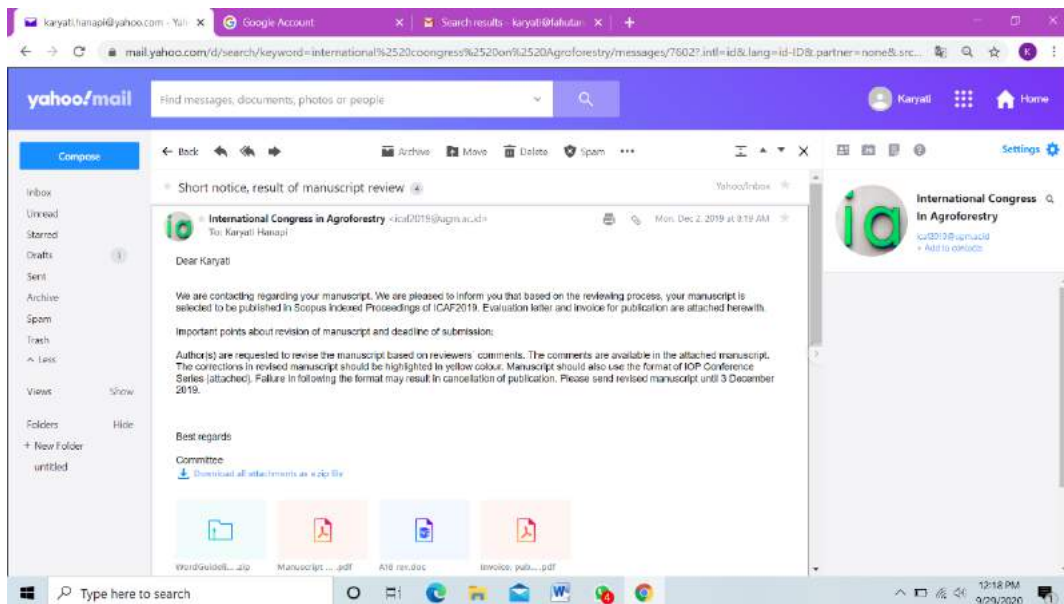
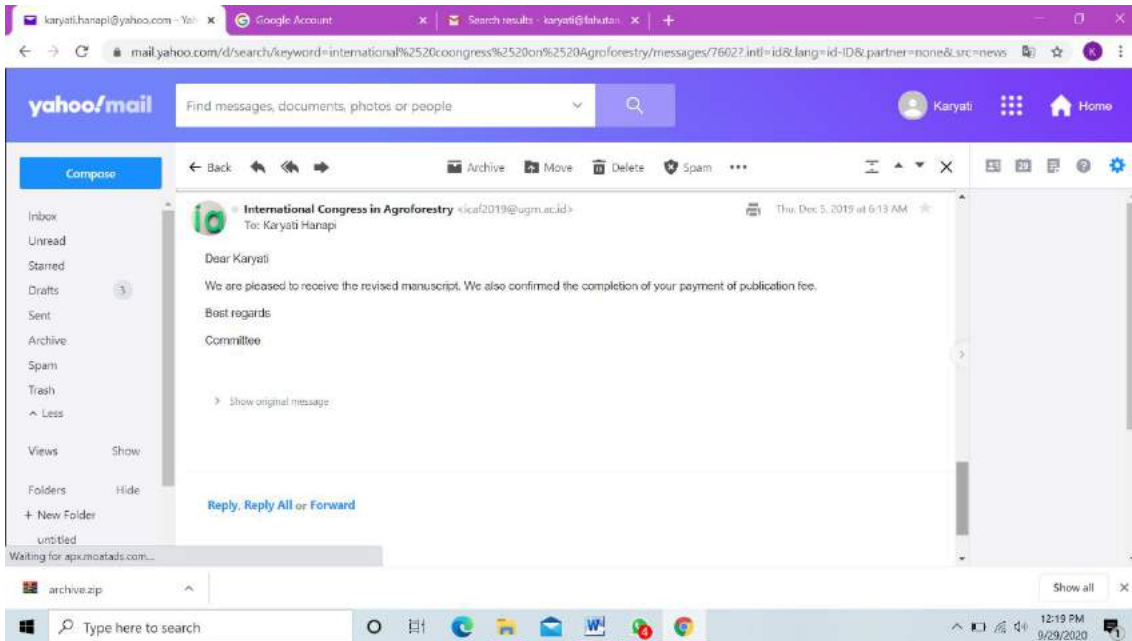
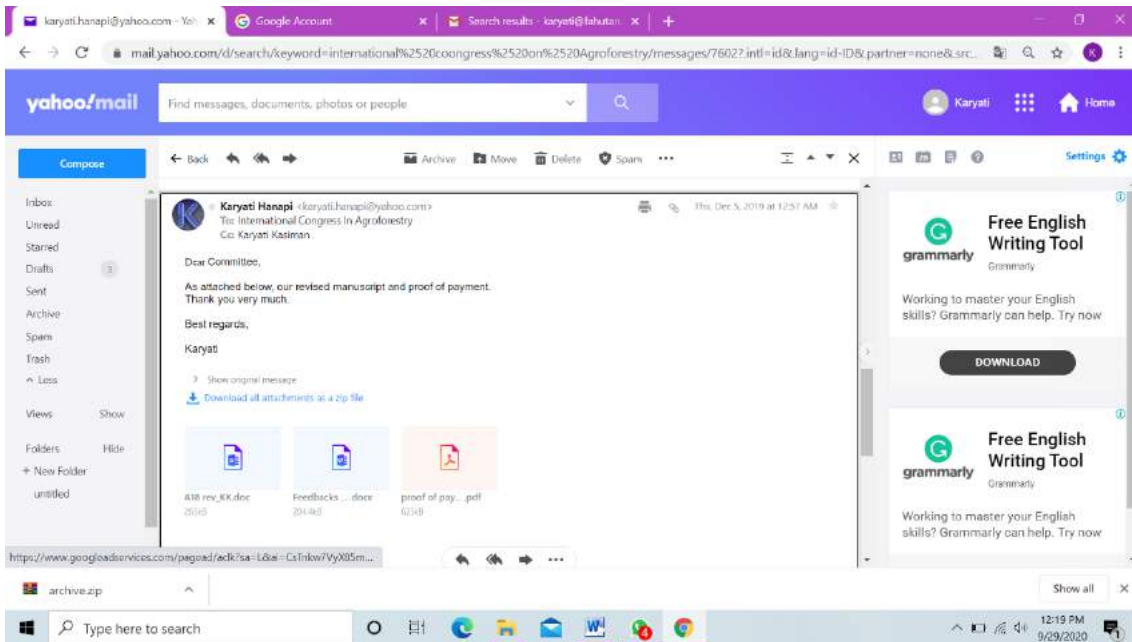
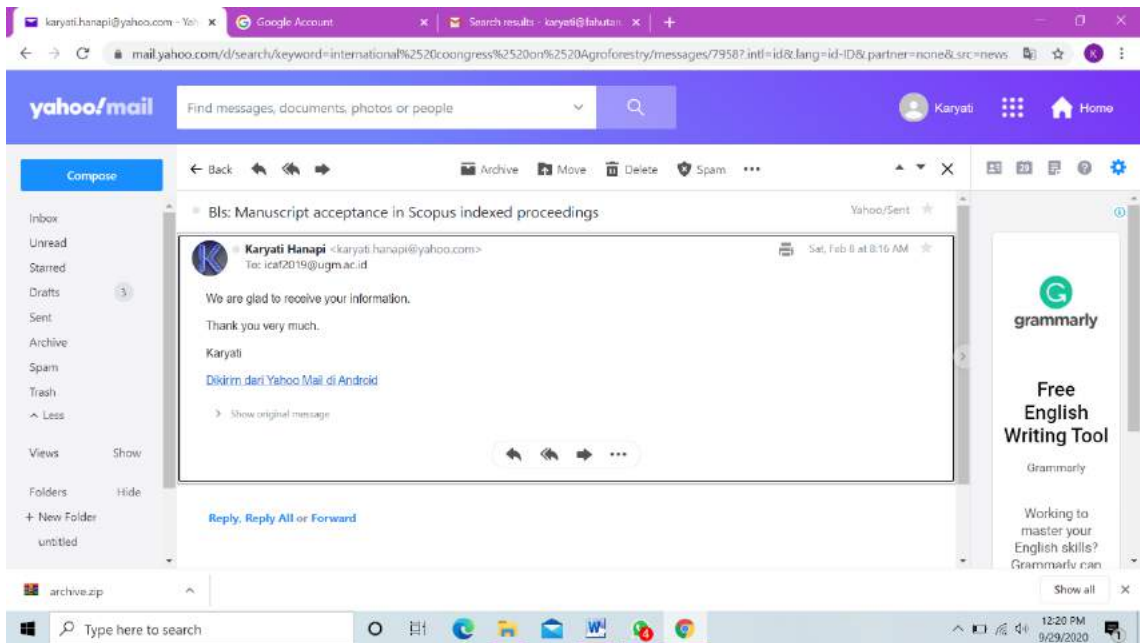
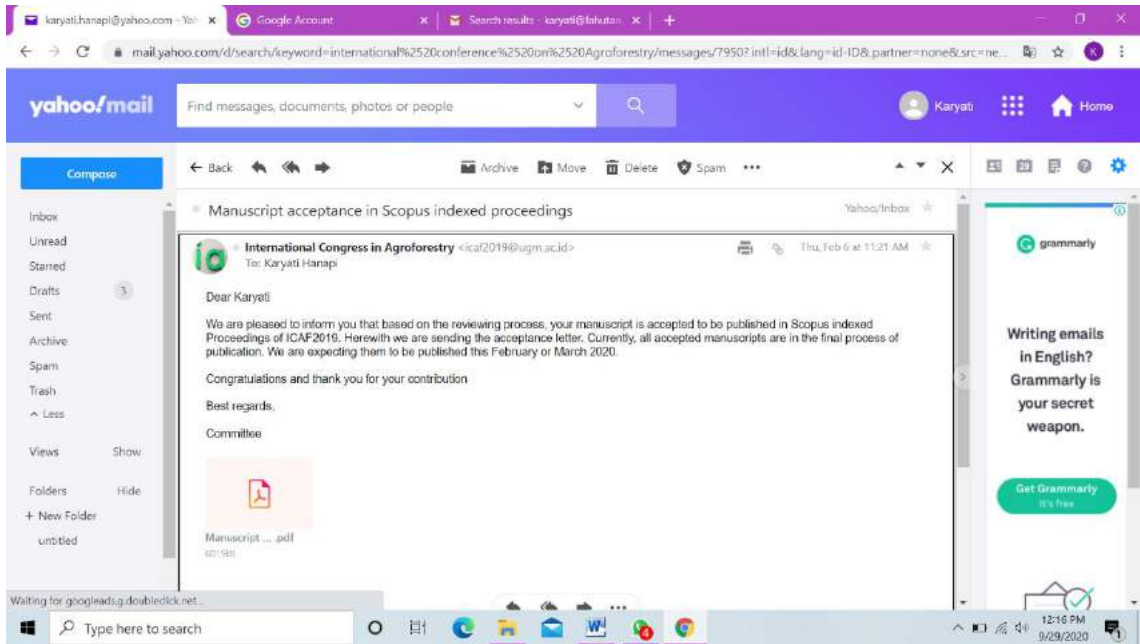


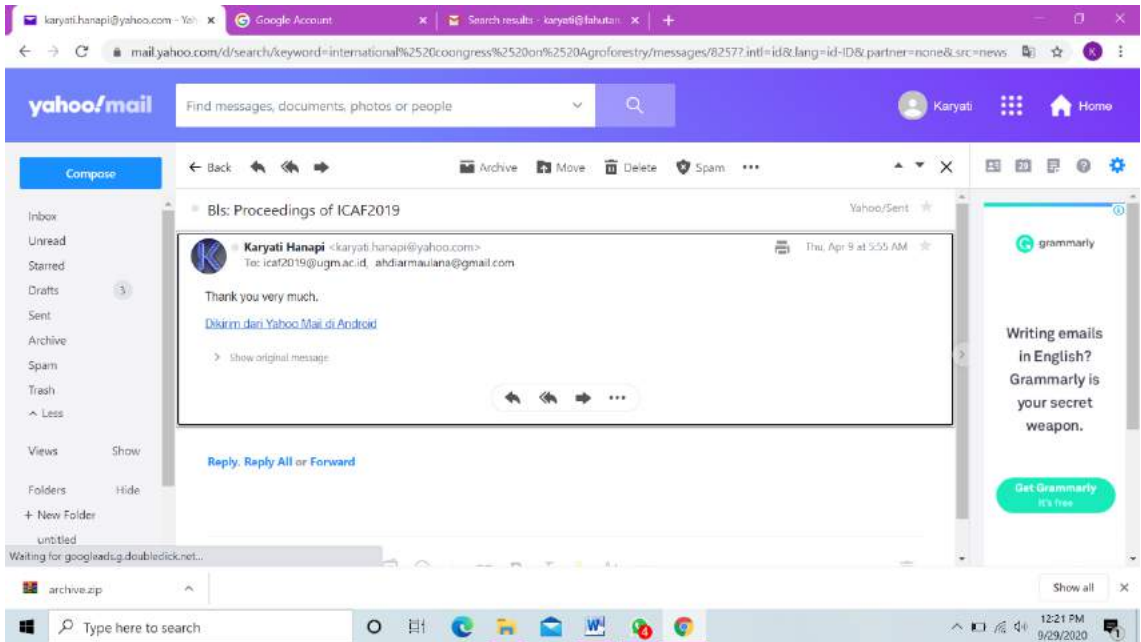
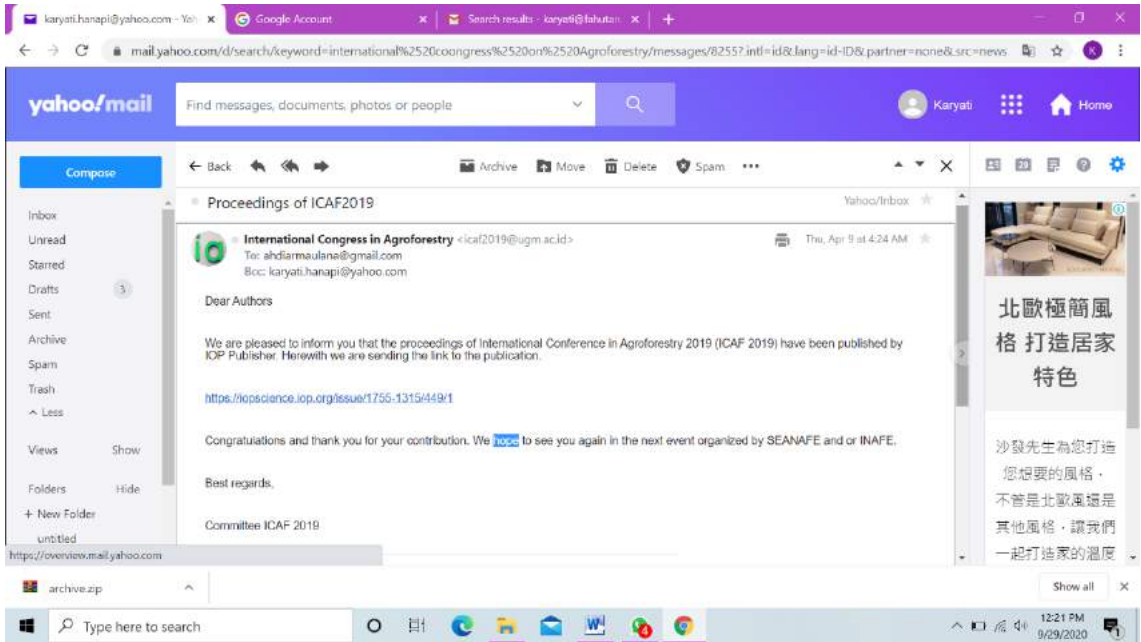
## BUKTI-BUKTI PROSES REVIEW (KORESPONDENSI)

Judul	:	Silvicultural and economic aspects on combination of vegetatives ( <i>Falcataria moluccana-Sorghum bicolor</i> L.) and terrace methods in the different slope lands
Penulis	:	Karyati, Anggelina Ellytasari Santoso, Muhammad Syafrudin, dan Karmini
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## Silvicultural and economic aspects on combination of vegetatives (*Falcataria moluccana*-*Sorghum bicolor* L.) and terrace methods in the different slope lands

**Abstract.** The vegetative and mechanic methods are soil and water conservation technology to prevent surface run off and soil erosion as well as protect soil nutrient. The study objectives were to know silvicultural and economic aspects on combination of vegetatives between *Falcataria moluccana* (*sengon*) and *Sorghum bicolor* L. (sorghum) and terrace methods in a steep slope (>25-45%) and a very steep slope (>45%) lands. The silvicultural parameters measured were healthy plant, survival rate, stem diameter, and height increments of *sengon* trees and sorghum' yield. The economic aspect was analyzed to calculate the cost, revenue, and profit of the application of sorghum as intercropping plants in vegetative method. The healthy plant of *sengon* and sorghum reached 80-89% (good), survival rate of *sengon* reached 80-89% (good) and sorghum reached 90% (very good), stem diameter and height increments of *sengon* trees reached 2.90 cm year<sup>-1</sup> and 2.06 m year<sup>-1</sup>, and the height increment of sorghum was 45.55 cm month<sup>-1</sup> in the steep slope (>25-45%). In the very steep slope (>45%), healthy plant of *sengon* and sorghum were 70-79% (moderate) and 80-89% (good), survival rate of *sengon* and sorghum was 80-89% (good), stem diameter and height increments of *sengon* were 2.43 cm year<sup>-1</sup> and 1.73 m year<sup>-1</sup>, and height increment of sorghum was 33.05 cm month<sup>-1</sup>. Total cost, total revenue, and profit of the vegetative (*sengon* and sorghum) and terrace methods combination in the steep slope (>25-45%) were Rp9,181,128.47 ha<sup>-1</sup>cs<sup>-1</sup>; Rp1,800,000.00 ha<sup>-1</sup>cs<sup>-1</sup>; and (-)Rp7,181,128.47 ha<sup>-1</sup>cs<sup>-1</sup>, respectively. In the steeper ground (>45%), this application expended total cost as much as Rp9,181,128.47 ha<sup>-1</sup>cs<sup>-1</sup>, total revenue as much as Rp650,000.00 ha<sup>-1</sup>cs<sup>-1</sup>, and profit as much as (-)Rp8,531,128.47 ha<sup>-1</sup>cs<sup>-1</sup>. Although sorghum was not profitable economically as intercropping plant in agroforestry system (*sengon*-sorghum) in different slope lands for short term, the method combination between vegetative (*sengon*-sorghum) and terrace techniques could be useful to soil and water conservation as well as environmental aspect for long term.

### 1. Introduction

Agroforestry as the future land use could be hoped to increase the environmental services such as conserving hydro-ecological and biodiversity functions, and carbon sequestration as well as economic value [1]. Agroforestry is also may recommended to overcome sloping land management. The application of combination of vegetative and mechanic methods is often the best recommendation in relation to soil and water conservation technology. Land is part of landscape including physical factor such as climate, topography, hydrology, or natural vegetation that had influenced to land use potentially [2]. Terrace is used to reduce surface run off and directing it to the stable outlet [3].

Sorghum (*Sorghum bicolor*) has been cultivated in many developing countries in Asia, Africa, and America [4], and many regions in Indonesia especially in Java, South Sulawesi, Southeast Sulawesi, Nusa Tenggara Barat, and Nusa Tenggara Timur [5]. Agroforestry sorghum (*Sorghum* spp.) and *Acacia crassicarpa* in Industrial Plantation Forest could increase bees honey productivity (silvopastura) [6]. The agroforestry *sengon* (*Falcataria moluccana*) - peanut (*Arachis hypogaea*) and *jabon* (*Anthocephalus cadamba*) - soybeans (*Glycine max*) could be applied in different soil slopes in terms of growth and hydro-ecological parameters [7] [8]. The implementation of these two

agroforestry is also give economical benefit from peanut and soybean's selling for the short term [9].

The best application soil and water conservation technique is usually combination vegetative and mechanical methods. This way may give more benefits in terms consevation and environmental aspects for long term. In addition, this implementation needs the cheaper cost and could give added economic from short term plantation. The objective of this study were to investigate silvicultural and economic aspects of application vegetative (*Falcataria moluccana*-*Sorghum bicolor* L.Moench) and terrace on different slope lands.

## 2. Material and methods

### 2.1. Study site

This study was conducted in Education Forest of Forestry Faculty of Mulawarman University, Lempake District, Samarinda City, Province of East Kalimantan. The study took place for six months from July to December 2018. The study was located at 0°25'10"-0°25'24" South latitude and 117°14'00"-117°14'14" East longitude. The average rainfall, temperature, and relative humidity were 211.5 mm monthly, 27.4°C, and 82.2% with type A climate (a quotient (Q) of 4.8 per cent) [10] [11].

### 2.2. Data collection and analysis

2.2.1. *Experimental procedures.* Two experimental plots sized 10 m × 10 m each were located in two different slope classes (a steep slope of >25-45% and a very steep slope of >45%) in the experimental forest. Terraces sized 2 m wide were established in experimental plots. The ditch sized 25 cm wide and 10 cm depth was completed terraces. *Sengon* (*F. moluccana*) and sorghum (*S. bicolor*) were planted on both experimental plots. *Sengon* trees were planted with a spacing of 3 m × 3 m. Sorghum was planted in between *sengon* trees. Sorghum was chosen as intercropping among *sengon* trees two months after long beans (*V. cylindrica*) harvesting. Plant maintenance was done by watering, weeding, fertilizer application, and pest and plant diseases control. The harvesting was done for sorghum only, but not on *sengon* trees.

2.2.2. *Silvicultural parameters.* The observation and measurement of plant growth were conducted at the end of every month for four months. The observation was carried out on both *sengon* and sorghum plants. The *sengon* and sorghum's healthy plant, survival rate, and tree height measured as well as *sengon*'s diameter and sorghum's yield. The height of twenty sorghum plants were measured every two weeks during four months.

2.2.3. *Economic parameters.* The economy parameters were analyzed to calculate cost, revenue, and profit from the implementation of sorghum as intercropping in *sengon*-sorghum agroforestry systems. Cost is analysed from price and quantity of inputs, thus revenue is price of production yield, and meanwhile profit is revenue minus cost [12].

## 3. Results and discussion

### 3.1. Silvicultural aspects of vegetative (*sengon*-sorghum) and terrace combination

The plant growth parameters of *sengon* and sorghum combination were on categories "moderate" to "very good" in the steep and very steep slopes. The plant growth parameters of *sengon* and sorghum in application vegetative and terrace combination system on the two different slope classes are summarized in Table 3. The healthy plant and survival rate of *sengon* were categorized to "good" (80-89%) on the steep slope as well as the healthy plant of sorghum on the steep slope and very steep slope plots. The *sengon* trees on very steep slope showed the moderate healthy plant and the good survival rate. The survival rate of sorghum in steep slope was better than those in very steep slope. Meanwhile,

the yield of sorghum was also higher (360 kg ha<sup>-1</sup>) in steep slope than those in very steep slope (130 kg ha<sup>-1</sup>).

**Table 3.** The plant growth parameters of sengon and sorghum in vegetative and terrace combination system on the two different slope classes

Plant species	Steep slope (>40%)			Very steep slope (>40%)		
	Healthy plant (%)	Survival rate (%)	Yield (kg ha <sup>-1</sup> )	Healthy plant (%)	Survival rate (%)	Yield (kg ha <sup>-1</sup> )
Sengon	80-89 (Good)	80-89 (Good)	-	70-79 (Moderate)	80-89 (Good)	-
Sorghum	80-89 (Good)	90 (Very good)	360	80-89 (Good)	80-89 (Good)	130

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The monthly diameter and height increments of *sengon* trees that were measured for four months are illustrated Tables 4 and 5. The stem diameter and height increment of *sengon* trees is faster on the steep slope than those on the steeper slope. The average stem diameter and height increments of *sengon* were 2.90 cm year<sup>-1</sup> and 2.06 m year<sup>-1</sup> on the steep slopes. The average stem diameter increments of sengon trees were 2.43 cm year<sup>-1</sup> on the steep slope, while the average height increment was 1.73 m year<sup>-1</sup>. The height increment of sorghum in steep slope was better (45.55 cm month<sup>-1</sup>) than those in very steep slope (33.05 cm month<sup>-1</sup>).

**Commented [w2]:** Is it significant different between treatment? Please test the result with T-test or others statistic method

**Commented [w3]:** The MAI is in the very steep slope?

**Commented [w4]:** Why the growth of sengon in the steep slope is higher than very steep slope? (Table 4)

The average diameter increment of *sengon* in *sengon* and sorghum agroforestry system (on steep and very steep slopes) was lower compared than those *sengon* and peanut in agroforestry system (on slight steep and steep slopes) as reported by [8]. Contrarily, the average height increment of this combination was higher than those.... reported by [8]. Similarly the diameter increment of *sengon* in this study is also lower than those in agroforestry system, monoculture system, and intensive monoculture system [13] [14]. However, the average diameter increments of sengon trees on the steep slope were higher than those planted on the conventional monoculture system [14]. The average height increment of sorghum on sengon and sorghum agroforestry system were 45.55 cm month<sup>-1</sup> dan 33.05 cm month<sup>-1</sup> in steep slope and very steep slope respectively.

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**Table 4.** *Sengon* stem diameter increments (mm) on the two different slopes classes

Tree number	Steep slope (>25-45%)					Very steep slope (>45%)				
	D <sub>0</sub>	d <sub>1</sub>	d <sub>2</sub>	d <sub>3</sub>	d <sub>4</sub>	D <sub>0</sub>	d <sub>1</sub>	d <sub>2</sub>	d <sub>3</sub>	d <sub>4</sub>
1	41.4	43.2	44.8	46.4	48.5	41.4	43.2	44.4	46.4	47.7
2	40.3	41.7	42.7	44.5	46.8	40.3	41.7	42.7	44.5	46.8
3	32.1	33.0	-	-	-	51.2	53.7	56.7	58.4	62.1
4	51.2	53.7	56.7	58.4	62.8	34.2	36.4	38.7	41.0	43.1
5	44.2	46.4	48.7	51.0	53.1	40.1	42.0	43.2	47.4	51.3
6	30.1	32.0	33.2	39.3	41.3	38.0	39.1	41.1	44.2	47.6
7	38.0	39.1	41.5	44.2	47.6	41.3	42.2	43.1	44.8	47.3
8	30.3	32.5	32.9	-	-	42.1	43.0	-	-	-
9	41.3	42.2	43.5	44.8	47.3	50.3	52.0	53.2	54.0	56.2
10	50.3	52.0	53.2	54.0	56.2	57.7	59.6	61.3	63.2	65.6
11	57.7	59.6	61.3	63.2	65.6	45.9	47.1	48.2	50.1	51.2
12	38.2	39.7	42.1	47.9	49.8	47.0	48.2	49.1	51.0	52.5
13	47.0	48.2	49.1	51.0	54.1	31.3	32.5	32.9	-	-
14	47.6	49.3	51.4	53.0	55.0	47.6	49.3	51.0	53.0	54.2
15	39.8	51.1	57.9	52.6	65.3	39.8	41.1	47.4	52.6	54.5
16	52.1	53.4	55.5	58.3	61.0	52.1	53.4	55.1	58.3	60.2
Mean	42.6	44.8	47.6	50.6	53.9	43.8	45.3	47.2	50.6	52.9
SD	8.1	8.3	8.6	6.6	7.6	7.0	7.1	7.5	6.4	6.4
Annual diameter increment	28.97 mm year <sup>-1</sup> = 2.90 cm year <sup>-1</sup>					24.30 mm year <sup>-1</sup> = 2.43 cm year <sup>-1</sup>				

Note: D<sub>0</sub> = initial stem diameter (diameter measurement at the beginning of experiment); d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub> = diameter at the end of the first, second, third, and fourth month after planting; SD=Standard Deviation

**Table 5.** *Sengon* height increments (cm) on the two different slopes

Tree number	Steep slope (>25-45%)					Very steep slope (>45%)				
	H <sub>0</sub>	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>	H <sub>0</sub>	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>
1	207.5	223.5	235.1	250.6	267.0	209.3	227.3	244.2	261.5	275.0
2	193.4	217.5	224.2	252.0	270.2	205.0	219.7	234.2	252.1	267.5
3	215.5	230.1	-	-	-	231.1	245.2	262.1	280.1	295.2
4	218.3	234.5	251.2	266.8	282.3	206.7	225.0	236.2	240.3	255.0
5	206.2	231.2	245.3	253.0	263.2	200.2	215.7	232.6	250.3	263.4
6	198.2	203.0	245.8	262.3	280.9	203.0	221.3	235.4	252.4	270.0
7	216.3	231.6	245.1	269.7	276.9	209.5	226.2	241.5	257.3	274.8
8	217.5	225.2	-	-	-	216.6	221.6	-	-	-
9	219.3	233.4	255.8	267.7	278.2	223.1	238.2	248.3	265.0	280.2
10	223.4	240.1	256.8	272.0	289.9	271.1	285.8	300.2	315.2	322.5
11	206.0	223.5	242.0	259.8	274.2	204.3	217.3	233.5	250.3	267.9
12	203.5	220.8	245.7	262.3	279.0	212.2	227.7	244.7	259.8	275.0
13	188.9	213.2	245.9	267.3	273.3	214.2	219.6	225.8	-	-
14	209.9	213.2	240.9	257.0	274.3	206.8	223.2	237.1	244.9	253.6
15	232.8	247.6	274.1	297.0	305.4	187.9	205.4	213.0	222.1	231.4
16	208.7	214.2	249.7	277.8	291.8	183.2	198.1	205.2	230.8	235.5
Mean	210.3	225.2	247.0	265.4	279.0	211.5	226.1	239.6	255.9	269.1
SD	11.3	11.4	11.3	12.1	10.9	19.7	19.3	21.6	22.3	22.8
Annual height increment	206.12 cm year <sup>-1</sup> =2.06 m year <sup>-1</sup>					Annual height increment 172.68 cm year <sup>-1</sup> =1.73 m year <sup>-1</sup>				

Note: H<sub>0</sub> = initial tree height (height measurement at the beginning of experiment); h<sub>1</sub>, h<sub>2</sub>, h<sub>3</sub>, h<sub>4</sub> = height at the end of the first, second, third, and fourth month after planting; SD=Standard Deviation.

**Table 6.** Sorghum height increments (cm) on steep slope (>25-45%)

Plant number	Weeks							
	2	4	6	8	10	12	14	16
1	28.0	49.1	58.9	100.1	132.8	146.3	162.7	192.4
2	29.5	45.6	61.3	86.7	128.0	145.5	160.9	183.9
3	26.5	43.6	62.3	104.6	137.2	153.6	165.8	195.2
4	24.4	36.6	38.0	56.7	63.8	93.2	153.5	178.2
5	26.5	40.1	60.2	75.7	111.2	124.3	158.2	197.3
6	21.9	52.5	82.0	116.0	166.5	174.8	197.8	213.4
7	28.0	51.8	70.5	127.7	167.1	179.2	208.5	235.2
8	23.7	43.6	77.3	128.6	173.2	189.7	219.0	247.3
9	26.5	38.0	73.5	121.3	182.7	196.8	237.3	264.1
10	21.0	44.0	74.8	137.1	175.3	187.7	225.4	252.8
11	21.4	53.0	71.0	113.8	168.2	181.5	198.3	223.0
12	18.5	51.0	82.2	103.5	149.9	162.1	187.5	212.7
13	28.5	48.5	54.7	80.0	108.8	119.0	145.2	178.9
14	15.0	42.6	63.2	77.6	97.8	106.9	132.5	173.4
15	16.0	23.0	46.7	66.0	74.1	85.8	93.4	107.9
16	23.0	36.1	57.5	85.0	113.7	81.8	95.5	123.0
17	11.0	45.5	50.0	61.5	70.2	81.5	92.4	119.5
18	18.9	24.0	46.0	55.4	63.2	72.1	84.6	103.2
19	24.0	44.0	51.5	71.0	89.8	100.1	119.8	137.9
20	20.1	23.1	41.1	49.5	63.3	74.8	87.8	105.0
Mean	22.6	41.4	61.1	90.9	121.8	132.8	156.3	182.2
SD	5.0	9.5	13.2	27.2	42.1	43.7	49.3	51.3
Annual height increment	45.55 cm month <sup>-1</sup>							

**Table 7.** Sorghum height increments (cm) on very steep slope (>45%)



Plant number	Weeks							
	2	4	6	8	10	12	14	16
1	20.0	62.6	85.4	103.4	112.3	142.5	156.7	163.7
2	18.8	38.7	59.3	87.6	95.2	106.6	121.0	142.9
3	20.0	36.0	88.0	124.6	143.2	152.3	161.2	152.5
4	16.5	37.2	77.9	88.5	117.8	138.2	142.7	148.2
5	22.0	40.1	61.0	91.9	130.5	134.2	150.2	163.6
6	34.0	61.3	68.7	84.7	121.1	125.8	141.8	151.0
7	16.5	37.5	60.9	98.1	113.8	115.7	125.1	134.9
8	34.0	47.5	79.4	98.2	115.4	129.8	136.1	142.5
9	14.0	35.2	59.4	90.8	114.0	139.5	157.8	171.2
10	22.5	37.0	65.4	92.7	109.8	117.8	124.8	132.8
11	18.9	47.0	53.7	78.6	104.0	115.3	125.7	142.6
12	12.0	27.1	41.0	52.3	60.1	78.2	92.0	105.1
13	14.1	23.8	48.7	65.9	76.0	97.5	104.2	117.0
14	12.0	21.3	35.8	56.1	75.0	89.2	102.0	115.2
15	10.7	16.2	28.5	36.1	54.2	76.3	87.1	99.5
16	15.1	18.3	25.1	35.4	51.7	65.2	85.5	92.7
17	11.8	30.8	43.8	55.2	77.3	99.7	107.3	97.5
18	17.1	37.5	43.4	69.7	79.8	95.6	103.5	132.8
19	15.3	32.4	41.2	64.7	75.2	93.1	100.2	124.7
20	25.8	29.0	42.2	48.0	65.4	78.7	98.8	113.8
Mean	18.6	35.8	55.4	75.4	94.6	109.6	121.2	132.2
SD	6.6	12.3	18.3	24.4	27.0	25.3	24.7	23.3
Annual height increment	33.05 cm month <sup>-1</sup>							

### 3.2. Economical aspects of vegetative (sengon-sorghum) and terrace combination

The implementation vegetative (*sengon-sorghum*) and terrace systems in different slope classes need the cost expenditure to buy materials, depreciation of equipment, and wage of labor. Besides cost expenditure, this implementation gives revenue and profit, especially from sorghum yield. Table 9 shows economic analysis of sorghum as intercropping in vegetatives (*sengon-sorghum*) and terrace combination system on the two different slope classes. The material cost was used to buying sengon seedling, sorghum seed, string of raffia, plastic bottle, plastic, fertilizers, and pesticide. Fertilizer is given to increase soil fertility. The profit of sengon and sorghum plantation in steep slope was (-) Rp7,381,128.47 ha<sup>-1</sup> cs<sup>-1</sup> and in very steep slope was (-) Rp8,531,128.47 ha<sup>-1</sup> cs<sup>-1</sup>. Although there no profit are obtained from implementation *sengon-sorghum* on steep slope and very steep slope plots, but the revenue from selling sorghum yield are resulted. These revenue were Rp1,800,000.00 and Rp650,000.00 ha<sup>-1</sup> cs<sup>-1</sup> on steep slope and very steep slope plots, respectively.

The profit of sorghum yield in steep slope was higher than peanut yield on agroforestry system of sengon-peanut as reported by [9]. The total cost, total revenue, and profit on agroforestry system of sengon and peanut were Rp10,985,000.00 ha<sup>-1</sup> cs<sup>-1</sup>, Rp14,000,000.00 ha<sup>-1</sup> cs<sup>-1</sup> and Rp3,015,000.00 ha<sup>-1</sup> cs<sup>-1</sup>. However, implementation of sorghum as intercropping in vegetative (*sengon-sorghum*) and terrace combination system on the two different slope classes is still give benefit compared to soy beans yield on agroforestry system *jabon* and soy beans. The total cost of Rp11,019,000.00 ha<sup>-1</sup> cs<sup>-1</sup>, total revenue of Rp3,500,000.00 ha<sup>-1</sup> cs<sup>-1</sup>, and profit of (-) Rp7,519,000.00 ha<sup>-1</sup> cs<sup>-1</sup> are from soybeans yield on agroforestry system *jabon* and soybeans [9]. The application vegetative (*sengon-sorghum*) and terrace system in different slope classes could add economic values for short term. For long term, sengon is also increase added value, especially soil and water conservation as well as environmental impacts such as microclimate aspect, carbon stock, etc.

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**Table 9.** Economic analysis of sorghum as intercropping in vegetatives (*sengon-sorghum*) and terrace combination system on the two different slope classes

No.	Item	Quantity	Unit	Price (Rp)	Unit	Total (Rp. ha <sup>-1</sup> cs <sup>-1</sup> )
<b>Production cost (Steep slope and very steep slope plots)</b>						

No.	Item	Quantity	Unit	Price (Rp)	Unit	Total (Rp. ha <sup>-1</sup> cs <sup>-1</sup> )
<b>Raw materials cost</b>						
1	<i>Sengon</i> seedling	1,600.00	seedling ha <sup>-1</sup> cs <sup>-1</sup>	1,000.00	seedling <sup>-1</sup>	1,600,000.00
2	Sorghum seed	50.00	pack ha <sup>-1</sup>	27,500.00	pack <sup>-1</sup>	1,375,000.00
3	String of raffia	500.00	units ha <sup>-1</sup>	2,000.00	units <sup>-1</sup>	1,000,000.00
4	Plastic bottle	2,500.00	units ha <sup>-1</sup>	200.00	units <sup>-1</sup>	500,000.00
5	Plastic	100.00	pack ha <sup>-1</sup>	2,000.00	pack <sup>-1</sup>	200,000.00
6	Organic fertilizer	50.00	gunny sack ha <sup>-1</sup>	15,000.00	gunny sack <sup>-1</sup>	750,000.00
7	Urea fertilizer	50.00	pack ha <sup>-1</sup>	7,500.00	pack <sup>-1</sup>	375,000.00
8	TSP fertilizer	250.00	kg ha <sup>-1</sup> cs <sup>-1</sup>	6,000.00	kg <sup>-1</sup>	1,500,000.00
9	Petrokum	250.00	pack ha <sup>-1</sup>	6,000.00	pack <sup>-1</sup>	1,500,000.00
10	Matador	50.00	units ha <sup>-1</sup>	21,000.00	unit <sup>-1</sup>	1,050,000.00
11	Regent	50.00	units ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	1,000,000.00
	Subtotal					10,850,000.00
<b>Depreciation cost</b>						
12	Hoe	1.00	unit ha <sup>-1</sup>	25,000.00	unit <sup>-1</sup>	2,083.33
13	Chopper	1.00	unit ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	1,666.67
14	Sickle	1.00	unit ha <sup>-1</sup>	7,500.00	unit <sup>-1</sup>	1,562.50
15	Sprayer	1.00	unit ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	2,777.78
16	Furious	1.00	unit ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	2,777.78
17	Grass knife	1.00	unit ha <sup>-1</sup>	10,000.00	unit <sup>-1</sup>	1,388.89
	Subtotal					12,256.94
<b>Labourers cost</b>						
18	Land preparation	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
19	Planting	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
20	Plantation maintenance					
	a. Replanting	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
	b. Fertilizing	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
	c. Control pest and diseases	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
21	Harvesting	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
	Subtotal	75.00	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	7,500,000.00
	Total cost of <i>sengon</i> and sorghum plantation					18,362,256.94
	Steep slope plot (>25-45%)					9,181,128.47
	Very steep slope plot (>45%)					9,181,128.47
<b>Revenue from Sorghum</b>						
	Steep slope plot (>25-45%)	360.00	kg ha <sup>-1</sup>	5,000.00	kg	1,800,000.00
	Very steep slope plot (>45%)	130.00	kg ha <sup>-1</sup>	5,000.00	kg	650,000.00
	Total					2,450,000.00
<b>Profit</b>						
	Steep slope plot (>25-45%)					-7,381,128.47
	Very steep slope plot (>45%)					-8,531,128.47
	Total					-15,912,255.94

Note: cs = cropping season

#### 4. Conclusion

The implementation of vegetative and terrace systems combination in soil and water conservation technology could apply in the different slope lands. This application will give benefit based on silvicultural and economic aspects. The combination vegetative and civil technique methods still show good growth parameters on the steep slope lands. The economic benefit will be given by agricultural

yield as cropping plant in the short term. In long term, this application gives away benefit to conserve soil and water as well as environment aspects. The important information on silvicultural and economic aspects could be basic recommendation in relation to alternative agroforestry system for small scale and soil conservation program for wide scale. The basic data could be used as consideration by all stakeholders, including farmer, forester, private parties and the government in terms of land management and soil conservation activities.

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# Silvicultural and economic aspects on combination of vegetatives (*Falcataria moluccana*-*Sorghum bicolor* L.) and terrace methods in the different slope lands

Karyati<sup>1</sup>, Angelina Ellytasari Santoso<sup>1</sup>, Muhammad Syafrudin<sup>1</sup>, Karmini<sup>2</sup>

<sup>1</sup>\*Faculty of Forestry, University of Mulawarman, Samarinda, East Kalimantan, Indonesia 75123

<sup>2</sup>Faculty of Agriculture, University of Mulawarman, Samarinda, East Kalimantan, Indonesia

\*Corresponding Author : [karyati@fahutan.unmul.ac.id](mailto:karyati@fahutan.unmul.ac.id); [karyati.hanapi@yahoo.com](mailto:karyati.hanapi@yahoo.com)

**Abstract.** The vegetative and mechanic methods are soil and water conservation technology to prevent surface run off and soil erosion as well as protect soil nutrient. The study objectives were to know silvicultural and economic aspects on combination of vegetatives between *Falcataria moluccana* (*segon*) and *Sorghum bicolor* L. (sorghum) and terrace methods in a steep slope (>25-45%) and a very steep slope (>45%) lands. The silvicultural parameters measured were healthy plant, survival rate, stem diameter, and height increments of *segon* trees and sorghum' yield. The economic aspect was analyzed to calculate the cost, revenue, and profit of the application of sorghum as intercropping plants in vegetative method. The healthy plant of *segon* and sorghum reached 80-89% (good), survival rate of *segon* reached 80-89% (good) and sorghum reached 90% (very good), stem diameter and height increments of *segon* trees reached 2.90 cm year<sup>-1</sup> and 2.06 m year<sup>-1</sup>, and the height increment of sorghum was 45.55 cm month<sup>-1</sup> in the steep slope (>25-45%). In the very steep slope (>45%), healthy plant of *segon* and sorghum were 70-79% (moderate) and 80-89% (good), survival rate of *segon* and sorghum was 80-89% (good), stem diameter and height increments of *segon* were 2.43 cm year<sup>-1</sup> and 1.73 m year<sup>-1</sup>, and height increment of sorghum was 33.05 cm month<sup>-1</sup>. Total cost, total revenue, and profit of the vegetative (*segon* and sorghum) and terrace methods combination in the steep slope (>25-45%) were Rp9,181,128.47 ha<sup>-1</sup>cs<sup>-1</sup>; Rp1,800,000.00 ha<sup>-1</sup>cs<sup>-1</sup>; and (-)Rp7,181,128.47 ha<sup>-1</sup>cs<sup>-1</sup>, respectively. In the steeper ground (>45%), this application expended total cost as much as Rp9,181,128.47 ha<sup>-1</sup>cs<sup>-1</sup>, total revenue as much as Rp650,000.00 ha<sup>-1</sup>cs<sup>-1</sup>, and profit as much as (-)Rp8,531,128.47 ha<sup>-1</sup>cs<sup>-1</sup>. Although sorghum was not profitable economically as intercropping plant in agroforestry system (*segon*-sorghum) in different slope lands for short term, the method combination between vegetative (*segon*-sorghum) and terrace techniques could useful to soil and water conservation as well as environmental aspect for long term.

## 1. Introduction

Agroforestry as the future land use could be hoped to increase the environmental services such as conserving hydro-oroological and biodiversity functions, and carbon sequestration as well as economic value [1]. Agroforestry is also may recommended to overcome sloping land management. The application of combination of vegetative and mechanic methods is often the best recommendation in relation to soil and water conservation technology. Land is part of landscape including phisic factor

such as climate, topography, hydrology, or natural vegetation that had influenced to land use potentially [2]. Terrace is used to reduce surface run off and directing it to the stable outlet [3].

Sorghum (*Sorghum bicolor*) has been cultivated in many developing countries in Asia, Africa, and America [4], and many regions in Indonesia especially in Java, South Sulawesi, Southeast Sulawesi, Nusa Tenggara Barat, and Nusa Tenggara Timur [5]. Agroforestry sorghum (*Sorghum* spp.) and *Acacia crassicarpa* in Industrial Plantation Forest could increase bees honey productivity (silvopastura) [6]. The agroforestry *sengon* (*Falcataria moluccana*) - peanut (*Arachis hypogaea*) and *jabon* (*Anthocephalus cadamba*) - soybeans (*Glycine max*) could be applied in different soil slopes in terms of growth and hydro-orological parameters [7] [8]. The implementation of these two agroforestry is also give economical benefit from peanut and soybean's selling for the short term [9].

The best application soil and water conservation technique is usually combination vegetative and mechanical methods. This way may give more benefits in terms consevation and environmental aspects for long term. In addition, this implementation needs the cheaper cost and could give added economic from short term plantation. The objective of this study were to investigate silvicultural and economic aspects of application vegetative (*Falcataria moluccana-Sorghum bicolor* L.Moench) and terrace on different slope lands.

## 2. Material and methods

### 2.1. Study site

This study was conducted in Education Forest of Forestry Faculty of Mulawarman University, Lempake District, Samarinda City, Province of East Kalimantan. The study took place for six months from July to December 2018. The study was located at 0°25'10"-0°25'24" South latitude and 117°14'00"-117°14'14" East longitude. The average rainfall, temperature, and relative humidity were 211.5 mm monthly, 27.4°C, and 82.2% with type A climate (a quotient (Q) of 4.8 per cent) [10] [11].

### 2.2. Data collection and analysis

2.2.1. *Experimental procedures.* Two experimental plots sized 10 m × 10 m each were located in two different slope classes (a steep slope of >25-45% and a very steep slope of >45%) in the experimental forest. Terraces sized 2 m wide were established in experimental plots. The ditch sized 25 cm wide and 10 cm depth was completed terraces. *Sengon* (*F. moluccana*) and sorghum (*S. bicolor*) were planted on both experimental plots. *Sengon* trees were planted with a spacing of 3 m × 3 m. Sorghum was planted in between *sengon* trees. Sorghum was chosen as intercropping among *sengon* trees two months after long beans (*V. cylindrica*) harvesting. Plant maintenance was done by watering, weeding, fertilizer application, and pest and plant diseases control. The harvesting was done for sorghum only, but not on *sengon* trees.

2.2.2. *Silvicultural parameters.* The observation and measurement of plant growth were conducted at the end of every month for four months. The observation was carried out on both *sengon* and sorghum plants. The *sengon* and sorghum's healthy plant, survival rate, and tree height measured as well as *sengon*'s diameter and sorghum's yield. The criteria of plant growth parameters (healthy plant, survival rate, and ground coverage) were described based on Regulation of Ministry of Forestry Republic of Indonesia Number: P.60/Menhut-II/2009 [12]. The height of twenty sorghum plants were measured every two weeks during four months.

2.2.3. *Economic parameters.* The economy parameters were analyzed to calculate cost, revenue, and profit from the implementation of sorghum as intercropping in *sengon*-sorghum agroforestry systems. Cost is analysed from price and quantity of inputs, thus revenue is price of production yield, and meanwhile profit is revenue minus cost [13].

### 3. Results and discussion

#### 3.1. Silvicultural aspects of vegetative (*sengon*-sorghum) and terrace combination

The plant growth parameters of *sengon* and sorghum combination were on categories “moderate” to “very good” in the steep and very steep slopes. The plant growth parameters of *sengon* and sorghum in application vegetative and terrace combination system on the two different slope classes are summarized in Table 3. The healthy plant and survival rate of *sengon* were categorized to “good” (80-89%) on the steep slope as well as the healthy plant of sorghum on the steep slope and very steep slope plots. The *sengon* trees on very steep slope showed the moderate healthy plant and the good survival rate. The survival rate of sorghum in steep slope was better than those in very steep slope. Meanwhile, the yield of sorghum was also higher (360 kg ha<sup>-1</sup>) in steep slope than those in very steep slope (130 kg ha<sup>-1</sup>).

**Table 3.** The plant growth parameters of *sengon* and sorghum in vegetative and terrace combination system on the two different slope classes

Plant species	Steep slope (>40%)			Very steep slope (>40%)		
	Healthy plant (%)	Survival rate (%)	Yield (kg ha <sup>-1</sup> )	Healthy plant (%)	Survival rate (%)	Yield (kg ha <sup>-1</sup> )
<i>Sengon</i>	80-89 (Good)	80-89 (Good)	-	70-79 (Moderate)	80-89 (Good)	-
Sorghum	80-89 (Good)	90 (Very good)	360	80-89 (Good)	80-89 (Good)	130

The monthly diameter and height increments of *sengon* trees that were measured for four months are illustrated Tables 4 and 5. The stem diameter and height increment of *sengon* trees is faster on the steep slope than those on the steeper slope. The average stem diameter and height increments of *sengon* were 2.90 cm year<sup>-1</sup> and 2.06 m year<sup>-1</sup> on the steep slopes. The average stem diameter increments of *sengon* trees were 2.43 cm year<sup>-1</sup> on the very steep slope, while the average height increment was 1.73 m year<sup>-1</sup>. However, the t-test showed no significant differences between stem diameter increments in the steep slope and very steep slope as well as height increments. The height increment of sorghum in steep slope was better (45.55 cm month<sup>-1</sup>) than those in very steep slope (33.05 cm month<sup>-1</sup>). This might be caused by the different slope gradient in the study plots. The decreasing length and gradient of slope tends to decreasing surface runoff and soil erosion. The soil nutrient contents especially in the surface soils will be maintained in the less steep slope, because the risk of soil erosion is relatively smaller when it rains on the ground. Similarly, the stem diameter and plant height were higher in a slightly steep slope than those in the steep slope [7] as well as in the steep slope than those in a very steep slope [14].

The average diameter increment of *sengon* in *sengon* and sorghum agroforestry system (on steep and very steep slopes) was lower compared than those *sengon* and peanut in agroforestry system (on slight steep and steep slopes) [8]. This result implied that slope gradient and ground cover plants might influence stem diameter. On the steeper soils, the diameter growth is relatively slower. In addition, the types and characteristics of cover crop as intercropping plant in agroforestry system also influence growth of forestry plants. The legume plant such as peanuts may reduce leaching of organic matter and increase soil nutrients potentially. Contrarily, the average height increment of this combination was higher than those [8]. Similarly the diameter increment of *sengon* in this study is also lower than those in agroforestry system, monoculture system, and intensive monoculture system [15] [16]. However, the average diameter increments of *sengon* trees on the steep slope were higher than those planted on the conventional monoculture system [16]. The combination of forestry and agriculture plants in agroforestry systems can increase the system sustainability and complexity compared to monocultures. This is likely to influence soil nitrogen cycling by altering soil microbial community structure and functions [17]. The plants will grow better on fertile soils. The implementation of

vegetative and terrace system is also hoped to reduce the potential soil erosion [14]. The average height increment of sorghum on sengon and sorghum agroforestry system were 45.55 cm month<sup>-1</sup> dan 33.05 cm month<sup>-1</sup> in steep slope and very steep slope respectively.

**Table 4.** *Sengon* stem diameter increments (mm) on the two different slopes classes

Tree number	Steep slope (>25-45%)					Very steep slope (>45%)				
	D <sub>0</sub>	d <sub>1</sub>	d <sub>2</sub>	d <sub>3</sub>	d <sub>4</sub>	D <sub>0</sub>	d <sub>1</sub>	d <sub>2</sub>	d <sub>3</sub>	d <sub>4</sub>
1	41.4	43.2	44.8	46.4	48.5	41.4	43.2	44.4	46.4	47.7
2	40.3	41.7	42.7	44.5	46.8	40.3	41.7	42.7	44.5	46.8
3	32.1	33.0	-	-	-	51.2	53.7	56.7	58.4	62.1
4	51.2	53.7	56.7	58.4	62.8	34.2	36.4	38.7	41.0	43.1
5	44.2	46.4	48.7	51.0	53.1	40.1	42.0	43.2	47.4	51.3
6	30.1	32.0	33.2	39.3	41.3	38.0	39.1	41.1	44.2	47.6
7	38.0	39.1	41.5	44.2	47.6	41.3	42.2	43.1	44.8	47.3
8	30.3	32.5	32.9	-	-	42.1	43.0	-	-	-
9	41.3	42.2	43.5	44.8	47.3	50.3	52.0	53.2	54.0	56.2
10	50.3	52.0	53.2	54.0	56.2	57.7	59.6	61.3	63.2	65.6
11	57.7	59.6	61.3	63.2	65.6	45.9	47.1	48.2	50.1	51.2
12	38.2	39.7	42.1	47.9	49.8	47.0	48.2	49.1	51.0	52.5
13	47.0	48.2	49.1	51.0	54.1	31.3	32.5	32.9	-	-
14	47.6	49.3	51.4	53.0	55.0	47.6	49.3	51.0	53.0	54.2
15	39.8	51.1	57.9	52.6	65.3	39.8	41.1	47.4	52.6	54.5
16	52.1	53.4	55.5	58.3	61.0	52.1	53.4	55.1	58.3	60.2
Mean	42.6	44.8	47.6	50.6	53.9	43.8	45.3	47.2	50.6	52.9
SD	8.1	8.3	8.6	6.6	7.6	7.0	7.1	7.5	6.4	6.4
Annual diameter increment	28.97 mm year <sup>-1</sup> = 2.90 cm year <sup>-1</sup>					Annual diameter increment 24.30 mm year <sup>-1</sup> = 2.43 cm year <sup>-1</sup>				

Note: D<sub>0</sub> = initial stem diameter (diameter measurement at the beginning of experiment); d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, d<sub>4</sub> = diameter at the end of the first, second, third, and fourth month after planting; SD=Standard Deviation

**Table 5.** *Sengon* height increments (cm) on the two different slopes

Tree number	Steep slope (>25-45%)					Very steep slope (>45%)				
	H <sub>0</sub>	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>	H <sub>0</sub>	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>
1	207.5	223.5	235.1	250.6	267.0	209.3	227.3	244.2	261.5	275.0
2	193.4	217.5	224.2	252.0	270.2	205.0	219.7	234.2	252.1	267.5
3	215.5	230.1	-	-	-	231.1	245.2	262.1	280.1	295.2
4	218.3	234.5	251.2	266.8	282.3	206.7	225.0	236.2	240.3	255.0
5	206.2	231.2	245.3	253.0	263.2	200.2	215.7	232.6	250.3	263.4
6	198.2	203.0	245.8	262.3	280.9	203.0	221.3	235.4	252.4	270.0
7	216.3	231.6	245.1	269.7	276.9	209.5	226.2	241.5	257.3	274.8
8	217.5	225.2	-	-	-	216.6	221.6	-	-	-
9	219.3	233.4	255.8	267.7	278.2	223.1	238.2	248.3	265.0	280.2
10	223.4	240.1	256.8	272.0	289.9	271.1	285.8	300.2	315.2	322.5
11	206.0	223.5	242.0	259.8	274.2	204.3	217.3	233.5	250.3	267.9
12	203.5	220.8	245.7	262.3	279.0	212.2	227.7	244.7	259.8	275.0
13	188.9	213.2	245.9	267.3	273.3	214.2	219.6	225.8	-	-
14	209.9	213.2	240.9	257.0	274.3	206.8	223.2	237.1	244.9	253.6
15	232.8	247.6	274.1	297.0	305.4	187.9	205.4	213.0	222.1	231.4
16	208.7	214.2	249.7	277.8	291.8	183.2	198.1	205.2	230.8	235.5
Mean	210.3	225.2	247.0	265.4	279.0	211.5	226.1	239.6	255.9	269.1
SD	11.3	11.4	11.3	12.1	10.9	19.7	19.3	21.6	22.3	22.8
Annual height increment	206.12 cm year <sup>-1</sup> = 2.06 m year <sup>-1</sup>					Annual height increment 172.68 cm year <sup>-1</sup> = 1.73 m year <sup>-1</sup>				

Note: H<sub>0</sub> = initial tree height (height measurement at the beginning of experiment); h<sub>1</sub>, h<sub>2</sub>, h<sub>3</sub>, h<sub>4</sub> = height at the end of the first, second, third, and fourth month after planting; SD=Standard Deviation.

**Table 6.** Sorghum height increments (cm) on steep slope (>25-45%)

Plant number	Weeks							
	2	4	6	8	10	12	14	16
1	28.0	49.1	58.9	100.1	132.8	146.3	162.7	192.4
2	29.5	45.6	61.3	86.7	128.0	145.5	160.9	183.9
3	26.5	43.6	62.3	104.6	137.2	153.6	165.8	195.2
4	24.4	36.6	38.0	56.7	63.8	93.2	153.5	178.2
5	26.5	40.1	60.2	75.7	111.2	124.3	158.2	197.3
6	21.9	52.5	82.0	116.0	166.5	174.8	197.8	213.4
7	28.0	51.8	70.5	127.7	167.1	179.2	208.5	235.2
8	23.7	43.6	77.3	128.6	173.2	189.7	219.0	247.3
9	26.5	38.0	73.5	121.3	182.7	196.8	237.3	264.1
10	21.0	44.0	74.8	137.1	175.3	187.7	225.4	252.8
11	21.4	53.0	71.0	113.8	168.2	181.5	198.3	223.0
12	18.5	51.0	82.2	103.5	149.9	162.1	187.5	212.7
13	28.5	48.5	54.7	80.0	108.8	119.0	145.2	178.9
14	15.0	42.6	63.2	77.6	97.8	106.9	132.5	173.4
15	16.0	23.0	46.7	66.0	74.1	85.8	93.4	107.9
16	23.0	36.1	57.5	85.0	113.7	81.8	95.5	123.0
17	11.0	45.5	50.0	61.5	70.2	81.5	92.4	119.5
18	18.9	24.0	46.0	55.4	63.2	72.1	84.6	103.2
19	24.0	44.0	51.5	71.0	89.8	100.1	119.8	137.9
20	20.1	23.1	41.1	49.5	63.3	74.8	87.8	105.0
Mean	22.6	41.4	61.1	90.9	121.8	132.8	156.3	182.2
SD	5.0	9.5	13.2	27.2	42.1	43.7	49.3	51.3
Annual height increment	45.55 cm month <sup>-1</sup>							

**Table 7.** Sorghum height increments (cm) on very steep slope (>45%)

Plant number	Weeks							
	2	4	6	8	10	12	14	16
1	20.0	62.6	85.4	103.4	112.3	142.5	156.7	163.7
2	18.8	38.7	59.3	87.6	95.2	106.6	121.0	142.9
3	20.0	36.0	88.0	124.6	143.2	152.3	161.2	152.5
4	16.5	37.2	77.9	88.5	117.8	138.2	142.7	148.2
5	22.0	40.1	61.0	91.9	130.5	134.2	150.2	163.6
6	34.0	61.3	68.7	84.7	121.1	125.8	141.8	151.0
7	16.5	37.5	60.9	98.1	113.8	115.7	125.1	134.9
8	34.0	47.5	79.4	98.2	115.4	129.8	136.1	142.5
9	14.0	35.2	59.4	90.8	114.0	139.5	157.8	171.2
10	22.5	37.0	65.4	92.7	109.8	117.8	124.8	132.8
11	18.9	47.0	53.7	78.6	104.0	115.3	125.7	142.6
12	12.0	27.1	41.0	52.3	60.1	78.2	92.0	105.1
13	14.1	23.8	48.7	65.9	76.0	97.5	104.2	117.0
14	12.0	21.3	35.8	56.1	75.0	89.2	102.0	115.2
15	10.7	16.2	28.5	36.1	54.2	76.3	87.1	99.5
16	15.1	18.3	25.1	35.4	51.7	65.2	85.5	92.7
17	11.8	30.8	43.8	55.2	77.3	99.7	107.3	97.5
18	17.1	37.5	43.4	69.7	79.8	95.6	103.5	132.8
19	15.3	32.4	41.2	64.7	75.2	93.1	100.2	124.7
20	25.8	29.0	42.2	48.0	65.4	78.7	98.8	113.8
Mean	18.6	35.8	55.4	75.4	94.6	109.6	121.2	132.2
SD	6.6	12.3	18.3	24.4	27.0	25.3	24.7	23.3
Annual height increment	33.05 cm month <sup>-1</sup>							

### 3.2. Economical aspects of vegetative (*sengon-sorghum*) and terrace combination

The implementation vegetative (*sengon-sorghum*) and terrace systems in different slope classes need the cost expenditure to buy materials, depreciation of equipment, and wage of labor. Besides cost



expenditure, this implementation gives revenue and profit, especially from sorghum yield. Table 9 shows economic analysis of sorghum as intercropping in vegetatives (*sengon*-sorghum) and terrace combination system on the two different slope classes. The material cost was used to buying *sengon* seedling, sorghum seed, string of raffia, plastic bottle, plastic, fertilizers, and pesticide. Fertilizer is given to increase soil fertility. The profit of *sengon* and sorghum plantation in steep slope was (-) Rp7,381,128.47 ha<sup>-1</sup> cs<sup>-1</sup> and in very steep slope was (-) Rp8,531,128.47 ha<sup>-1</sup> cs<sup>-1</sup>. Although there no profit are obtained from implementation *sengon*-sorghum on steep slope and very steep slope plots, but the revenue from selling sorghum yield are resulted. These revenue were Rp1,800,000.00 and Rp650,000.00 ha<sup>-1</sup> cs<sup>-1</sup> on steep slope and very steep slope plots, respectively.

The profit of sorghum yield in steep slope was higher than peanut yield on agroforestry system of *sengon*-peanut as reported by [9]. The total cost, total revenue, and profit on agroforestry system of *sengon* and peanut were Rp10,985,000.00 ha<sup>-1</sup> cs<sup>-1</sup>, Rp14,000,000.00 ha<sup>-1</sup> cs<sup>-1</sup> and Rp3,015,000.00 ha<sup>-1</sup> cs<sup>-1</sup>. However, implementation of sorghum as intercropping in vegetative (*sengon*-sorghum) and terrace combination system on the two different slope classes is still give benefit compared to soy beans yield on agroforestry system *jabon* and soy beans. The total cost of Rp11,019,000.00 ha<sup>-1</sup> cs<sup>-1</sup>, total revenue of Rp3,500,000.00 ha<sup>-1</sup> cs<sup>-1</sup>, and profit of (-) Rp7,519,000.00 ha<sup>-1</sup> cs<sup>-1</sup> are from soybeans yield on agroforestry system *jabon* and soybeans [9]. The application vegetative (*sengon*-sorghum) and terrace system in different slope classes could add economic values for short term. For long term, *sengon* is expected to increase added value, especially soil and water conservation such as reduce surface runoff and erosion rate [8] [14] as well as environmental impacts such as microclimate aspect, carbon stock, etc [18].

**Table 9.** Economic analysis of sorghum as intercropping in vegetatives (*sengon*-sorghum) and terrace combination system on the two different slope classes

No.	Item	Quantity	Unit	Price (Rp)	Unit	Total (Rp. ha <sup>-1</sup> cs <sup>-1</sup> )
<b>Production cost (Steep slope and very steep slope plots)</b>						
Raw materials cost						
1	<i>Sengon</i> seedling	1,600.00	seedling ha <sup>-1</sup> cs <sup>-1</sup>	1,000.00	seedling <sup>-1</sup>	1,600,000.00
2	Sorghum seed	50.00	pack ha <sup>-1</sup>	27,500.00	pack <sup>-1</sup>	1,375,000.00
3	String of raffia	500.00	units ha <sup>-1</sup>	2,000.00	units <sup>-1</sup>	1,000,000.00
4	Plastic bottle	2,500.00	units ha <sup>-1</sup>	200.00	units <sup>-1</sup>	500,000.00
5	Plastic	100.00	pack ha <sup>-1</sup>	2,000.00	pack <sup>-1</sup>	200,000.00
6	Organic fertilizer	50.00	gunny sack ha <sup>-1</sup>	15,000.00	gunny sack <sup>-1</sup>	750,000.00
7	Urea fertilizer	50.00	pack ha <sup>-1</sup>	7,500.00	pack <sup>-1</sup>	375,000.00
8	TSP fertilizer	250.00	kg ha <sup>-1</sup> cs <sup>-1</sup>	6,000.00	kg <sup>-1</sup>	1,500,000.00
9	Petrokum	250.00	pack ha <sup>-1</sup>	6,000.00	pack <sup>-1</sup>	1,500,000.00
10	Matador	50.00	units ha <sup>-1</sup>	21,000.00	unit <sup>-1</sup>	1,050,000.00
11	Regent	50.00	units ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	1,000,000.00
	Subtotal					10,850,000.00
Depreciation cost						
12	Hoe	1.00	unit ha <sup>-1</sup>	25,000.00	unit <sup>-1</sup>	2,083.33
13	Chopper	1.00	unit ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	1,666.67
14	Sickle	1.00	unit ha <sup>-1</sup>	7,500.00	unit <sup>-1</sup>	1,562.50
15	Sprayer	1.00	unit ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	2,777.78
16	Furious	1.00	unit ha <sup>-1</sup>	20,000.00	unit <sup>-1</sup>	2,777.78
17	Grass knife	1.00	unit ha <sup>-1</sup>	10,000.00	unit <sup>-1</sup>	1,388.89
	Subtotal					12,256.94
Labourers cost						
18	Land preparation	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
19	Planting	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
20	Plantation maintenance					
	a. Replanting	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00

No.	Item	Quantity	Unit	Price (Rp)	Unit	Total (Rp. ha <sup>-1</sup> cs <sup>-1</sup> )
	b. Fertilizing	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
	c. Control pest and diseases	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
21	Harvesting	12.50	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	1,250,000.00
	Subtotal	75.00	days ha <sup>-1</sup> cs <sup>-1</sup>	100,000.00	day <sup>-1</sup>	7,500,000.00
Total cost of <i>seigon</i> and sorghum plantation						18,362,256.94
Steep slope plot (>25-45%)						9,181,128.47
Very steep slope plot (>45%)						9,181,128.47
<b>Revenue from Sorghum</b>						
Steep slope plot (>25-45%)						1,800,000.00
Very steep slope plot (>45%)						650,000.00
Total						2,450,000.00
<b>Profit</b>						
Steep slope plot (>25-45%)						-7,381,128.47
Very steep slope plot (>45%)						-8,531,128.47
Total						-15,912,255.94

Note: cs = cropping season

#### 4. Conclusion

The implementation of vegetative and terrace systems combination in soil and water conservation technology could apply in the different slope lands. This application will give benefit based on silvicultural and economic aspects. The combination vegetative and civil technique methods still show good growth parameters on the steep slope lands. The economic benefit will be given by agricultural yield as cropping plant in the short term. In long term, this application gives away benefit to conserve soil and water as well as environment aspects. The important information on silvicultural and economic aspects could be basic recommendation in relation to alternative agroforestry system for small scale and soil conservation program for wide scale. The basic data could be used as consideration by all stakeholders, including farmer, forester, private parties and the government in terms of land management and soil conservation activities.

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Dear Committee,

We would like to say thanks and appreciate for constructive suggestion from reviewer.

As attached below, our feedback for the reviewer's comments on our manuscript entitled "Silvicultural and economic aspects on combination of vegetatives (*Falcataria moluccana-Sorghum bicolor* L.) and terrace methods in the different slope lands"

No.	Page/ Comment	Review	Feedback and revision
1	Page 3, Comment 1	Please describe the method to evaluate/measure the healthy plant in the material and method	Explanation had added → The criteria of plant growth parameters (healthy plant, survival rate, and ground coverage) were described based on Regulation of Ministry of Forestry Republic of Indonesia Number: P.60/Menhut-II/2009 (Page 2).
2	Page 3, Comment 1	Is it significant different between treatment? Please test the result with T-test or others statistic method	Explanation had added.
3	Page 3, Comment 3	The MAI is in the very steep slope?	The sentence had revised → The average stem diameter increments of sengon trees were 2.43 cm year <sup>-1</sup> on the very steep slope, ... (Page 3)
4	Page 3, Comment 4	Why the growth of sengon in the steep slope is higher than very steep slope? (Table 4)	Explanation had added.
5	Page 3, Comment 5	Why?	Explanation had added.
6	Page 3, Comment 6	Please give the scientific reason (citation) to explain that sentences?	Explanation had added.
7	Page 5, Comment 7	References?	References had added.

Samarinda, 4 December 2019



Karyati

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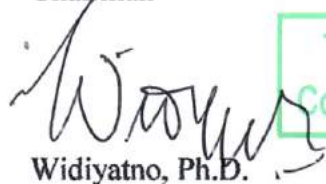
## Evaluation Letter

Dear Karyati  
Mulawarman University, Indonesia

We are pleased to inform you that your manuscript entitled “Silvicultural and economic aspects on combination of vegetative (*Falcataria moluccana* - *Sorghum bicolor* L.) and terrace methods in the different land slopes” has been selected to be published in Proceeding of the 3<sup>rd</sup> International Conference in Agroforestry under IOP Conference Series. Author(s) need to revise the manuscript based on comments and questions from reviewers before it can be officially accepted for publication. Submission due date of the revised version is 3 December 2019.

With warmest regards,

Chairman

  
Widiyatno, Ph.D.

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Indonesia Network for Agroforestry Education (INAFE) and Faculty of Forestry, Universitas Gadjah Mada (UGM).  
Jl. Agro No.1, Bulaksumur, Yogyakarta 55281 INDONESIA  
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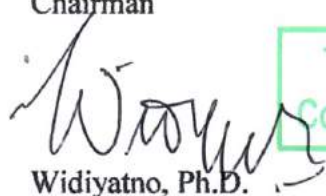
## Manuscript Acceptance Letter

Dear Karyati  
Mulawarman University, Indonesia

We are pleased to inform you that the Editorial Board has accepted and approved your manuscript entitled “Silvicultural and economic aspects on combination of vegetative (*Falcataria moluccana* - *Sorghum bicolor* L.) and terrace methods in the different land slopes” to be published in Proceeding of the 3<sup>rd</sup> International Conference in Agroforestry under IOP Conference Series. Thank you for your contributions.

On behalf of the Editorial Board,

Chairman



Widiyatno, Ph.D.

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Jl. Agro No.1, Bulaksumur, Yogyakarta 55281 INDONESIA  
Fax: +62 274550541, Email: [icaf2019@ugm.ac.id](mailto:icaf2019@ugm.ac.id)

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