Bogor, Bogor. [Indonesian]

Najiyati, Danarti. 2000. Food Crops. Cultivation and Farm Analysis. Penebar Swadaya, Jakarta. [Indonesian]

Nasution K. 2010. Economic analysis of community and forest sustainability in national movement of forest and land rehabilitations in Karo District. Abdi Ilmu 3(2): 415-416. [Indonesian]

Olayinka BU, Etejere EO. 2015. Growth analysis and yield of two varieties of groundnut (*Arachis hypogaea* L.) as influenced by different weed control methods. Ind J Plant Physiol. 20(2): 130-136.

Raja BSL, Damani BSJ, Ginting. 2013. Respon of growth and production groundnuts to organic material *Tithonia diversifolia* and fertilizer SP-36. Agroekoteknologi 1(3): 725-731. [Indonesian]

Riska. 2014. Analysis of production and profit of groundnut farming in Boya Baliase Village, Marawola Subdistrict, Sigi District. Agroland 21(1): 49-54. [Indonesian]

Sembiring M, Sipayung R, Sitepu FE. 2014. Growth and production of groundnuts by giving compost of palm oil bunch at different pile up frequency. Agroekoteknologi 2(2): 598-607. [Indonesian]

Senoaji G. 2012. Land management with agroforestry system by Baduy community in South Banten. Bumi Lestari 12(2): 283-293. [Indonesian]

Seo JW, Kim H, Chun JH, Mansur I, Lee CB. 2015. Silvicultural practice and growth of the jabon tree (*Anthocephalus cadamba* Miq.) in community forests of West Java, Indonesia. Agriculture and Life Science 49(4): 81-93.

Soerianegara I and Lemmens RHMJ. 1993. Plant Resources of South-East Asia 5(1): Timber Trees: Major Commercial Timbers. Pudoc Scientific Publishers, Wageningen, Netherlands.

Sudarmo MK. 1957. Tabel Hasil Sementara *Anthocephalus cadamba* Mig. (jabon). Pengumunan No. 59. Lembaga Penelitian Kehutanan, Bogor, Indonesia.

Sudomo A. 2007. The influence of loamy sand soil on growth of sengon and nilam in agroforestry system. Pemuliaan Tanaman Hutan 1(2): 1-8. [Indonesian]

Sudomo A. 2013. Productivity of groundnut (*Arachis hypogeae* L.) under manglid plantation in agroforestry system. Prosiding Seminar Nasional Agroforestri. 215-221. [Indonesian]
Sudrajat DJ, Siregar IZ, Khumaida N, Siregar UJ, Mansur I. 2015. Adaptability of white jabon (*Anthocephalus cadamba* Miq.) seedling from 12 populations to drought and waterlogging. Agrivita 37(2): 130-143.
Slavin SL. 2009. Economics. McGraw-Hill Irwin, New York.
Swestiani D, Purwaningsih S. 2013. Production of groundnut (*Arachis hypogaea* L.) in agroforestry based sengon and manglid timbers. Agroforestry 1(2): 71-82.
Wahyudi, Panjaitan S. 2013. The comparison of agroforestry system, intensive monoculture, and conventional monoculture in the development of sengon plantation forest. Prosiding Seminar Nasional Agroforestri 165-171. [Indonesian]
Widiyanto A, Sudomo A. 2014. The influence of sengon litter giving (*Paraserianthes falcataria* (L.) Nielsen) to groundnut productivity (*Arachis hypogeae* L.) in agroforestry system. Agroforestry 2(1): 1-12. [Indonesian]
Zoundji CC, Houngnandan P, Dedehouanou H, Toukourou F. 2015. Determinants of soybean [*Glycine max* (L.) Merrill] production system in Benin. Experimental Biology and Agricultural Sciences 3(V): 430-439.

## SUBMISSION CHECKLIST

Ensure that the following items are present:

| The first corresponding author must be accompanied with contact details: | **Give mark (X)** |
|---|---|
| • E-mail address | X |
| • Full postal address (incl street name and number (location), city, postal code, state/province, country) | X |
| • Phone and facsimile numbers (incl country phone code) | X |

All necessary files have been uploaded, and contain:

| | |
|---|---|
| • Keywords | X |
| • Running titles | X |
| • All figure captions | X |
| • All tables (incl title and note/description) | X |

Further considerations

| | |
|---|---|
| • Manuscript has been "spell & grammar-checked" Better, if it is revised by a professional science editor or a native English speaker | X |
| • References are in the correct format for this journal | X |
| • All references mentioned in the Reference list are cited in the text, and vice versa | X |
| • Colored figures are only used if the information in the text may be losing without those images | X |
| • Charts (graphs and diagrams) are drawn in black and white images; use shading to differentiate | X |

## COVERING LETTER

Dear **Editor-in-Chief,**

I herewith enclosed a research article,

**Title:**

Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping in two agroforestry systems

**Author(s) name:**

Karmini, Sri Sarminah, dan Karyati

**Address**

(Fill in your institution's name and address, your personal cellular phone and email)

Department of Agribusiness, Faculty of Agriculture, University of Mulawarman.
Jln. Pasir Balengkong, Kampus Gunung Kelua.
Samarinda, East Kalimantan, Indonesia. 75119.
Hp: 081258194386
email: karmini.kasiman@yahoo.com.

**For possibility publication on the journal:**

(fill in *Biodiversitas* or *Nusantara Bioscience*)

Biodiversitas

**Novelty:**

(state your claimed novelty of the findings versus current knowledge)

This study offers an agroforestry system from economic aspect.

**Statements:**

This manuscript has not been published and is not under consideration for publication to any other journal or any other type of publication (including web hosting) either by me or any of my co-authors.
Author(s) has been read and agree to the Ethical Guidelines.

**List of five potential reviewers**

(Fill in names of five potential reviewers and their **email** address. He/she should have Scopus ID and come from different institution with the authors)

**Place and date:**

Samarinda, 21 November 2016

**Sincerely yours,**

(fill in your name, no need scanned autograph)

KARMINI

**BIODIVERSITAS**
Volume 18, Number 2, April 2017
Pages: xxxx

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d1802xx

# Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping plants in two agroforestry systems

**KARMINI[1,♥], SRI SARMINAH[2], KARYATI[2]**

[1] Department of Agribusiness, Faculty of Agriculture, Universitas Mulawarman. Jl. Pasir Balengkong, Kampus Gunung Kelua, Samarinda 75119, East Kalimantan, Indonesia. Tel: +62-541-749161, Fax: +62-541-738341. ♥email: karmini.kasiman@yahoo.com

[2]Faculty of Forestry, Universitas Mulawarman. Jl. Ki Hajar Dewantara, Kampus Gunung Kelua Samarinda 75119, East Kalimantan, Indonesia.

Manuscript received: 2 December 2016. Revision accepted: xxx February 2017.

**Abstract.** *Karmini, Sarminah S, Karyati. 2017. Economic analysis of groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) as intercropping plants in two agroforestry systems. Biodiversitas 18: xxxx.* An agroforestry is a farming system combining forestry plant and agricultural plant. Two agroforestry systems of sengon (*Falcataria moluccana*)-groundnut (*Arachis hypogaea*) and jabon (*Anthocephalus cadamba)*-soybean (*Glycine max*) have been done and are proven to be successful. The objective of this study was to analyze the application of *A. hypogaea* and *G. max* as intercropping plants in two agroforestry systems from the aspect of economy. The study was conducted from January to May 2016 in Education Forest, Forestry Faculty, Mulawarman University, Samarinda City, East Kalimantan Province, Indonesia. Data analysis was done to calculate cost, revenue, and profit of the application of *A. hypogaea* and *G. max* as intercropping plants in two agroforestry systems. The results indicate that two agroforestry systems of *F. moluccana*-*A. hypogaea* and *A. cadamba*-*G. max* are feasible and applicable to rehabilitate the critical lands. The application of *A. hypogaea* as intercropping plant in the agroforestry system of *F. moluccana* and *A. hypogaea* expended total cost as much as Rp. 10,985,000.00 ha$^{-1}$ cs$^{-1}$, and it obtained total revenue as much as Rp. 14.000.000,00 ha$^{-1}$ cs$^{-1}$, so it gave profit as much as Rp. 3,015,000.00 ha$^{-1}$ cs$^{-1}$. An agroforestry system of *F. moluccana* and *A. hypogaea* gives many benefits from the aspect of economy, social, ecology, and conservation. Total cost, total revenue, and profit of the application of *G. max* as intercropping plant in the agroforestry system of *A. cadamba* and *G. max*, in the first year in the first cropping season, were Rp. 11,019,000.00 ha$^{-1}$ cs$^{-1}$; Rp. 3,500,000.00 ha$^{-1}$ cs$^{-1}$; and Rp. -7,519,000.00 ha$^{-1}$ cs$^{-1}$. Although it was not profitable to do in some critical lands, it gave many benefits from the aspect of ecology and conservation.

**Keywords:** Agroforestry, *Arachis hypogaea*, economic analysis, *Glycine max*

## INTRODUCTION

Agroforesty is a system of farm qactivities which combines plant or other kinds of forestry plant with agricultural plant. Agroforestry activity could be done at farm area, inside or outside of forest area. Agroforestry system could be applied at critical land or degraded land. According to Sudomo (2007), an agroforestry is a model of community forest or social forestry which is expected to enable the increase of land productivity per wide area and, in future, it can increase community welfare. Besides, agroforestry is expected to have positive function in land and in water conservation, since it is applied mostly in degraded areas as an effort to rehabilitate the land.

Agroforestry system uses combination of many kinds of forestry plants with agricultural plants. The tree raises positive effect on the supply of ground water for the intercrops that grow among trees. Besides, shelter gives buffer effect to anticipate the temperature fluctuation and extreme temperature of both ground temperature and atmosphere temperature of the land (Hamid 2008). Some previous researches chose sengon (*Falcataria moluccana* (Miq.) Barneby & J.W. Grimes) as forestry plant in agroforestry system, and combined it with other agricultural plants. The combination of sengon with other plants were as follows: sengon-nilam (Sudomo 2007), sengon-maize-chili-stick nut (Hamid 2008), sengon-coffee-cacao-gliricidia-maize-ginger-stick nut (Mindawati et al. 2013), groundnut-sengon-manglid (Swestiani and Purwaningsih 2013), sengon-paddy (Wahyudi and Panjaitan 2013), and sengon-groundnut (Widiyanto and Sudomo 2014).

Sudomo (2007) stated that most people like to cultivate *F. moluccana* because it was fast-growing and easy breeding, and its timber could be used to make many products such as furniture and firewood, and its leaf could be used as cattle provisions and as compost material. Moreover, *F. moluccana* and nilam are proven to have potential to be cultivated in agroforestry system at Sukamulih Village, Tasikmalaya District, Indonesia. Meanwhile, the study result of Wahyudi and Panjaitan (2013) indicated superiority of agroforestry system that uses combination of *F. moluccana* and upland paddy. That system becomes the best choice in the development of Industrial Plantation Forest, because it gives the best yield rate of *F. moluccana* and upland paddy, creates job opportunities, increases income of local community, grows own feeling on natural resources, creates positive perception to develop the plantation forest and agroforestry, guards the forest security, and decreases the degradation rate of forest. The fact in field shows that most land is in critical and damage condition because of the continuous effort to fulfill the economic need. People have to contact with nature, so the activity to rehabilitate forest and its surrounding area has potential conflict (Nasution 2010).

According to Sembiring et al. (2014), groundnut (*Arachis hypogaea* L.) is a food commodity that has high economic value. *A. hypogaea* has high nutrition ingredient especially protein and grease. *A. hypogaea* is mostly used as food-stuff and industrial material (Raja et al. 2013). Researches on *A. hypogaea* farming have been done by some researchers such as Hidayat et al. (2004), Muklis et al. (2012), Raja et al. (2013), Riska (2014), Sembiring et al. (2014), and Boekoesoe and Saleh (2015).

Jabon (*Anthocephalus cadamba* (Roxb.) Miq.) is a tropical tree species that is native to South Asia and Southeast Asia, including Indonesia (Krisnawati et al. 2011b). *A. cadamba* is preferred by the local community because it is a fast-growing tree species and has good adaptability to drought and waterlogging stresses (Hadi et al. 2015; Seo et al. 2015; Sudrajat et al. 2015). *A. cadamba* is used in community forests and greening activities such as reforestation programmes, afforestation programmes, rehabilitation activities of waterlogged marginal sites, and replanting the dryer marginal sites. *A. cadamba* has wood for multiple end uses such as plywood, light construction materials, flooring, beams and rafters, boxes and crates, tea-chests, packing cases, shuttering, ceiling boards, toys, wooden shoes, bobbins, yokes, carvings, matches, chopsticks, pencils, canoes, and inexpensive furniture. The pulp of *A. cadamba* for medium quality paper and the fresh leaves are used as cattle fodder or as plates and serviettes (Soerianegara and Lemmens 1993).

Soybean (*Glycine max* (L.) Merrill) is valued as a productive and adaptable crops which fits well into the cropping patterns of varying agro-climatic conditions (Amusat and Ademola 2013). For a long time, soybean has been a part of traditional food for human population which comes in various forms such as tofu, soy-milk, green vegetable soybeans, tempeh, and soybean oil, and also, in its second generation of soy-foods such as soy-nuts, alternatives cheese, and soymilk yogurt. According to Agroudy et al. (2011), the soy oil is one of the widest spreaded vegetable oils. It is used directly in food to prevent its consumers from having blood pressure and arteriosclerosis; moreover seeds of soybean contain the highest number of vitamins that are essential for the body.

The establishment of two agroforestry systems using *F. moluccana* and *A. cadamba* as forestry plants and *A. hypogaea* and *G. max* as agricultural plants is important to apply because it has high economic potential. The aim of this study was to analyze the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems from the aspect of economy. The result of this study are expected to give information to businessman, government, stakeholders, and other researchers about cost expenditure, potential revenue, and profit estimation that could be obtained from the application of *A. hypogaea* and *G. max* as intercropping in the two agroforestry systems. Those information are useful to determine the capital needed to start an agro-business. This study compared two agroforestry systems of *F. moluccana*-*A. hypogaea* and *A. cadamba*-*G. max* to offer the best agroforestry system that could be applied in the critical lands.

The sections of this study are organized in the following sequence. First, Materials and methods section explaining the study area, materials and equipments, procedures, and data analysis. The next section presents the results and includes some discussions.The last section is the conclusion that summarizes findings and offers recommendations.

## MATERIALS AND METHODS

### Study area

This study was conducted for 4 months from January to May 2016. The experiment was done in Forest Education, Faculty of Forestry, Universitas Mulawarman, East Kalimantan, Indonesia. Experimental plots were located in Lempake, Samarinda City, East Kalimantan Province, Indonesia (Figure 1). There are many previous researches on agroforestry systems in some locations in Indonesia. Some of them did the research on *F. moluccana* in Tasikmalaya District, West Java Province (Sudomo 2007), in East Java Province (Hamid 2008; Mindawati et al. 2013), and in Ciamis District, West Java Province (Sudomo 2013; Swestiani and Purwaningsih 2013; Widiyanto and Sudomo 2014). The study on *A. hypogaea* had been done by some researchers in several provinces in Indonesia. Several *A. hypogaea* studies were located in West Java Province (Hidayat et al. 2004), in Purworejo District, Central Java Province (Muklis et al. 2012), in Medan City, North Sumatera Province (Raja et al. 2013), in Sigi District, Central Sulawesi Province (Riska 2014), in Deli Serdang District, North Sumatera Province (Sembiring et al. 2014), and in West Gorontalo District, Gorontalo Province (Boekoesoe and Saleh 2015). However, the publication of researches about two agroforestry systems of *F. moluccana*-*A. hypogaea* and *A. cadamba*-*G. max* in East Kalimantan Province is still limited.

### Materials

Some materials were used in this study such as *F. moluccana* seedling, *A. cadamba* seedling, *A. hypogaea* seed, *G. max* seed.

### Procedures

Some researchers collected primary data through survey to a number of farmers as respondents to reach their aims of research. Siregar et al. (2007) surveyed 40 respondents to analyze the economic value of some agroforestry systems. Asnah and Natal (2009) surveyed 45 respondents to calculate the profit of *A. hypogaea* farm. Other researcher, Muklis et al. (2012), surveyed 26 respondents to analyze the profit of *A. hypogaea* farm. Amusat and Ademola (2013) collected primary data using interview schedules from the 130 selected *G. max* farmers, but only 123 of the schedules were found to be useable. Dogbe et al. (2013) determined 140 *G. max* farmers as enumerators for their study. In addition, Riska (2014) surveyed 30 respondents to analyze the production and profit of *A.*

*hypogaea* farm. Zoundji et al. (2015) selected 324 soybean producers as respondents.

This study was different from those studies above in which primary data for the analysis of economy were collected from on-farm experimental plot established to study two agroforestry systems of *F. moluccana-A. hypogaea* and *A. cadamba-G. max*. Experimental researches related to agroforestry had been done by some researchers with different kinds of plant combination. For example, tree-maize (Bertomeu 2006), sengon-nilam (Sudomo 2007), sengon-maize-chili-stick nut (Hamid 2008), sengon-coffee-cacao-gliricidia-maize-ginger-stick nut (Mindawati et al. 2013), groundnut-manglid (Sudomo 2013), groundnut-sengon-manglid (Swestiani and Purwaningsih 2013), sengon-paddy (Wahyudi and Panjaitan 2013), and sengon-groundnut (Widiyanto and Sudomo 2014).

In this study, experimental plot (Figure 2) of *F. moluccana* and *A. hypogaea* had size of 10 m × 10 m per plot with 2 replications or as many as 2 plots. Similar to *F. moluccana* and *A. hypogaea*, experimental plot of *A. cadamba* and *G. max* had the same of size and replication. *F. moluccana* and *A. cadamba* were cultivated with distance of 3 m × 3 m. *A. hypogaea* crops were cultivated among *F. moluccana* trees as intercropping with size of 20 cm x 20 cm. *G. max* crops were also cultivated among *A. cadamba* trees as intercropping with size of 20 cm x 20 cm. The cultivation activities included land preparation, planting, crop maintenance (weeding, fertilizing, and control of pests and diseases), and harvesting. Harvesting activity was only done to gather *A. hypogaea* and *G. max* yields, but no timber harvesting of *F. moluccana* and *A. cadamba* trees.

**Data analysis**

This study was different from previous study by Bertomeu (2006) which also made experimental plot to collect primary data. Bertomeu (2006) collected primary data to study the financial evaluation of agroforestry systems of tree and maize. However, this study collected primary data to analyze the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems from the aspect of economy. In this study, data were analyzed to calculate cost, revenue, and profit from the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems. Cost is calculated from price and quantity of inputs, thus revenue is price of production yield, and meanwhile profit is revenue minus cost (Slavin 2009). Besides primary data, this study also collected secondary data from the results of previous studies.

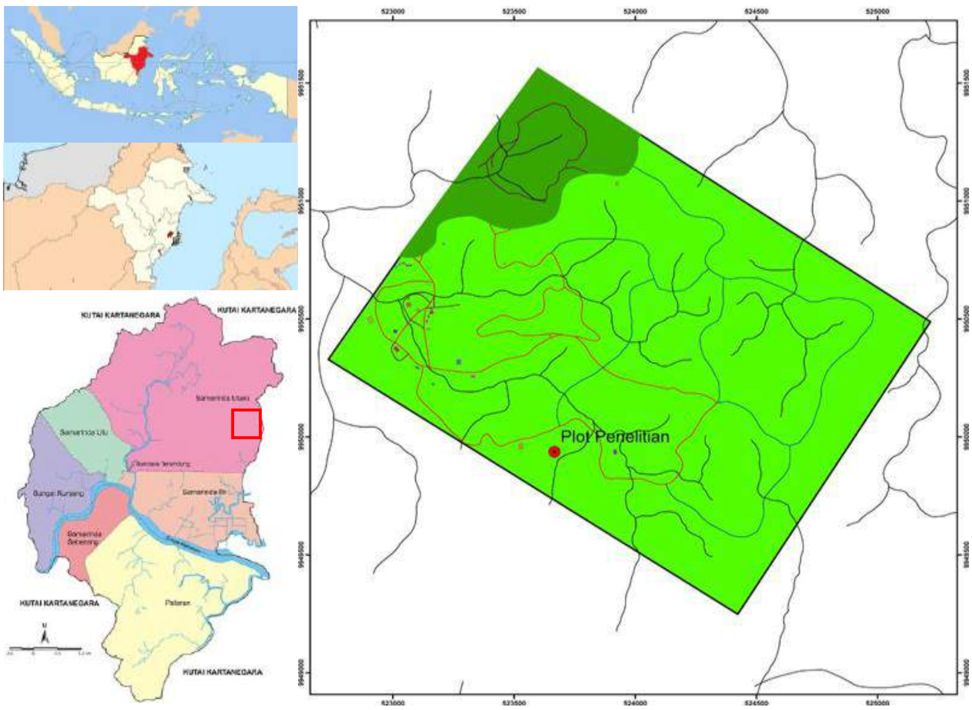



**Figure 1.** Study location in Forest Education, Faculty of Forestry, Universitas Mulawarman, East Kalimantan, Indonesia

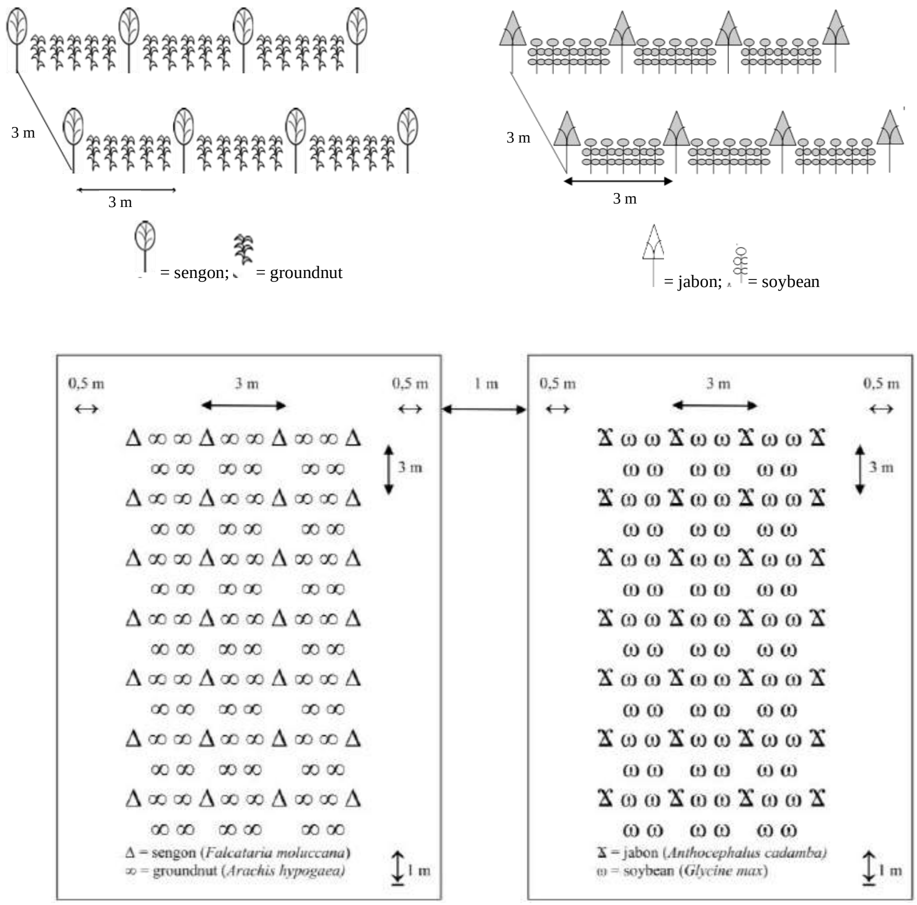



**Figure 2.** Layout of experimental plots in two agroforestry systems of *Falcataria moluccana-Arachis hypogaea* and *Anthocephalus cadamba-Glycine max*

## RESULTS AND DISCUSSION

The application of an agroforestry system needs the cost expenditure to buy materials, depreciation of equipment, and wage of labor. Besides cost expenditure, the application of an agroforestry system results revenue and profit. Table 1 shows economic analysis of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* (Figure 3.A) and *A. hypogaea* (Figure 3.B) during 4 months in East Kalimantan in the 2016 cropping season. Meanwhile, economic analysis of *G. max* as intercropping in an agroforestry system of *A. cadamba* (Figure 3.C) and *G. max* (Figure 3.D) during 4 months in East Kalimantan in the 2016 cropping season is presented in Table 2.

Material cost was expended on buying *F. moluccana* seedling, *A. hypogaea* seed, *A. cadamba* seedling, *G. max* seed, and NPK fertilizer. Fertilizer is given to increase soil fertility. In this study, pesticide, plastic strings, and gunny sack were also bought. Material cost for the application of an agroforestry system of *A. cadamba* and *G. max* (Rp. 7,754,000.00 $ha^{-1}$ $cs^{-1}$) was bigger than that of *F. mollucana* and *A. hypogaea* (Rp. 7,720,000.00 $ha^{-1}$ $cs^{-1}$). Material cost was difference between the application of an agroforestry system of *F. mollucana-A. hypogaea* and *A. cadamba-G. max* because of some reasons. Price of *A. cadamba* seedling was more expensive than that of *F. mollucana* seedling, however price of *A. hypogaea* seed was more expensive than that of *G. max.* That two agroforestry systems need gunny sack in different number depends on its yield.

**Table 1.** Economic analysis of *Arachis hypogaea* as intercropping in an agroforestry system of *Falcataria moluccana* and *Arachis hypogaea* during 4 months in East Kalimantan in the 2016 cropping season

| No. | Cost | Quantity | | Price | | | Total (Rp. $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|---|---|
| **Production cost** | | | | | | | |
| Material cost | | | | | | | |
| 1. | *F. moluccana* seedling | 800.00 | units $ha^{-1}$ | Rp. | 3,000.00 | $unit^{-1}$ | 2,400,000.00 |
| 2. | *A. hypogaea* seed | 150.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp. | 20,000.00 | $kg^{-1}$ | 3,000,000.00 |
| 3. | NPK fertilizer | 100.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp. | 15,000.00 | $kg^{-1}$ | 1,500,000.00 |
| 4. | Pesticide | 25.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp. | 30,000.00 | $kg^{-1}$ | 750,000.00 |
| 5. | Plastic strings | 1.00 | unit $ha^{-1}$ $cs^{-1}$ | Rp. | 30,000.00 | $unit^{-1}$ | 30,000.00 |
| 6. | Gunny sack | 20.00 | units $ha^{-1}$ $cs^{-1}$ | Rp. | 2,000.00 | $unit^{-1}$ | 40,000.00 |
| Subtotal | | | | | | | 7,720,000.00 |
| Depreciation cost | | | | | | | |
| 7. | Hoe | 2.00 | units $ha^{-1}$ | Rp. | 125,000.00 | $unit^{-1}$ | 20,833.33 |
| 8. | Chopper | 2.00 | units $ha^{-1}$ | Rp. | 100,000.00 | $unit^{-1}$ | 16,666.67 |
| 9. | Sickle | 2.00 | units $ha^{-1}$ | Rp. | 60,000.00 | $unit^{-1}$ | 10,000.00 |
| 10. | Sprayer | 1.00 | unit $ha^{-1}$ | Rp. | 350,000.00 | $unit^{-1}$ | 17,500.00 |
| Subtotal | | | | | | | 65,000.00 |
| Labor cost | | | | | | | |
| 11. | Land preparation | 7.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 700,000.00 |
| 12. | Planting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 600,000.00 |
| 13. | Crop maintenance: | | | | | | |
| | a. Fertilizing | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 400,000.00 |
| | b. Weeding | 5.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 500,000.00 |
| | c. Pests and diseases controlling | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 400,000.00 |
| 14. | Harvesting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 600,000.00 |
| Subtotal | | | | | | | 3,200,000.00 |
| **Total cost** | | | | | | | 10,985,000.00 |
| **Total revenue** | | | | | | | |
| | *A. hypogaea* yield | 1,000.00 | kg $ha^{-1}$ | Rp. | 14,000.00 | $kg^{-1}$ | 14,000,000.00 |
| **Profit** | | | | | | | 3,015,000.00 |

**Table 2.** Economic analysis of *Glycine max* as intercropping in an agroforestry system of *Anthocephalus cadamba* and *Glycine max* during 4 months in East Kalimantan in the 2016 cropping season

| No. | Cost | Quantity | | Price | | | Total (Rp. $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|---|---|
| **Production cost** | | | | | | | |
| Material cost | | | | | | | |
| 1. | *A. cadamba* seedling | 800.00 | units $ha^{-1}$ | Rp. | 4,000.00 | $unit^{-1}$ | 3,200,000.00 |
| 2. | *G. max* seed | 150.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp. | 15,000.00 | $kg^{-1}$ | 2,250,000.00 |
| 3. | NPK fertilizer | 100.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp. | 15,000.00 | $kg^{-1}$ | 1,500,000.00 |
| 4. | Pesticide | 25.00 | kg $ha^{-1}$ $cs^{-1}$ | Rp. | 30,000.00 | $kg^{-1}$ | 750,000.00 |
| 5. | Plastic strings | 1.00 | unit $ha^{-1}$ $cs^{-1}$ | Rp. | 30,000.00 | $unit^{-1}$ | 30,000.00 |
| 6. | Gunny sack | 12.00 | units $ha^{-1}$ $cs^{-1}$ | Rp. | 2,000.00 | $unit^{-1}$ | 24,000.00 |
| Subtotal | | | | | | | 7,754,000.00 |
| Depreciation cost | | | | | | | |
| 7. | Hoe | 2.00 | units $ha^{-1}$ | Rp. | 125,000.00 | $unit^{-1}$ | 20,833.33 |
| 8. | Chopper | 2.00 | units $ha^{-1}$ | Rp. | 100,000.00 | $unit^{-1}$ | 16,666.67 |
| 9. | Sickle | 2.00 | units $ha^{-1}$ | Rp. | 60,000.00 | $unit^{-1}$ | 10,000.00 |
| 10. | Sprayer | 1.00 | unit $ha^{-1}$ | Rp. | 350,000.00 | $unit^{-1}$ | 17,500.00 |
| Subtotal | | | | | | | 65,000.00 |
| Labor cost | | | | | | | |
| 11. | Land preparation | 7.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 700,000.00 |
| 12. | Planting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 600,000.00 |
| 13. | Crop maintenance: | | | | | | |
| | a. Fertilizing | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 400,000.00 |
| | b. Weeding | 5.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 500,000.00 |
| | c. Pests and diseases controlling | 4.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 400,000.00 |
| 14. | Harvesting | 6.00 | days $ha^{-1}$ $cs^{-1}$ | Rp. | 100,000.00 | $day^{-1}$ | 600,000.00 |
| Subtotal | | | | | | | 3,200,000.00 |
| **Total cost** | | | | | | | 11,019,000.00 |
| **Total revenue** | | | | | | | |
| | *G. max* yield | 500.00 | kg $ha^{-1}$ | Rp. | 7.000.00 | $kg^{-1}$ | 3,500,000.00 |

| | |
|---|---|
| **Profit** | -7,519,000.00 |

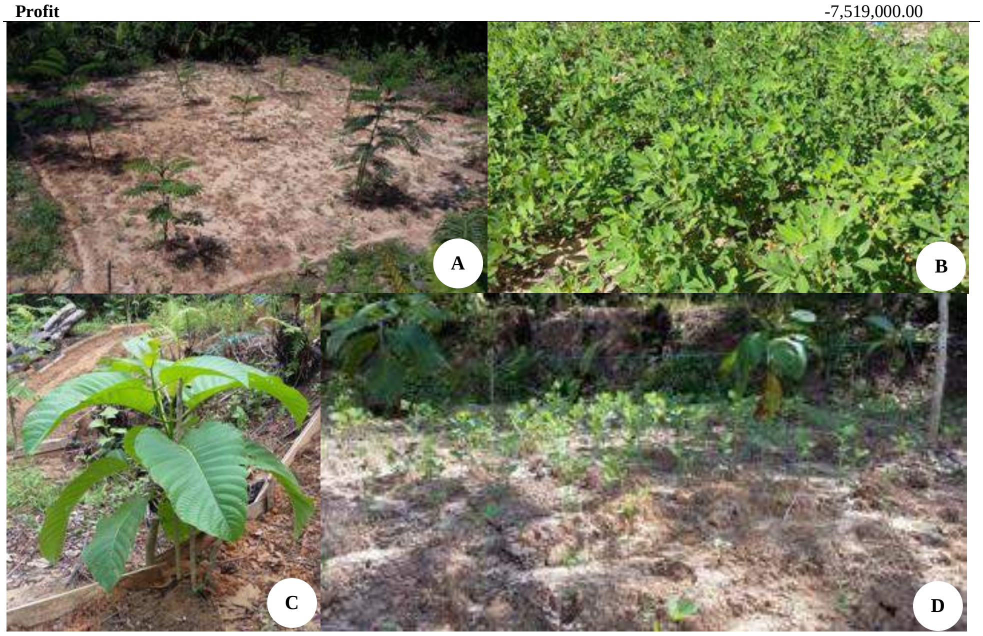



**Figure 3.** A. *Falcataria moluccana*, B. *Arachis hypogaea*, C. *Anthocephalus cadamba*, D. *Glycine max*

There was no difference between depreciation cost for the application of an agroforestry system of *F. mollucana-A. hypogaea* and that of *A. cadamba-G. max* because the kind, quantity, and price of equipment were same. There were many kinds of equipment needed to support farm activity. The equipments were hoe, chopper, sickle, and sprayer. The price of these equipments was different and it depended on the material and the quality of the equipment. Technical duration of a equipment is commonly 3 years, however sprayer can be used until 5 years. Depreciation cost in the application of *A. hypogaea* and *G. max* as intercropping in two agroforestry systems was lower than material cost and labor cost.

The application of that two agroforestry systems expended labor cost in same numbers because those applications are done in the same critical land which have similar soil properties. Many kinds of activities are done in the application of two agroforestry systems of *F. mollucana-A. hypogaea* and that of *A. cadamba-G. max.* Those activities are land preparation, planting, crop maintenance, and harvesting. Land preparation expended more money than the planting activity. Activities of crop maintenance included fertilizing, weeding, and pests and diseases controlling. Weed control methods significantly affected *A. hypogaea* yield both on the Samnut 10 and MK 373 varieties (Olayinka and Etejere 2015). Crop maintenance needed more cost than harvesting activity because it involved more labor.

Total cost of the application was material buying, depreciation cost, and labor cost. Total cost for the application of an agroforestry system of *F. mollucana* and *A. hypogaea* (Rp. 10,985,000.00 $ha^{-1}$ $cs^{-1}$) was smaller than that of *A. cadamba* and *G. max* (Rp. 11,019,000.00 $ha^{-1}$ $cs^{-1}$). Material cost was different between an agroforestry system of *F. mollucana-A. hypogaea* and that of *A. cadamba-G. max,* however, depreciation cost and labor cost were same.

In an agroforestry system of *F. moluccana* and *A. hypogaea*, there was no harvesting of *F. moluccana* yield in the first year because the aim of *F. mollucana* planting was to rehabilitate the critical lands. Crop maintenance of *F. mollucana* was done in the following year. There is a possibility that the harvesting activity is only to take the economic value of *F. moluccana* timbers. Farmers can obtain revenue from selling the *F. moluccana* timbers, so when there is no harvesting, it means no revenue. Economic potential of *F. moluccana* trees is very high from the aspect of tree growth level.

There were several prior researches measuring the growth level of diameter and height of *F. moluccana* in some plantation systems (Table 3). Sudomo (2007) investigated an agroforestry system of *F. moluccana* and nilam and found that the growth of *F. moluccana* on loamy sand soil is good enough. It was proven by the increasing of height and diameter at 18 months and 24 months. Meanwhile, two best agroforestry systems that could be applied widely in Blitar, East Java Province, are sengon-coffee-gliricidia-cassava-stick nut and sengon-coffee-cacao-gliricidia-ginger-stick nut because those systems gave the best sengon diameter growth (Mindawati et al. 2013). The result of study by Swestiani and Purwaningsih (2013) and Wahyudi and Panjaitan (2013) showed that Mean Annual Increment (MAI) of *F. moluccana's* diameter in agroforestry system is wider than in monoculture system. The study by Krisnawati et al. (2011a) in smallholder plantations in Ciamis (West Java Province) recorded the mean diameter and height of *F. moluccana* trees which were younger than 4 years old, older than 5 years (but less than 10 years), and 12 years old of stands. The wide variations in mean diameter and height are probably due to differences in growing conditions, including site quality, altitude, slope, and silvicultural management.

*Arachis hypogaea* matures at 90 and 95 days (Najiyati and Danarti 2000) or at between 98 and 105 days (Olayinka and Etejere 2015). There were differences in *A. hypogaea* yield that obtained in monoculture system in some farm areas, as shown in Table 4. In United States of Amerika, *A. hypogaea* yield is higher than the average yield in tropical Africa. *A. hypogaea* yield of Macan variety in monoculture system is between 1,200 and 1,800 kg ha$^{-1}$ (Najiyati and Danarti 2000). According to Asnah and Natal (2009), *A. hypogaea* farmers in Tagawiti Village, Ile Ape Subdistrict, Lembata District, who own land more than 0.5 ha have bigger profit than those who own land less than 0.5 ha.

There were differences in *A. hypogaea* yield in agroforestry system in some locations. In this study, *A. hypogaea* as intercropping in an agroforestry system of *F. mollucana* and *A. hypogaea* could produce yield as much as 1,000.00 kg ha$^{-1}$. The result of this study which was conducted in Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province was higher than the result of studies by Swestiani and Purwaningsih (2013) in Ciamis District, West Java Province and Widiyanto and Sudomo (2014) in Raksabaya Village, Cimaragas Subdistrict, Ciamis District, West Java Province. When the price of *A. hypogaea* yield was Rp. 14.000,00 kg$^{-1}$, the farmer could get potential revenue as much as Rp. 14,000,000.00 ha$^{-1}$ cs$^{-1}$.

Sudomo (2013) reported that *A. hypogaea* yield decreases in an agroforestry system of *A. hypogaea* and manglid (19.63%) compared to *A. hypogaea* in monoculture system. Similar to Sudomo's study (2013), Swestiani and Purwaningsih (2013), and Widiyanto and Sudomo (2014) also found that *A. hypogaea* yield in monoculture system was higher than that in an agroforestry system of *F. moluccana* and *A. hypogaea*. It was happened due to the shade of *F. moluccana* over *A. hypogaea* and the competition of *F. moluccana* with *A. hypogaea* in water and nutrition absorption (Widiyanto and Sudomo, 2014). According to Swestiani and Purwaningsih (2013), *F. moluccana*, manglid, and *A. hypogaea* will grow optimally when the environment factors (duration of sunshine, water, nutrition, $CO_2$, and growth space) are available adequately. The strategy to increase *A. hypogaea* yield is by increasing the area width for a more intensive farming and by expanding the planting area through the arrangement of planting pattern, the use of hybrid varieties, the use of appropriate machines and equipments, and the adequate supply of water (Agriculture Departement 2001 as citied by Hidayat et al. 2004).

Similar to an agroforestry system of *F. moluccana* and *A. hypogaea*, there was no harvesting of *A. cadamba* yield in the first year. However, crop maintenance is continued to be done to rehabilitate the critical lands in the following years. Reports by Sudarmo (1957) and Lemmens (1993) show an average diameter, a mean height, MAI, and wood production of *A. cadamba* (Tabel 5). The growth rates of both diameter and height of *A. cadamba* in Java are higher than those in South Kalimantan. The wide variations in mean diameter and height are probably due to differences in site quality and owners management practices (Krisnawati et al. 2011b).

The result of study by Dogbe et al. (2013) showed monoculture system of *G. max* produces 509-642 kg ha$^{-1}$ yield in Saboba and Chereponi Districts, Northern Region of Ghana. Meanwhile, Zoundji et al. (2015) found that 60.5%, 28.1%, and 11.4% of the soybean farmers in Benin had low (< 700 kg ha$^{-1}$), medium (between 700 and 1,000 kg ha$^{-1}$), and high ( > 1,000 kg ha$^{-1}$) yield level, respectively (Table 6). The soybean grain yields obtained after harvest are inferior to 1,000 kg ha$^{-1}$ for the majority of respondents. In this study, the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max* could produce yield as much as 500.00 kg ha$^{-1}$. The selling price of *G. max* yield was Rp. 7,000.00 kg$^{-1}$, therefore the farmers owned revenue of Rp. 3,500,000.00 ha$^{-1}$ cs$^{-1}$ in the first cropping season. The revenue level is determined by yield quantity and selling price.

There are some factors influencing the level of *G. max* yield such as characteristic of land, quality and quantity of inputs (material, equipment, and labor), cropping practice, climate condition, environment condition, and other factors. Dogbe et al. (2013) explained several factors could account for the low levels of productivity of *G. max* including poor soil health, pest and diseases, unfavourable weather conditions, inadequate and untimely access to agroinputs, equipments, and labor. According to Zoundji et al. (2015), yield level is significantly determined by gender issues. Technical factors such as the use of improved *G. max* varieties, the use of fertilizers, the plant density, and the practice of fallow in the cropping system have significantly and positively determined the level of yields. Constrains to soybean production include mainly inadequate cropping practices.

The application of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* and *A. hypogaea* gave profit as much as Rp. 3,015,000.00 ha$^{-1}$ cs$^{-1}$. That profit could be increased when *A. hypogaea* yield is higher than the yield result in the time of the study. That profit was higher than the profit of monoculture system of *A. hypogaea* in Central Java Province, but it was smaller than the profit of that in Gorontalo Province and in Central Sulawesi Province (Table 7). The difference of total cost could be happened because of the difference in input usage and input price. The number and the price of outputs are the determining factors affecting revenue. Meanwhile, profit is determined by total revenue and total cost.

**Table 3.** An average diameter, a mean height, and Mean Annual Increment (MAI) of *Falcataria moluccana* in some plantation systems

| Researcher (year) | Important findings |
|---|---|
| Sudomo (2007) | Agroforestry system of *F. moluccana*-nilam.<br>*F. moluccana* diameter:<br>- 18 months: 6.85 cm;<br>- 24 months: 9.48 cm.<br>*F. moluccana* height:<br>- 18 months: 5.59 m;<br>- 24 months: 7,28 m. |
| Krisnawati et al. (2011a) | Monoculture system of *F. moluccana*<br>*F. moluccana* diameter:<br>- < 4 years: 3.4-16.7 cm;<br>- 5-10 years: 8.7-40.1 cm;<br>- 12 years: 24.6-74 cm.<br>*F. moluccana* height:<br>- < 4 years: 3.9-19.6 m;<br>- 5-10 years: 9.9-27.9 m;<br>- 12 years: 15.3-36.2 m. |
| Mindawati et al. (2013) | Agroforestry system of sengon-coffee-gliricidia-cassava-stick nut and sengon-coffee-cacao-gliricidia-ginger-stick nut<br>*F. moluccana* diameter: 17.2-28.6 cm. |
| Swestiani and Purwaningsih (2013) | MAI *F. moluccana* in agroforestry system: 5.25 cm year$^{-1}$.<br>MAI *F. moluccana* in monoculture system: 3,2 cm year$^{-1}$. |
| Wahyudi and Panjaitan (2013) | *F. moluccana* diameter:<br>- Agroforestry system: 3.45 cm year$^{-1}$;<br>- Intensive monoculture system: 3.21 cm year$^{-1}$;<br>- Conventional monoculture system: 1.99 cm year$^{-1}$. |

**Table 4.** *Arachis hypogaea* yield of monoculture and agroforestry systems

| Researcher (year) | Farming system | *Arachis hypogaea* yield | Location |
|---|---|---|---|
| Akobundu (1987) | Monoculture system of *A. hypogaea* | 3,000 kg ha$^{-1}$<br>800 kg ha$^{-1}$ | USA<br>Africa |
| Najiyati and Danarti (2000) | Monoculture system of *A. hypogaea* | 1,200-1,800 kg ha$^{-1}$ | |
| Swestiani and Purwaningsih (2013) | Monoculture system of *A. hypogaea*<br>Agroforestry system of *F. moluccana* and *A. hypogaea* | 1.01 ton ha$^{-1}$<br>0.83 ton ha$^{-1}$ | Ciamis District, West Java Province, Indonesia |
| Riska (2014) | Monoculture system of *A. hypogaea* | 1,003.96 kg ha$^{-1}$ | Boya Baliase Village, Marawola Subdistrict, Sigi District, Central Sulawesi Province, Indonesia |
| Widiyanto and Sudomo (2014) | Monoculture system of *A. hypogaea*<br>Agroforestry system of *F. moluccana* and *A. hypogaea* | 1,349.4 kg ha$^{-1}$<br>861 kg ha$^{-1}$ | Raksabaya Village, Cimaragas Subdistrict, Ciamis District, West Java Province, Indonesia |
| This study (2016) | Agroforestry system of *F. moluccana* and *A. hypogaea* | 1,000.00 kg ha$^{-1}$ | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, |

Indonesia

**Table 5.** An average diameter, a mean height, Mean Annual Increment (MAI), and wood production of *Anthocephalus cadamba*

| Researcher (year) | Important findings |
|---|---|
| Sudarmo (1957) | MAI *A. cadamba*:<br>- Age of 9 years in good-quality sites: 20 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 183 $m^3$ $ha^{-1}$;<br>- Age of 9 years in medium-quality sites: 16 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 145 $m^3$ $ha^{-1}$;<br>- Age of 9 years in poor-quality site: 15 $m^3$ $ha^{-1}$ $year^{-1}$, producing up to 105 $m^3$ $ha^{-1}$. |
| Lemmens (1993) | *A cadamba*: an average diameter of 65 cm, a mean height of 39 m, wood production 350 $m^3$ $ha^{-1}$ |
| Krisnawati et al. (2011b) | *A. cadamba* diameter at breast height (DBH) < 5 years old: 8-18 cm.<br>*A. cadamba* growth > 5 years:<br>- Java: diameter 1.2-11.6 cm $year^{-1}$, height 0.8-7.9 m $year^{-1}$.<br>- South Kalimantan: diameter 1.2-4.8 cm $year^{-1}$, height 0.8-3.7 m $year^{-1}$.<br>*A. cadamba* height:<br>- < 10 years old: 19.6 m;<br>- > 10 years old: 17.3-30 m. |

**Table 6.** *Glycine max* yield on monoculture and agroforestry systems

| Researcher (year) | Plantation system | *Glycine max* yield | Location |
|---|---|---|---|
| Dogbe et al. (2013) | Monoculture system of *G. max* | 509-642 kg $ha^{-1}$ | Saboba and Chereponi Districts, Northern Region of Ghana |
| Zoundji et al. (2015) | Monoculture system of *G. max* | 1,000 kg $ha^{-1}$ | Benin |
| This study (2016) | Agroforestry system of *A. cadamba* and *G. max* | 500 kg $ha^{-1}$ | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia. |

**Table 7.** Total cost, revenue, and profit of monoculture and agroforestry system of *Arachis hypogaea*

| Researcher (year) | Plantation system | Research location | Total cost (Rp. $ha^{-1}$ $cs^{-1}$) | Total revenue (Rp. $ha^{-1}$ $cs^{-1}$) | Profit (Rp. $ha^{-1}$ $cs^{-1}$) |
|---|---|---|---|---|---|
| Muklis et al. (2012) | Monoculture system of *A. hypogaea* | Pasar Anom Village, Grabag Subdistrict, Purworejo District, Central Java Province, Indonesia | 7,402,092 | 9,562,860 | 2,160,769 |
| Riska (2014) | Monoculture system of *A. hypogaea* | Boya Baliase Village, Marawola Subdistrict, Sigi District, Central Sulawesi Province, Indonesia | 3,688,412 | 15,069,434 | 11,371,022 |
| Boekoesoe and Saleh (2015) | Monoculture system of *A. hypogaea* | Pulahenti Village, Sumalata Subdistrict, West Gorontalo District, Gorontalo Province, Indonesia | 4,049,003 | 7,600,242 | 3,551,238 |
| This study (2016) | Agroforestry system of *F. moluccana* and *A. hypogaea* | Forest Education, Forestry Faculty, Mulawarman University, Lempake Subcity, Samarinda City, East Kalimantan Province, Indonesia | 10,985,000 | 14,000,000 | 3,015,000 |

The income from the application of an agroforestry system of *F. moluccana* and *A. hypogaea* during four months comes only from the selling of *A. hypogaea* yield. However, farmer can achieve other income from harvesting the trees in the fifth year. According to Widiyanto and Sudomo (2014), *F. moluccana* has short harvest cycle from 5 to 7 years. The result of study by Siregar et al. (2007) in East Java Province showed that *F. moluccana* is usually harvested after 10 years; however there is a tendency to shorten the harvesting time to 8 years. The higher income will come as *F. moluccana* grows taller and its stalk diameter gets bigger.

In the first cropping season in the first year, the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max* , gives no profit whereas the farmer has spent as much as Rp. 7,519,000.00 $ha^{-1}$ $cs^{-1}$. The small revenue and the big cost cause little motivation for farmer to do this system. In the first cropping season, the big portion of capital is to buy *A. cadamba* seedling. In the following cropping season, it is not need to buy *A. cadamba* seedling therefore production cost will decrease. When there are adequate cropping practices, the *G. max* production will increase. It affects the increase of the revenue, and there is opportunity to reach the higher profit. The result of this study is similar to the result of the study of Dogbe et al. (2013) that found the soybean production in Chereponi District, Northern Region of Ghana is not profitable even though it is done by female who are relatively better than male farmers. On the other hand, soybean production is profitable in Saboba District which is done by male farmers.

The application of an agroforestry system of *A. cadamba* and *G. max* during four months gives income only from the selling of *G. max* yield. When the trees have the best growth of diameter and height, producer could harvest them and collects higher income. Logs from tree plantations of *A cadamba* are mostly from young trees with the age of 5-8 years (Hadi et al. 2015). Similar to the agroforestry system of *F. moluccana* and *A. hypogaea*, this agroforestry system gives more than a source of income for farmers.

The result indicates two agroforestry systems of *F. moluccana-A. hypogaea* and *A. cadamba-G. max* are feasible and applicable to rehabilitate the critical lands. Both agroforestry systems give many benefits from the aspect of economy, social, ecology, and conservation. The owner has possibility to manage their small forest more flexibly and effectively especially in yield arrangement and control (Muliawati 2006). Moreover, if both agroforestry systems are reckoned from social aspect, it supplies timber product, provides food-stuff, and creates job opportunities for community. According to Bertomeu (2006), agroforestry systems with wide-spaced trees have the potential of diversifying farm production. The establishment of agroforestry aims to develop the community forest. The application of *A. hypogaea* as intercropping in an agroforestry system of *F. moluccana* and *A. hypogaea* is profitable in the critical lands. From the aspect of economy, agroforestry system has important role for community life as a source of income (Senoaji 2012), it produces higher economic returns, and it provides other economic profit (Bertomeu 2006).

In the critical land, the application of *G. max* as intercropping in an agroforestry system of *A. cadamba* and *G. max* in the first year in the first cropping season is not profitable based on economic analysis. However, from the aspect of ecology, agroforestry system can increase land fertility and environment protection (Senoaji 2012). From the aspect of conservation, both agroforestry systems can rehabilitate critical land. Another study showed that agroforestry systems with wide-spaced trees have environmental benefits derived from tree planting, including erosion control, soil fertility improvement, and windbreaks (Bertomeu 2006). Conservation benefit is also reported by Labata et al. (2012) who found that the agroforestry systems (mixed multistorey system, taungya agroforestry system, and falcata-coffee multistorey system) have the capacity to store carbon in trees, herbaceous vegetation, litter, and soil. According to their study in Bukidnon, Philippines, agroforestry systems can store 92 MgC $ha^{-1}$ to 174 MgC $ha^{-1}$ of carbon.

## REFERENCES

Commented [M1]: Re-check

Agroudy NE, Mokhtar S, Zaghlol EA, Gebaly ME. 2011. An economic study of the production of soybean in Egypt. Agric. Biol. J. N. Am. 2(2): 221-225.

Akobundu IO. 1987. Weed Science in Tropics, Principles and Practices. Wiley, New York.

Amusat AS, Ademola AO. 2013. Utilisation of soybean in Oniyo community of Oyo State, Nigeria. Global Journal of Science Frontier Research Agriculture and Veterinary 13(7): 6-14.

Asnah, Natal V. 2009. Profit of groundnut farming in Tagawiti Village, Ile Ape Subdistrict, Lembata District. Buana Sains 9(1): 25-30. [Indonesian]

Bertomeu M. 2006. Financial evaluation of smallholder timber-based agroforestry systems in Claveria, Northern Mindanao, the Philippines. Small-scale Forest Economics, Management and Policy 5(1): 57-82.

Boekoesoe Y, Saleh Y. 2015. Cost structure and profitability of groundnut farming in Pulahenti Village, Sumalata Subdistrict, West Gorontalo District. Perspektif Pembiayaan dan Pembangunan Daerah 3(1): 19-26. [Indonesian]

Dogbe W, Etwire PM, Martey E, Etwire JC, Baba IIY, Siise A. 2013. Economics of soybean production: Evidence from Saboba and Chereponi Districts of Northern Region of Ghana. Agricultural Science 5(12): 38-46.

Hadi YS, Rahayu IS, Danu S. 2015. Termite resistance of jabon wood impregnated with methyl methacrylate. Tropical Forest Science 27(1): 25-29.

Hamid A. 2008. The effect of sengon tree pruning to diversity intercrop in agroforestry system of sengon. Buana Sains 8(2): 189-202. [Indonesian]

Hidayat A, Adiningsih ES, Setiawan P. 2004. Analysis of land development for groundnut plant in West Java from landsat data with geografic information system. Penginderaan Jauh dan Pengolahan Data Citra Digital 1(1): 46-50. [Indonesian]

Krisnawati H, Varis E, Kallio M, Kanninen M. 2011a. *Paraserianthes falcataria* (L.) Nielsen. Ecology, Silviculture and Productivity. Center for International Forestry Research (CIFOR), Bogor.

Krisnawati H, Kallio M, Kanninen M. 2011b. *Anthocephalus cadamba* Miq. Ecology, Silviculture and Productivity. Center for International Forestry Research (CIFOR), Bogor.

Labata MM, Aranico EC, Tabaranza ACE, Patricio JHPP, Amparado RF. 2012. Carbon stock assessment of three selected agroforestry systems in Bukidnon, Philippines. Advances in Environmental Sciences 4(1): 5-11.

Mindawati N, Kosasih AS, Bustomi S, Sitompul SM, Tyasmoro SY. 2013. Agroforestry system to increase ecology and agroeconomic functions of social forest. Proceeding of National Seminary on Agroforestry. 189-196. [Indonesian]

Muklis I, Wicaksono IA, Hasanah U. 2012. Analysis of groundnut farming (*Arachis hypogaea* L.) in Pasar Anom Village, Grabag Subdistrict, Purworejo District. Surya Agritama 1(2): 46-56. [Indonesian]

Muliawati A. 2006. Model and Scenario of Sengon Forest Management (*Paraserianthes falcataria* (L.) Nielsen) Small Scale in Pasir Ipis Village, Surade Subdistrict, Sukabumi District. Institut Pertanian Bogor, Bogor. [Indonesian]

Najiyati, Danarti. 2000. Food Crops. Cultivation and Farm Analysis. Penebar Swadaya, Jakarta. [Indonesian]

Nasution K. 2010. Economic analysis of community and forest sustainability in national movement of forest and land rehabilitations in Karo District. Abdi Ilmu 3(2): 415-416. [Indonesian]

Olayinka BU, Etejere EO. 2015. Growth analysis and yield of two varieties of groundnut (*Arachis hypogaea* L.) as influenced by different weed control methods. Ind J Plant Physiol. 20(2): 130-136.

Raja BSL, Damani BSJ, Ginting. 2013. Respon of growth and production groundnuts to organic material *Tithonia diversifolia* and fertilizer SP-36. Agroekoteknologi 1(3): 725-731. [Indonesian]

Riska. 2014. Analysis of production and profit of groundnut farming in Boya Baliase Village, Marawola Subdistrict, Sigi District. Agroland 21(1): 49-54. [Indonesian]

Sembiring M, Sipayung R, Sitepu FE. 2014. Growth and production of groundnuts by giving compost of palm oil bunch at different pile up frequency. Agroekoteknologi 2(2): 598-607. [Indonesian]

Senoaji G. 2012. Land management with agroforestry system by Baduy community in South Banten. Bumi Lestari 12(2): 283-293. [Indonesian]

Seo JW, Kim H, Chun JH, Mansur I, Lee CB. 2015. Silvicultural practice and growth of the jabon tree (*Anthocephalus cadamba* Miq.) in community forests of West Java, Indonesia. Agriculture and Life Science 49(4): 81-93.

Soerianegara I and Lemmens RHMJ. 1993. Plant Resources of South-East Asia 5(1): Timber Trees: Major Commercial Timbers. Pudoc Scientific Publishers, Wageningen, Netherlands.

Sudarmo MK. 1957. Tabel Hasil Sementara *Anthocephalus cadamba* Mig. (jabon). Pengumunan No. 59. Lembaga Penelitian Kehutanan, Bogor, Indonesia.

Sudomo A. 2007. The influence of loamy sand soil on growth of sengon and nilam in agroforestry system. Pemuliaan Tanaman Hutan 1(2): 1-8. [Indonesian]

Sudomo A. 2013. Productivity of groundnut (*Arachis hypogeae* L.) under manglid plantation in agroforestry system. Prosiding Seminar Nasional Agroforestri. 215-221. [Indonesian]

Sudrajat DJ, Siregar IZ, Khumaida N, Siregar UJ, Mansur I. 2015. Adaptability of white jabon (*Anthocephalus cadamba* Miq.) seedling from 12 populations to drought and waterlogging. Agrivita 37(2): 130-143.

Slavin SL. 2009. Economics. McGraw-Hill Irwin, New York.

Swestiani D, Purwaningsih S. 2013. Production of groundnut (*Arachis hypogaea* L.) in agroforestry based sengon and manglid timbers. Agroforestry 1(2): 71-82.

Wahyudi, Panjaitan S. 2013. The comparison of agroforestry system, intensive monoculture, and conventional monoculture in the development of sengon plantation forest. Prosiding Seminar Nasional Agroforestri 165-171. [Indonesian]

Widiyanto A, Sudomo A. 2014. The influence of sengon litter giving (*Paraserianthes falcataria* (L.) Nielsen) to groundnut productivity (*Arachis hypogeae* L.) in agroforestry system. Agroforestry 2(1): 1-12. [Indonesian]

Zoundji CC, Houngnandan P, Dedehouanou H, Toukourou F. 2015. Determinants of soybean [*Glycine max* (L.) Merrill] production system in Benin. Experimental Biology and Agricultural Sciences 3(V): 430-439.