PAPER • OPEN ACCESS

Preface

To cite this article: 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **449** 011001

IOP Conf. Series: Earth and Environmental Science **449** (2020) 011001 doi:10.1088/1755-1315/449/1/011001

The 3rd International Conference in Agroforestry (ICAF)

"Adopting modern agroforestry toward smart social program"

Introduction

It is no doubt that farming systems in developing countries faces two different interfering threats, i.e. decrease of farmland per capita and significant population growth. Less farmland and increasing the need of people livelihood impacts on dynamics change of small holder agroforestry. Traditional agroforestry may be characterized by low productivity but more sustainable, and probably higher characters in adoptability by small holder farmers. In some countries, agroforestry is neither recognized as agriculture nor forestry practice by the government. Based on the situation, the current agroforestry practices has to be improved through accommodating new or modern approaches, to increase the socio-economy and ecological impact on local and global communities. Employing high quality and vast impact of integrated research program, will able to change the traditional (primitive) agroforestry to modern (science-based) agroforestry. The change includes restoration of traditional knowledge and local wisdom that is believed as the baseline for the improvement, and utilizing modern technology that will challenge agroforestry to increase its economic productivity and sustainability. A "modern agroforestry" will be characterized by intensive use of vertical growing space (Budiadi et al., 2013) or multilayers, high diversity, products and markets (Elevitch & Wilkinson, 2000), and more closed-to nature practice (Montagnini and Ashton, 1999).

The jargon of "developing from the end" will change the thought that managing agroforestry system at the upstream must be oriented toward increasing value chain of the product through improving smart processing and marketing at the downstream. In fact, adoption of new approach as "modern agroforestry" will always be challenged by anthropological approach to develop smart social forestry programs. The use of artificial intelligent, open access of big data and high quality equipment's will be a necessity for supporting future extension works.

Objective

The seminar is conducted to formulate strategy and approach in accelerating traditional agroforestry through science-based agroforestry in different societies in the changing world.

The specific objectives of the seminar are:

IOP Conf. Series: Earth and Environmental Science **449** (2020) 011001 doi:10.1088/1755-1315/449/1/011001

1. To share varies of knowledge and practices in managing upstream to downstream agroforestry
2. To improve the current system and practices of agroforestry by employing modern and scientific based approach
3. To manage the science and knowledge of agroforestry in developing smart social forestry programs

IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Organizers and sponsors

To cite this article: 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **449** 011002

Organizers and sponsors

Organizers

Southeast Asian Network for Agroforestry Education (SEANAFE)
Indonesian Network for Agroforestry Education (INAFE)
Faculty of Forestry, Universitas Gadjah Mada (UGM)

Sponsors

Ministry of Environment and Forestry, Indonesia
World Agroforestry
Kyushu University
KEHATI, Biodiversity Conservation Trust Fund
Forest-Land Policy and History (SEBIJAK), UGM

Committee

Steering Committee

1. Dr. Budiadi (INAFE; Universitas Gadjah Mada, Indonesia)
2. Dr. Christine Wulandari (University of Lampung, Indonesia)
3. Prof. Dr. M. Sambas Sabarnurdin (Universitas Gadjah Mada, Indonesia)
4. Prof. Dr. Suryo Hardiwinoto (Universitas Gadjah Mada, Indonesia)
5. Dr. Leila Landicho (SEANAFE, Philippines)
6. Dr. Kurniatun Hairiyah (Brawijaya University, Indonesia)
7. Dr. Betha Lusiana (World Agroforestry, Indonesia)

Organizing Committee

Coordinator	: Widiyatno, Ph.D (Universitas Gadjah Mada, Indonesia)
Vice Coordinator	: Atus Syahbudin, Ph.D (Universitas Gadjah Mada, Indonesia)
Secretary	: Ratih Madya Septiana, M.Sc. (Universitas Gadjah Mada, Indonesia)
	Ferrieren Curassavica A., M.Sc. (Universitas Gadjah Mada, Indonesia)
	Ahdiar Fikri Maulana, Ph.D (Universitas Gadjah Mada, Indonesia)
	Marya Tiara Hapsari, M.Sc. (Universitas Gadjah Mada, Indonesia)

IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Species test of Mulberry plants on agroforestry land for silk yarn quality improvement in Bali

To cite this article: N Sasmita *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **449** 012015

Species test of Mulberry plants on agroforestry land for silk yarn quality improvement in Bali

N Sasmita[1*], J H Purba[1], L L Komara[2] and I G A D Yuniti[3]

[1]Faculty of Agriculture, Udayana University, PB Sudirman, Denpasar 80234, Indonesia
[2]Study Program of forestry, East Kutai School of Agriculture, 01 Soekarno Hatta Street, Sangatta75611, Indonesia
[3]Faculty of Agriculture, Mahasaraswati University, 17 Kamboja, Denpasar 80233, Indonesia

*Corresponding author`s email address: sasmita_na@yahoo.com

Abstract. Mulberry plants are tested on agroforestry land because of its well adaptation. The agroforestry model is a combination of sengon (*Falcataria moluccana*) and mulberry (*Morus* sp.) plants. The selected mulberry plants consisted of three species, namely *M. alba*, *M. cathayana* and *M. nigra*. The study objective was to determine the best mulberry species leaves as silkworm feed to produce quality cocoons on agroforestry area in Bali. The test was carried out in a complete randomized design (CRD) with the species treatment of *M. alba*, *M. cathayana* and *M. nigra*. It consists of three replications each. Each replication consists of 100 silkworms. The variables observed in this study were cocoon quality and thread/fibber including the percentage of larvae which become a cocoon, the percentage of normal cocoon, cocoon weight, cocoon skin weight, ratio of cocoon skin and fiber length. The results showed that the maintenance rendement (%) was *M. alba* (70%), *M. cathayana* (62,0) and *M. nigra* (60,5), weight of cocoon (g), was *M. alba* (1,47) , *M. cathayana* (1.53) and *M. nigra* (1.41), Weight of filaments (mg) namely *M. alba* (30,12), *M. cathayana* (25,35) and *M. nigra* (26,25), and the rolling strength of silk thread, namely *M. alba* (97.45), *M. cathayana* (74.11) *and M. nigra* (69.27). *M. alba*, *M. nigra* and *M. cathayana* mulberry leaf species grown from agroforestry patterns can be used to feed silkworms. The mulberry cropping pattern type both monoculture and agroforestry did not show a significant difference in the silkworm cocoons quality and quantity. The highest maintenance rendement is silkworm fed by *M. alba,* second is *M. cathayana* and third *M. nigra*. *M. nigra* and *M. cathayana* compared to *M. alba* did not show significant differences in cocoon weight, cocoon skin weight, percentage of filaments and rolling strength of silkyarn.

Keywords: agroforestry, cocoon, mulberry, silkworm, feed

1. Introduction

The regulation of Minister of forestry of the Republic of Indonesia in 2007 states that non-timber forest products are forest products along with other products, except wood as material that is used for economic activities and improving people's welfare. The government has set criteria and indicators for determining the national flagship types that are prioritized in its development, namely natural silk, honey (natural honey), aloes, and bamboo. The volume of exports and imports of natural silk commodities in the form of cocoon, silk yarn and silk fabrics fluctuated from year to year. The natural silk imports volume in 2012 was smaller but the volume of natural silk exports was 95.000 tons. In 2013 the imports volume of natural silk declined. The natural silk exports volume has increased, previously in 2012 it exported 95.000 tons, but in 2013 it increased to 141.654 tons. The import volume decline and export volume increase is an opportunity for Indonesia's natural silk to be developed again, because Indonesia's ability to meet national demand is quite well marked by declining of imports volume and the export volumes increasing [1]. This shows that the natural silk commodity can be one of the leading commodities for Indonesia.

Mulberry (*Morus* sp.) is a broadleaf wood plant. Mulberry plants have been cultivated for silkworm maintenance. The determinants of mulberry plants quality and quantity is one of silkworm maintenance the continuity. Availability of quality plants is strongly influenced by mulberry cultivation systems. The selection of planted varieties, pruned, fertilized, the pests and diseases attacks and drought in the dry season need to be considered. Most areas of mulberry plant development in Bali are in areas with wet climates. The main centers of natural silk in Bali located in Bangli Regency. The availability of water in the dry season has a significant effect on the growth and loss of mulberry leaves. The mulberry species that are developed in general are quite maximal because of the optimal growth requirements. The loss level of mulberry leaves is influenced by the local climate, wet climate areas have a fairly low loss rate of around 5% while the dry climate regions reach 13% to 48.41% [2].

Mulberry cultivation is generally done by monoculture. In this study mulberry plants were tested on agroforestry area. Agroforestry is an activity that’s supporting sustainable forestry and agricultural activities. Mulberry plants are tested on agroforestry area because of its well adaptation. The shape of the agroforestry model studied was a combination of sengon (*Falcataria moluccana*) and mulberry (*Morus* sp.) plants. Mulberry plant breeding consists of three species, namely *M. alba, M. cathayana* and *M. nigra* show high vigority, but still need further research. *M. nigra* is a mulberry species which is resistant to drought conditions, but the size of leaves is small, whereas *M. cathayana* is a mulberry species which has a high leaf production.

In supporting natural silk beside productivity, the high silkworm cocoons productivity is also needed. The silkworm growth and development were influenced by the mulberry quality and quantity as feed [3]. A high quality of cocoons for silk raw material are obtained from mulberry leaves quality as silkworms feed. For this reason, the research on various mulberry plants species as silkworm feed to produce quality cocoons on agroforestry land in Bali were done.

2. Materials and Methods

2.1. Materials

The study of the effect of mulberry leaves on cocoon productivity and quality was carried out from August to September 2018. The study site was in Kintamani, Bangli Regency, at an elevation of 1000 m above sea level (Figure 1). The average temperature conditions range from 20-26 °C with of 80% - 90% humidity. Mulberry leaves (Figure 2) are used as silkworm feed from *M. alba*, *M. cathayana* and *M. nigra* which show high vigority. Silkworm seeds used from PPUS Candiroto, Central Java Province. Before the maintenance of silkworms, disinfection of the silkworm maintenance room using formalin was carried out, while the disinfection of the silkworm's body used lime mixed with chlorine. The silkworm process to become a cocoon uses paraffin paper. The cementing of silkworms uses a seri frame tool. Furthermore, the resulting cocoon was selected and observed its quality with cocoon quality testing equipment and the data obtained was recorded with writing instruments.

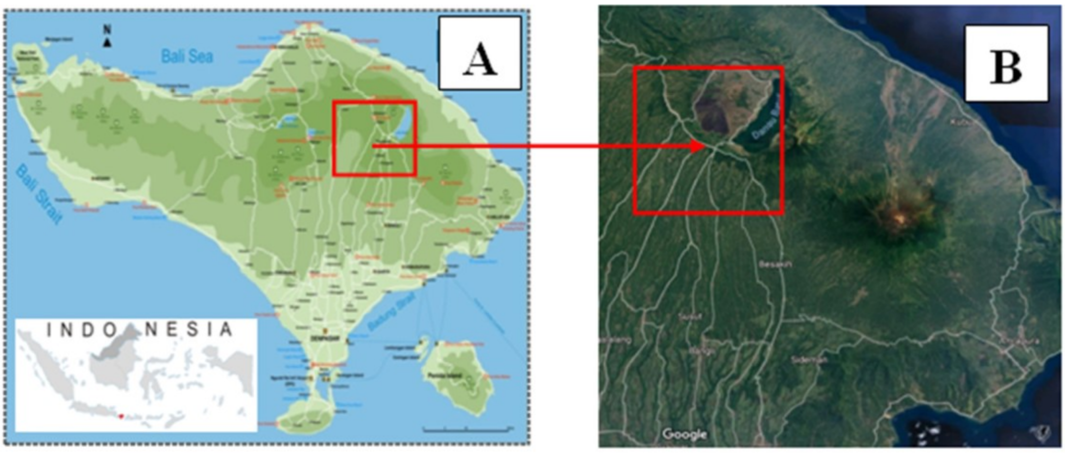

Figure 1. (A) Research Sites in Bali Province, Indonesia. (B) The Centre of Agroforestry Kintamani at 8°26'80.10"SL and115°33'54.14"EL

2.2. Research design

The test was carried out in a completely randomized design (CRD) with the species treatment of *M. alba*, *M. cathayana* and *M. nigra*. Consists of three replications each. Each replication consists of 100 silkworms. The variables observed in this study were the quality of cocoon and thread/ fiber including: become a cocoon larvae percentage, normal cocoon percentage, cocoon weight, cocoon skin weight, cocoon skin ratio and fiber length [4].

2.2.1. The percentage of become a cocoon larva

$$\frac{\text{The amount of cocoon formed}}{\text{Number of silkworm samples}} \times 100\%$$

2.2.2. Normal cocoon percentage. The normal cocoons collected are separated from the defective cocoon and are counted in number.

$$\frac{\text{Normal amount of cocoon}}{\text{Overall number of cocoon grains}} \times 100\%$$

2.2.3 Cocoon weight, cocoon skin weight and cocoon skin ratio. Cocoon weight and cocoon skin weight are calculated by taking a normal cocoon that has been selected, then peeling the cocoon skin as much as 20 cocoons then weighing the cocoon with pupa and cocoon skin. The weight of the cocoon and the weight of the cocoon skin is the average weight of 20 sample cocoon grains in grams. Cocoon skin ratio is calculated using this approach:

$$\frac{\text{Cocoon skin weight}}{\text{Cocoon weight}} \times 100\%$$

2.2.4. length

$$\frac{\text{Thread length x average number of cocoons per thread}}{\text{The amount of cocoon spun}} \times 100\%$$

Matters related to the research are as follows:

a. Cocoon quality
stated that based on Indonesia National Standard (INS) stated that the class of fresh cocoon quality was divided into four classes. They are A, B, C, and D with three test parameters, namely cocoon weight, cocoon skin ratio and percentage of defective cocoon. Besides that, it was also observed the percentage of larvae that become a cocoon because cocoon is the result of silkworm maintenance. This cocoon will then be processed into silk yarn, so that the quality and quantity will affect the productivity of the business that carried out [5].

b. The percentage of become a cocoon larva
The percentage of become a cocoon larva is the ratio between the number of larvae that become a cocoon with the number of sample larvae. This is supported by the study results of [6] that differences in mulberry species and maintenance season can affect the growth and nature of silkworm cocoons.

c. Normal cocoon
Normal cocoon is a cocoon that is in good condition (normal shape, not thin and not deformed) so that it can be spun into silk thread. The higher the percentage of the normal cocoon, the lower the number of defective cocoons and the more cocoons that can be spun so that the yarn produced will also increase.

d. Cocoon weight, cocoon skin weight and percentage of cocoon skin
Cocoon weight is important in silkworm cultivation because it will affect the fiber and yarn produced. One of the main factors that can affect the quality of the cocoon become better is the quality of the leaves. A mulberry leave with a good quality is easily digested according to their growth rate and contain all the substances needed for the silkworm growth [7][8]. The weight of the cocoon's skin, which is the higher the weight of the skin, the greater the content of the cocoon. This varies, according to silkworm varieties, maintenance conditions and process to become a cocoon [9]. Skin ratio of cocoon is a comparison between the weight of the cocoon skin and the weight of the whole cocoon.

e. Fiber quality
The silk fibers quality determines in the spinning process because it will affect the silk thread produced. The better the quality of the fiber from the cocoon to be spun, the silk yarn obtained will also increase both the quality and quantity.

2.3. Data Analysis
The linear model used is $Yst = \mu + As + \mathcal{E}s$, where Yst = observation value, μ = general mean, As = Mulberry species affect and $\mathcal{E}st$ = eror random affect.

$$Yst = \mu + Bi + \mathcal{E}stq$$

where:
Yst = observed variable
μ = middle population value
Bi = mulberry species to i
$\mathcal{E}stq$ = Trial error

The response variable that observed was the percentage of the small silkworm deaths (instar I-III). It was the number of dead silkworms divided by the number of silkworms (instar I-III) x 100%. The percentage of large silkworm deaths (instar IV-V) is the number of dead silkworms divided by the number of silkworms (instar IV-V) x 100%. The percentage of maintenance rendement is the amount of cocoon yield divided by the number of silkworms maintained from the initial instar IV x 100%. The wet cocoon weight is the weight of the whole cocoon including the cocoon skin and the pupil. Cocoon skin weight is the weight of a wet cocoon that has been removed from the cocoon. Percentage of cocoon skin weight is the weight of the cocoon skin divided by wet cocoon weight x 100%. Measuring filament length and rolling strength.

3. Results and Discussion

The analysis of variance of the three mulberry species *M. alba, M. cathayana* and *M. nigra*, showed that mulberry species had a significant effect on maintenance rendement, but mulberry species had no significant effect on the percentage of small silkworm deaths, percentage of large silkworm deaths, wet cocoon weight of cocoon skin, percentage of cocoon skin, filament length, filament weight, filament percentage, rolling strength. The results of the DMRT test for maintenance rendement, weight of filaments and rolling strength are presented in Table 1.

Table 1. Effect of mulberry leaves for silkworm feed on yield and quality of cocoon

Species	Maintenance Rendement (%)	Weight of Cocoon (g)	Filamen Weight (mg)	Rolling Strength (%)
M. alba	70.0 a	1.47 ab	30.12 a	97.45 a
M. cathayana	62.0 b	1.53 a	25.35 b	74.11 ab
M. nigra	60.5 c	1.41 b	26.25 b	69.27 b

The average value followed by the same letter is not significantly different at the level of 5% according to the Duncan test

3.1. Death of Silkworms (%)

Mulberry leaves feeding of *M. alba, M. cathayana* and *M. nigra* showed that the highest percentage of small silkworm death was silkworms fed with *M. alba* and *M. cathayana* leaves (2.1%), while the least were *M. nigra* silkworms fed (0.9%). From the statistical test it did not show any real differences. Variance analysis test results were not significantly different, that mean *M. cathayana* and *M. nigra* can be used as small silkworm feed, as *M. alba* which is commonly used by silkworm farmers in the area. The death of large silkworms showed that the highest percentage were silkworms fed with *M. cathayana* leaves (35.5%), while the least silkworms were fed *M. alba* (15.10%). Analysis of variance does not show a significant difference. The analysis results of non- significant variance analysis mean that *M. cathayana* and *M. nigra* can be used as large silkworm feed. The results stated that the use of *M. alba* or *M. cathayana* and *M. nigra* gave almost the same percentage of large silkworm deaths. This means that the use of *M. alba* can be replaced with *M. cathayana* and *M. nigra*. The silkworm survival is strongly influenced by environmental factors, especially temperature, humidity, environmental cleanliness during maintenance, beside the environmental factors the feeding must match with the needs and growth of silkworms [10]. Areas with a high pollution contaminated, cause the flour stored in the leaves of plants. Flour can damage the development of silkworms and cause high mortality rates [11]. The effect of temperature and humidity on the *Bombyx mori* life is significant at every 5°C temperature differences. Temperatures exceeding 35°C cause disturbed metabolic functions, resulting poor silkworm growth, which affects the silk gland growth and the larvae status health. Similarly, when temperatures drop below 20°C, metabolic functions become inactive again [12].

3.2. Maintenance Rendement (%)

Feeding mulberry leaves of *M. alba, M. cathayana* and *M. nigra* showed that the highest percentage of maintenance rendement was silkworms fed by *M. alba* (70.0%). The lowest maintenance rendement was silkworms fed by *M. nigra* (60.5%). Maintenance recovery is an important thing to know because it is very influential on the production produced from each unit of the number of eggs maintained. This study results indicate that the feeding of *M. alba* is still better than *M. cathayana* and *M. nigra* species. Andari et al. [13] showed that the silkworm maintenance rendement was 90% on average, which mean silkworms were adaptive to environmental conditions. This shows that the silkworm quality and health are maintained in good condition. In the end it will affect the level of cocoon production produced.

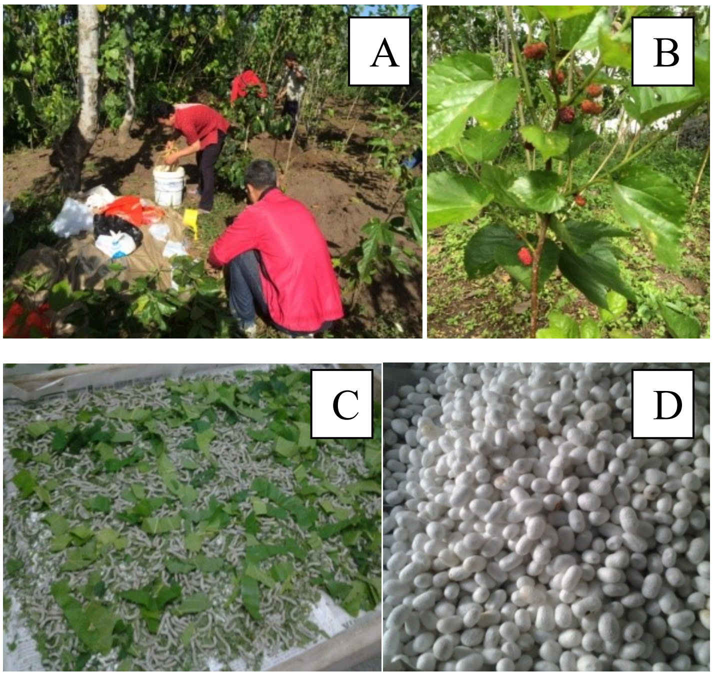

Figure 2. Agroforesty land and silkworm activities for cocoon production (A) Agroforesty land (B) Mulberry plants (C) Silk worm eat Mulberry leaf (D) Cocoon

3.3. Cocoon weight

The results showed that the heaviest weight of wet cocoon was silkworm fed by *M. cathayana* leaves (1.53 g). The lightest wet cocoon weight is the silkworm fed on *M. nigra* leaves (1.41 g). The results of this study indicate that different feeding provides different cocoon weights. The *M. cathayana* fed can produces the heaviest weight of wet cocoon compared to *M. nigra* but not significantly with the wet cocoon weight of *M. alba.* Furthermore, the heaviest weight of cocoon skin is silkworm fed on *M. nigra* leaves (0.32 g), while the lightest silkworms are fed *M. cathayana* (0.30 g). Analysis of variance does not show a significant difference. This means that mulberry feeding can be used as silkworm food. Even *M. nigra* feeds produce heavier cocoon skin weights compared to silkworms fed by *M. alba* which are commonly used as silkworm feed. The results showed that the heaviest percentage of skin weight of cocoon was silkworm fed *M. nigra* leaves (23.45%), while the lightest was silkworm fed *M. cathayana* (20.25%). The results of the analysis of variance did not show significant differences. The use of *M. nigra* or *M. cathayana* can be applied instead of *M. alba* silkworm feed. Even *M. nigra* produces a better percentage of cocoon skin weight compared to *M. alba.* If it is not the silkworm time to become a cocoon yet, it is forced to become cocoon, so the cocoon produced contains little silk thread. The weight percentage of cocoon skin is closely related to the percentage of raw silk in spinning. The weight percentage of cocoon skin depends on the type of silkworm seedlings [14]. Cocoon weight depends on the type of seed, the state of maintenance and process to become a cocoon [15]. Cocoon weight is related to the metabolic rate of silkworms [16]. In these animals there were 523 and 182 enzymes in the respective glands of silk and silkworms. Many products produced from metabolism detected from silkworms, especially glycosidase, lipase, and proteases [17] [18]. In addition, it has the potential ability to interact with carbohydrates, lipids, and other small molecules. This shows that carbohydrates, fatty acids, and amino acids are important metabolites in silkworms. It should be noted that glycine, alanine, and serine are the main constituents of silk proteins and play an important role in increasing the weight of silkworm cocoons [19].

3.4. Filament Length and Weight

Feeding mulberry leaves of M. *alba, M. cathayana* and *M. nigra* showed that the longest filament length was silkworms fed with *M. alba* leaves (910.35 m), while the shortest ones were silkworms fed by *M. nigra* (763.24 m). The analysis of variance results on filament length did not show any significant differences. This means that feeding *M. nigra* or *M. cathayana* can be used as a substitute for *M. alba* even though *M. alba* produces a better filament length than the two species of mulberry. Furthermore, the heaviest weight of the filament is the silkworm fed *M. alba* leaves (30.12 mg), while the lightest filament weight is the silkworm fed *M. cathayana* (25.35 mg). From the analysis of variants there is a real difference. Feeding silkworms with *M. alba* was significantly different from feeding with *M. nigra* and *M. cathayana*. But feeding silkworms with *M. nigra* leaves did not show differences with silkworms fed with *M. cathayana* leaves. This study results showed thatsilkworms fed with *M. alba* leaves still showed the greatest filament weight and were significantly different from feeding *M. nigra* or *M. cathayana*. Between the two species of mulberry does not show a real difference. The results showed that the largest percentage of filaments were fed *M. alba* leaves (20.15%), while the smallest ones were silkworms fed by *M. nigra* (19.27%). The result of variance analysis did not show any real differences. The percentage of filaments is determined by the ratio of the weight of the filament and the weight of the cocoon. In this study the percentage of filaments ranged from 19.27% to 20.15%. It is can be said that the feeding of *M. nigra* and *M. cathayana* is relatively the same in terms of producing the percentage of filaments compared to *M. alba*.The length and weight of the filament is closely related to the smooth operation of the spinning (reliability). Changes often occur related to the size, weight and length of the silk filament. Silkworm populations breed throughout the year [20]. Superior seed selection was carried out for the effect of short filament lengths produced over 11 generations, producing two groups with each filament length averaging 876 m and 704 m. Feeding mulberry leaves is very important, but *B. mori* silkworms often experience aggressive insect attacks [21]. Therefore, silkworm disease causes a drastic and qualitative reduction in the yield of cocoon.

3.5. Rolling Strength

Feeding mulberry leaves of *M. alba, M. cathayana* and *M. nigra* showed that the largest rolling strength was silkworms fed with *M. alba* leaves (97.45), while the smallest ones were silkworms fed by *M. nigra* (69,27). The results of variance analysis showed that there was a significant difference between *M. alba* feeding and *M. nigra*, but *M. cathayana* feeding was not significantly different from *M. alba* leaf feeding. These results can be said that *M. alba* shows good rolling strength because *M. alba* has a rolling strength of 97.45%. Rolling strength can be said to be good if the rolling strength is greater or equal to 90.0%. The rolling strength test results of *M. nigra* 69.27% and *M. cathayana* 74.11% were still less than 90% because of that the rolling strength of the species was not good [22]. The maintained silkworm determines the significant increase in cocoon weight, filament weight and filament length and rolling strength which shows a positive effect of additional nutrition on mulberry leaves during larval development [23]. The effects of methoprene on *B. mori* resulted in a significant increase in larval weight, cocoon weight, filament and silk fiber rolling strength [24]. The mulberry species leaves of rolling strength and the quality of silk yarn [4]. Mulberry leaves usually have a direct effect on the quality of the cocoon produced, while the quality of fiber is influenced by the quality of spun cocoons [6]. The length of fiber investigated by [4] states that the fiber produced has an average value below 900 m (not good), so it is expected that in subsequent trials the effectiveness of mulberry plants will look more real.

4. Conclusion

Mulberry leaf of *M. alba, M. nigra* and *M. cathayana* species as a result of agroforestry pattern can be used as for feed silk worms. The cropping patterns type both monoculture and agroforestry patterns did not show significant differences in the quality and quantity of silkworm cocoons. The highest maintenance rendement is silkworm fed by *M. alba*, second is *M. cathayana* and third *M. nigra*. The mulberry species of *M. nigra* and *M. cathayana* compared to *M. alba* do not show any difference to the weight of the cocoon, the weight of the cocoon skin, filaments and rolling strength.

References

[1] Ministry of Agriculture. 2017. Statistics of animal husbandry and animal health on gross domestic product of agricultural business in 2012-2016 (at current prices). Directorate General of Animal Husbandry and Animal Health, Ministry of Agriculture, Republic of Indonesia. Jakarta. ISBN 9789796280346. Pg 1-234

[2] Santoso B, Wardani B W and Prayudyaningsih 2006 Effectivity Urea Fertilizer for Growth, Leaf Production, and Protein Content for Varieties Mulberry (*Morus* sp) *Jurnal Penelitian Hutan dan Konservasi Alam* **3(1)** pp 1-8 https://doi.org/10.20886/jphka.2006.3.1.1-8

[3] Murthy VNY, Ramesh HL and Munirajappa 2013 Impact of Feeding selected mulberry varieties on Silkworm (*Bombyx mory* L.) through bioassay techniques for commercial explotation *Asian Journal of Natural and Applied Sciences* **2(4)** pp 156-164

[4] Muin N, Suryan H and Minarningsih 2015 Test of Morus khunpai and M.indica Hybrid towards Silkworm Feed *Wallacea Forestry research journal* **4(2)** pp 137-145.

[5] Rochmawati R 201. The Quality of the Coconuts Crossed by Race Chinese Silkworm (Bombyx Lori) and reciprocal Japanese Race. Department of Animal Husbandry Production and Technology. Faculty of Animal Husbandry. Bogor Agricultural Institute.

[6] Kumar V, Kumar D and Ram P 2014. Varietal influence of mulberry on silkworm, *Bombyx mori* L. growth and development. Research Article. *International Journal of Advanced Research* **2(3)** pp 921-927.

[7] Sasmita N, Purba JH, Yuniti IGAD 2019 Adaptation of Morus alba and Morus cathayana plants in a different climate and environment conditions in Indonesia *Biodiversitas* **20** pp 544-554.

[8] Nursita I W 2011 Comparison of the productivity of silkworms from two different nurseries in the heat maintenance environment. *Journal of Animal Sciences*, **21(3)** pp 10-17

[9] Soedarjo S, Kartasubrata J, Kaomini M, Saleh Wand Murdoko W 2000 Sutera Alam Indonesia Natural Silk. SaranaWana Jaya Foundation Jakarta

[10] Reddy GR 1984Genetic and Breeding of Sericulture, *Bombyx mori* L (Bengalore: Lectures on Sericulture Publisher)

[11] Kamilova E, Tsarev B 2008 Mortality of silkworms due to air pollution: environmental indicators induced by ecological stress *WIT Transactions on Ecology and the Environment* **110** pp241-250.

[12] Sisodia NS, Gaherwal S 2017 Effects of temperature and relative humidity on commercial product of silkworm (*Bombyx mori*. L) *International Journal o fZoology* **2(5)** pp 52-55

[13] Andadari L, Minarningsih, Dewi R 2017 Effect of Mulberry species on the Two Hybrid Silkworm Productivity of *Bombyx mori* Cocoon *Widyariset Journal* **3(2)** pp 119 – 130

[14] AndadariL, Heriyadi E and Suhandi E 1998 The effect of feeding Mulberry species on the yields and Quality of *Bombyxmori* L Cocoon *Forest Research Bulletin* (Indonesia).

[15] Krishnaswami S 1973 Manual on Sericulture. Silkworm Rearing. Agricultural Service Division. Food and Agriculture Organization of The United Nations. Rome.

[16] Zhang Y, Zhao D, Meng Z, Dong Z, Lin Y, Chen S, Xia Q and Zhao P 2017 Wild Silkworm Cocoon Contains More Metabolites Than Domestic Silkworm Cocoon to Improve Its Protection *Journal of Insect Science* **17(5)** pp 1–6.

[17] Dong Z, Zhao P, Wang C, Zhang Y, Chen J, Wang X, Lin Y and Xia Q 2013 Comparative proteomics reveal diverse functions and dynamic changes of *bombyx mori* silk proteins spun from different development stages*J. Proteome Res*. **12** pp5213–5222.

[18] Dong Z, Song Q, Zhang Y, Chen S, Zhang X, Zhao P and Xia Q 2016 Structure, evolution, and expression of antimicrobial silk proteins, seroins in lepidoptera*Insect Biochem. Mol. Biol.* **75** pp 24–31.

IOP Conf. Series: Earth and Environmental Science **449** (2020) 012015 doi:10.1088/1755-1315/449/1/012015

[19] Mondal MK, Trivedyand Kumar S N 2007 The silk proteins, sericin and fibroin in silkworm, *Bombyx mori* Linn*a review. Caspian J. Env. Sci*. **5** pp 63–76.
[20] Nagaraju J, Kumar TP 1995 Effect of Selected on Cocoon Filament Length in Divergenty Selected Lines of The Silk worm *Bombyx mori* Linn *J. Seri Sci JPN.* **64** pp103–109.
[21] Rajitha K and Savithri G 2015 Studies on symptomological and economic parameters of silk cocoons of *Bombyx mori* inoculated with Beauveria Bassiana (Bals.) Vuill *International Journal of Current Microbiology and Applied Sciences*. **4(2)** pp 44-54.
[22] Choe, B.H. 1976. Silk Fiber in Sericulture Technology Part III Seoul National University Press. Korea.
[23] Gwalia A 2018 Effect of Spirulina, Zink and Their Mixture on The Coccon Characteristics of Silkworm, *Bombyx mori* L. Book of Indira Gandhi National Open University.
[24] Magadum S B, Hooli M A, Magdum V B. 1990. Effect of Methoprene on Larval and Cocoon Weight, Ovariole Length, Egg Number and Fecundity of *Bombyx mori* L *Journal of Entomologia* **8**. P 37-40.