Business feasibility of several PS-01 hybrid silkworms (Bombix mori L.) cultivation scheme

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Abstract. Forest Research and Development Center has developed technology to increase productivity of sericulture through selection of types and varieties and cross-breeding to obtain superior hybrids. One of the superior hybrids produced is superior silkworm PS-01. The use of PS-01 hybrid silkworm seeds has been officially carried out with the Minister of Forestry Decree Number 794 I Menhut-II / 2013 concerning the Release of PS-01 Hybrid Silkworm (Bombyx Mory L.) Seeds. Several variations in the cultivation of the PS-01 hybrid silkworm in the field result in several cultivation schemes. This study aims to assess feasibility of several of PS-01 hybrid silkworm cultivation schemes. The research is conducted at KTH Bina Mandiri Sukabumi. Data and information are obtained through in-depth interviews with several farmer group members Bina Mandiri Sukabumi, owner and manager of PT Begawan Nusantara as a partner of KTH, which cultivates PS-01 silkworm seeds. Data are analyzed descriptively and qualitatively. Feasibility of PS-01 hybrid silkworm cultivation business is assessed using several criteria, namely NPV, BCR, IRR, and BEP, during the 10-year business cycle. The results of financial analysis on four silkworm cultivation schemes using PS-01 hybrid silkworm seeds show Schema I: KTH farmers buy PS-01 hybrid silkworm eggs and sell their products in cocoons; it is not feasible; Schema II: KTH farmers buy PS-01 hybrid silkworm egg seeds and sell their products in the form of yarn, and it is feasible; Schema III: KTH farmers do not purchase PS-01 hybrid silkworm eggs and sell their products in the form of cocoons; it is not feasible; Schema IV. In a partnership scheme, KTH farmers are assisted with silkworm eggs, consumable operational materials, farmers receive maintenance assistance up to the 3rd instar, and the sale of the produce in the form of cocoons is feasible.

1. Introduction

Silkworms and their cultivation began in Indonesia in the 10th century through trade mechanisms and began to be seriously developed since 1953[1]. The development of the national silk industry is carried out through the establishment of institutions, including the establishment of the Sericulture Center in Lembang Bandung, the construction of the Sericulture Development Project in Sulawesi, the establishment of National Sericulture Deliberation Board (Bamus Sutera), the Indonesia-Japan Cooperation on sericulture ATA-72 (1978), the establishment of Pilot Project Regaloh spinning mill (1972), Candidro Silkworm Breeding Center, Perhutani (1975), the establishment of PT Indo Jado Pratama in cooperation with Jado Corporation and granting of Sericulture Farmer Credit (KUT) to...
farmers/groups silk farmer [1]. However, until now, the national silk thread production has not been able to meet domestic demands. The national demands for silk thread reaches around 800-900 tons, about 95% of which is completed by imports, mainly from China and Japan [2].

Based on the regional biophysical typology, Indonesia has a climate and land condition suitable for cultivating silkworms (Bombyx mori L.) [2]. The agro-climatic conditions with dry season conditions that are not too hot and rainy season that is not too cold allow mulberry as silkworm feed to grow and be cultivated throughout the year [3]. However, this carrying capacity has not encouraged the establishment of a strong and independent national sericulture industry. Several challenges in developing the national sericulture industry include high competition with other countries, low government support for national sericulture industry, lagging technology, and slow handling of pests and diseases[1]. In addition to these challenges, there are obstacles related to the availability of quality and silkworm seeds, because according to [4], silkworm egg seeds are a key factor in the sericulture industry. This is in line with the statement [5]. The quality of silkworm eggs is one factor that needs to be considered to realize the success of sericulture industry in Indonesia.

The Forestry Research and Development Agency of the Ministry of Environment and Forestry, through the Forest Research and Development Center, conducted a series of studies to increase the productivity of national sericulture by developing silkworm seeds with high productivity (superior). The development of superior silkworm seeds is carried out through species selection, variety selection, and cross-breeding. One of the superior silkworm seeds produced is the PS-01 hybrid. The use of PS-01 hybrid silkworm seeds for silkworm cultivation activities has officially been carried out with the Minister of Forestry Decree Number SK. 794 I Menhut-II/2013 concerning the Release of Silkworm Seeds (Bombyx mori L.). PS-01 silkworm seeds have a parent code (cross-type) 804 x 927 [6]. The 804 x 927 cross have a higher cocoon weight and cocoon shell ratio than the C3 01 produced by Perum Perhutani[7]. According to [8], cocoon weight has a positive correlation with cocoon yield per box and is closely related to the added value obtained by silk farmers.

PS-01 hybrid silkworms have been cultivated in several places, including Sukabumi, Garut, Boalemo, Pati, and Soppeng Regencies. Cultivation activity is a business activity that needs observation for the benefits and feasibility [9]. One aspect that needs to be assessed to see the benefits and feasibility is the financial aspect [9]. Therefore, to assess the benefits and feasibility of silkworm cultivation using PS-01 silkworm seeds, it is necessary to conduct a financial feasibility analysis. The results of the analysis are expected to be the basis for formulating policy recommendations for the development of sericulture using PS-01 hybrid silkworm seeds.

2. Methodology
2.1. Time and location of research
The study was conducted from January to April 2021 conducted by Bina Mandiri Forest Farmers Group, Sukabumi, West Java Province.

2.2. Data collection method
Data are collected in the form of primary and secondary data. Primary data are obtained from in-depth interviews with sericulture entrepreneurs and farmer groups who cultivate PS-01 hybrid silkworms and process products from PS-01 hybrid silkworm cultivation. Secondary data are obtained from various related agencies and literature studies from previous studies.

2.3. Data analysis method
Implementation of financial analysis can use the method or criteria for investment appraisal [9]. Through assessing investment criteria, it can be seen whether or not a project is feasible to be implemented from the aspect of commercial profitability [10]. Several investment criteria parameters to assess the feasibility of a project are Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit-Cost Ratio (Net B/C Ratio), and Pay Back Period (PBP) [9]. A business or activity is declared financially
feasible if the NPV is positive, BCR is more than 1, IRR is greater than the analytical interest rate, IRR analytic interest rate, and PBP in the business cycle [11].

3. Result and discussion

3.1. Origin, description, and productivity of PS-01 hybrid silkworm seeds.

The quality of silkworm seeds is an important factor in the sericulture industry, considering that production failures are generally caused by the low quality of silkworm seeds [12]. In connection with the low quality of silkworm seeds, many efforts have been made to increase productivity of silkworm seeds, one of which is cross or hybrid method [1]. Commercial silkworm seeds that exist today are hybrids between the Japanese and Chinese races [13]. One of the superior silkworm seeds from crosses currently available is PS-01. PS-01 hybrid silkworm seeds are a cross between pure Chinese and Japanese purebreds. The female PS-01 hybrid silkworm seeds are of Japanese race, and the male is Chinese race. These are a collection of plasma bank parent lines in the Research and Development Center for Forest Productivity Improvement (currently known as the Forest Research and Development Center) Bogor, and are collected since 1999 [6]. Physical description in a silkworm with spots, cocoons are white and oval [6]. The characteristics inherent in the SP-01 hybrid silkworm seeds include [6]: 1. high cocoon cult ratio; 2. High hatchability, above 90%; 3. Normal cocoons 90-96%, cocoon weight 1.8-1.97 grams, cocoon shell weight 0.31-0.49 grams, cocoon shell ratio 21.77-25.42%; 4. The filament length is 808-1003 meters, the winding power is 95-100%, the thickness is 2.3-2.43, and the spum yield is 13.29-15.31. PS-01 hybrid silkworm eggs produce optimally in lowlands (100-200 asl).

Using the same silkworm seed for rearing at different site conditions resulted in varying cocoon production [14], likewise, with cultivation applications using PS-01 hybrid silkworm seeds. However, despite showing variations in productivity, silkworm cultivation using PS-01 hybrid silkworm seeds result in higher productivity than C3-01 hybrid silkworm seeds produced from Perum Perhutani. Production data in several locations show variations in cocoons cultivated using PS-01 and C3-01 hybrid silkworm seeds, as shown in Table 1.

Tabel 1. Location and productivity of silkworm cultivation with hybrid silkworm seeds PS-01 and C3-01

| Cultivation location             | Cocoon productivity (kg) |
|----------------------------------|---------------------------|
|                                  | PS-01        | C3-01       |
| Regaloh Pati, Provinsi Jawa Barat | 35-40        | 25-30       |
| Soppeng, Provinsi Sulawesi Selatan | 35-40        | 25-30       |
| Kabupaten Sukabumi, Provinsi Jawa Barat | 40           | 30          |
| Kabupaten Boalemo, Provinsi Jawa Barat | 40-45       | 40          |
| Kabupaten Garut, Provinsi Jawa Barat | 40           | 30-35       |

Source: Andadari, 2017

3.2. Sericulture industry in Sukabumi Regency

Sukabumi community is a user of silk weaving but does not have a weaving tradition from generation to generation like other areas in Sulawesi and Kalimantan [16]. The sericulture industry in Sukabumi began with the establishment of PT Indo Jado Pratama in the 1990s,[17]. PT Indo Jado Pratama was the only silk thread processing industry with modern technology that existed in Indonesia at that time. PT Indo Jado Pratama accommodates cocoons from farmers on the island of Java and buys cocoons produced by farmers from Sumatra and other islands. [17]. However, unfortunately, PT Indo Jado Pratama is no longer operating due to a shortage of raw materials for silkworm thread, while the machine's production capacity is very large[18]. After PT Indo Jado Pratama ceased operations, sericulture farmers lost their silkworm seed suppliers and market guarantors, resulting in a decline in silkworm cultivation activities in Sukabumi [18]. This condition is exacerbated by the cessation of silkworm egg production belonging to Perum Perhutani [5].

After discovering PS-01 hybrid silkworm seeds, sericulture farmers in Sukabumi began to find new sources of silkworm seeds. However, PS-01 hybrid silkworm seeds are not immediately available for
widespread use by the community. The Center for Forest Research and Development (P3H), as the institution holding the patent for PS-01 hybrid silkworm eggs, has limited capacity and functional tasks to mass-produce PS-01 hybrid silkworm seeds. [18]. Therefore, there needs to be another party called a breeder. Breeders act as custodians of the 804 and 927 strains and produce PS-01 hybrid silkworm seeds, resulting from crossing pure 804 and 927 breeds. The breeders are expected to supply PS-01 hybrid silkworm eggs to sericulture farmers in the Sukabumi region. And the surrounding.

PT Begawan Sutra Nusantara is one of the breeders assisted by the Center for Forest Research and Development. PT Begawan Sutra Nusantara has 2 tasks: 1. Preserving 804 and 927 brooders and 2. Crossing to produce PS-01 hybrids. This authority is given after facilitated with various kinds of training and guidance from researchers and technicians who handle sericulture. However, due to limited equipment for storing eggs, some breeder activities are still carried out at Sericulture Laboratory of the Center for Forest Research and Development.

PT Begawan Sutra Nusantara will maintain the results of this PS-01 hybrid egg until instar 3. For the next maintenance stages, until it becomes a cocoon, PT Begawan Sutra Nusantara cooperates with the forest farmer group (KTH) Bina Mandiri Sukabumi. In addition to collaborating with KTH Bina Mandiri Sukabumi, PT Begawan Sutra Nusantara also collaborates with nine other KTHs. So, in this case, there is a dependence of KTH members on PT Begawan Sutera Nusantara in the form of providing silkworm seeds hybrid PS-01. As reciprocal cooperation, the results of silkworm cultivation from KTH in cocoons will be purchased by PT Begawan Sutra Nusantara.

3.3. Analysis of financial feasibility of sericulture industry using PS-10 silkworm seeds at KTH Bina Mandiri Sukabumi

Some assumptions used in the analysis of the financial feasibility of the sericulture industry using PS-01 hybrid silkworm seeds at KTH Bina Mandiri Sukabumi: 1. The scope of the analysis includes cultivation and processing of production up to yarn; 2. Cultivation stages include egg handling, rearing small silkworms, raising large silkworms, cocoon process; 3. The number of maintenance cycles in one year is eight times; 4. The production capacity of each KTH member is two boxes of egg seeds/cycle; 5. Productivity of cocoons harvested 38 kg/box/cycle; 6. 1 kg of yarn requires 9 kg of cocoons; 7. Price of hybrid silkworm eggs PS-01 Rp. 200,000/box; 8. The price of non-grade cocoons is Rp. 41,000/kg; 9. Yarn price Rp. 900,000/kg; 10. Labor wages Rp. 60,000 per HOK; 11. The demand for mulberry leaves per cycle 800 kg/box of hybrid silkworm eggs PS-01; 12. The price of mulberry leaves is approached from the wages for taking leaves because there is no data regarding the cost of building a mulberry garden; 13. Discount factor of 8%; 14. Financial feasibility assessment is carried out on a 10-year business cycle. The analysis is carried out in four schemes: Scheme I. KTH farmers buy PS-01 hybrid silkworm eggs and sell their products in cocoons; Scheme II. KTH farmers buy PS-01 hybrid silkworm egg seeds and sell their products in yarn; Scheme III. KTH farmers do not buy PS-01 hybrid silkworm eggs and sell their products in the form of cocoons; Scheme IV. In a partnership scheme, KTH farmers are assisted with silkworm eggs, consumable operational materials. Farmers receive maintenance assistance up to the 3rd instar and the sale of the product in the form of cocoons.

3.3.1. Input flow. The flow of revenue in silkworm cultivation activities are in sales of cocoons or cocoon spinning yarns. The following are the components and the amount of income received in one cycle of silkworm cultivation using PS-01 hybrid silkworm seeds in each financial feasibility analysis scheme.

| No | Details          | Scheme (Rp)       |
|----|------------------|-------------------|
|    |                  | I     | II       | III      | IV       |
| 1. | Cocoon sale      | 249,280.000 | 0       | 249,280.000 | 249,280.000 |
| 2. | Yarn sale        | 0     | 576,000.000 | 0       | 0       |

Source: Primary data analysis
3.3.2. Output flow. The disbursement stream is divided into 1. The investment cost, which includes making a house for the maintenance of silkworm, is only carried out once in one business cycle, namely at the beginning of the activity. 2. Operational costs are consisting of fixed operating costs and variable operating costs. Fixed operating costs include the purchase of a seriframe, payment for electricity, and purchase of cleaning equipment. Fixed operating costs are not affected by the amount of production. Variable operating costs depend on production, consisting of purchasing eggs, purchasing lime, purchasing chlorine, buying newsprint, maintaining wages, taking leaves, and spinning wages. The following are the components and costs incurred in 1 cycle of silkworm cultivation using PS-01 hybrid silkworm seeds in each financial feasibility analysis scheme.

| No | Description                                      | Scheme (Rp)       |
|----|--------------------------------------------------|-------------------|
| 1. | Investment cost                                  | 35.000.000        |
| 2. | Making a house for the maintenance of silkworms  | 35.000.000        |
| 3. | Operational cost                                 |                   |
| 4. | a. Fixed operating costs                         | 20.000.000        |
| 5. | Electricity payment                              | 2.400.000         |
| 6. | b. Variable operating costs                      | 1.200.000         |
| 7. | Purchase of PS-01 egg seeds                      | 32.000.000        |
| 8. | Purchasing chalk                                 | 1.200.000         |
| 9. | Purchasing chlorine                              | 6.400.000         |
| 10.| Purchase of used newsprint                       | 2.880.000         |
| 11.| Maintenance fee                                  | 153.600.000       |
| 12.| The wages of picking mulberry leaves             | 25.600.000        |
| 13.| The wages of spinning cocoons into yarn          | 0                 |
| 14.| Total investment                                 | 280.280.000       |

Source: Primary data analysis

Table 3 shows that the most significant cost component of silkworm cultivation activities comes from labor wages. Labor wages can be seen in investment components number 12, 13 and 14 in Table 3. The proportion of labor costs to the total investment costs for scheme I is 53.93%, scheme II is 73.14%, scheme III is 53.93% and scheme IV 20.17%. When compared to the other three schemes, scheme IV has the smallest proportion of wage costs. However, the cost of labor wages in scheme IV has a larger proportion compared to other costs, except for the cost of building a caterpillar rearing house which the proportion reaches 27.47%. So it can be said that the proportion of labor costs in scheme IV is also significant in the cultivation of sericulture. This follows the statement [19] that sericulture is a labor-intensive farming business that absorbs labor. Sericulture activities can also support social forestry programs that improve welfare and provide employment opportunities for communities both around the forest and further one from the forest areas [19].

3.3.3. Financial feasibility analysis results. In conducting financial feasibility analysis, it is necessary to consider changes in the value of money over time. This is because the flow of money used to calculate
the investment eligibility criteria uses a fairly long period, in this ten years activity. During this period, the value of money will continue to change. To consider changes in the value of money over time is it done by including a discount factor in the analysis. The discount factor is required to convert the expected future flow of resources into an estimated present value[20].

The results of the financial analysis of silkworm cultivation using PS-01 hybrid silkworm seeds in each scheme are presented in Table 4 with the assumption of a discount factor of 8%. The assumption of the discount rate is based on the rate of Bank Rakyat Indonesia’s credit interest in 2021. According to the statement [21], the interest rate for financial analysis is the cost of money prevailing in the market, which is the same as the interest rate for loans.

### Table 4. The results of the analysis of the financial feasibility of silkworm cultivation using PS-01 hybrid silkworm seeds

| Investment feasibility parameters | Scheme I | Scheme II | Scheme III | Scheme IV |
|-----------------------------------|----------|-----------|------------|-----------|
| NPV                               | Rp. -31,864.168 | Rp. 187,367.612 | Rp. -10,391.907 | Rp. 38,511.166 |
| BCR                               | 0.84     | 1.94      | 0.94       | 1.30      |
| IRR (%)                           | Not detected | 353       | 1          | 39        |
| PBP                               | PBP does not occur | 2nd year | PBP does not occur | 4th year |

*Source: Primary data analysis*

Net Present Value (NPV) is the present value of the difference between benefits and costs at a specific discount rate [22]. The results of the analysis show that schemes 1 and 3 have negative NPV values, which means that the cultivation of sericulture using PS-01 hybrid silkworm seeds with schemes I and III are not feasible if these activities are carried out. This is different from the results of research conducted by [23] FMU Boalemo, at Gorontalo Province. Using PS-01 hybrid silkworm seeds and a similar scheme, the NPV results of this activity show a positive value. This difference is possible because 1. Silkworm cultivation activities in FMU Boalemo include income from mulberry cuttings, not as it in KTH in Sukabumi Regency. 2. Cocoon productivity in FMU Boalemo reaches 40 kg/eggs-box, while KTH in Sukabumi Regency is only 38 kg/eggs-box. 3. The number of silkworm cultivation cycles in FMU Boalemo in one year is 12 times, while KTH in Sukabumi Regency is only eight times. This is possible because the silkworm cultivation in KPH Boalemo separates the building for rearing small caterpillars from large caterpillars. At the same time, KTH in Sukabumi Regency only has one building that is the same for keeping small silkworms and large silkworms. Although cultivation schemes I and III are not financially feasible in the field, the community continues to carry out these activities. This is because labor costs, which are the largest component of costs, are not actually incurred by farmers. Labor costs are often not taken into account so that when they generate final income where its value is greater than the actual costs incurred, the silk farmer already earn some profit.

In schemes II and IV, the NPV value shows a positive result. This shows that from the NPV criteria, silkworm cultivation activities using PS-01 hybrid silkworm seeds provide benefits so that they are feasible to do. The highest NPV value in scheme II is that farmers sell their cultivation in the form of yarn. To realize this scheme II, cooperation with partners is needed in the form of increasing the skills of farmers to process silkworm cocoons into yarn and a commitment from partners to receive production yarn from farmers. In the current partnership scheme, partners only receive non-grade cocoons and do not receive products in the form of yarn.

Internal Rate of Return (IRR) is a method for calculating the discount rate that makes the current value of all estimated cash inflows equal to the present value of expected cash outflows [24]. In principle, IRR is a series of calculations that make the NPV zero. In scheme I, from the beginning to the end of the business cycle, the present value is always negative. This results in the IRR value not being identified. The IRR scheme I is not identified and for scheme III is 1%. These values are smaller than
the interest rate used in the analysis of 8%. From the IRR criteria, silkworm cultivation with schemes I and III are not feasible. The IRR value in scheme II is 353% and IV is 39%. These values are greater than the interest rate used in the analysis of 8%. From the IRR criteria, silkworm cultivation with schemes II and IV are feasible.

Benefit-Cost Ratio (Gross B/C) is a comparison between present value of benefits and present value of cost. The BCR value for silkworm cultivation in scheme I is 0.88, and scheme III is 0.99 or less than 1, so that from the BCR criteria, these two schemes are not feasible to do. In scheme II, the BCR value is 2.03, and in scheme IV, it is 1.39 or greater than 1, so from the BCR criteria, both schemes are feasible.

Analysis of the payback period (PBP) is needed to determine the period takes for a business to return the investment value. The value of the Pay Back Period (PBP) of business II in the 2nd year and the IV scheme in the 4th year. So for schemes II and IV, from the PBP criteria, it is feasible. Schemes I and III until the end of the concession do not occur PBP, so the two schemes are not feasible from the PBP criteria.

4. Conclusion
The feasibility of silkworm cultivation using PS-01 hybrid silkworm seeds is determined mainly by the sales form of the end product. Sales of the end product in the form of yarn are more profitable than sales in cocoons. Although, compared to partnership schemes farmers receive various kinds of assistance from partners. However, farmers still have limitations if they have to sell silkworm cultivation in the form of yarn. These limitations include lack of farmers' access to the silk yarn market. In addition, the dependence of PS-01 hybrid silkworm seeds on partners has resulted in farmers being bound to sell their cultivation products to partners. Until now, partners have only received cultivated products from farmers in the form of cocoons.

For this reason, it is urgent to provide PS-01 hybrid silkworm seeds commercially so that farmers can obtain these silkworm seeds by buying them freely. Farmers must also increase their capacity to be able to process cocoons into quality silk thread. Provide facilitation for farmers to access the yarn market freely so that there is no monopsony of buyers of silk yarn as has happened so far.

References
[1] Hartati 2015 Analisis fenotip ulat sutera (bombyx mori l) hasil persilangan ras jepang, china dan rumania. Makassar: Global Research and Consulting Institute (Global-RCI).
[2] Sugiharto 2020 Wanawiyata widyakarya memacu produksi sutera nasional Jakarta: Agroindonesia.co.id; [cited 2021 20 Mei]. Available from: http://agroindonesia.co.id/2020/06/wanawiyata-widyakarya-memacu-produksi-sutera-nasional/
[3] Wijayanto N, Fauziah E 2007 Strategi pengembangan usaha persuteraan alam di kabupaten sukabumi, propinsi jawa barat J. Manajemen Hutan Tropika; 13(1):14-28.
[4] Andadari L, Kuntadi K 2019 Pengaruh penyimpanan dan waktu penetasan telur terhadap kualitas bibit ulat sutra dan kualitas kokon bombyx mori l,(the effect of egg preservation and hatching schedule on seed quality and cocoon quality of silkworm bombyx mori l.) J. Penelitian Hutan Tanaman; 16(1):35-45.
[5] Nurueni S 2019 Tantangan dalam mengurai benang kusut persuteraan alam Fakultas Kehutanan, Universitas Hasanuddin.
[6] KemenLHK 2013 Keputusan menteri kehutanan republik indonesia nomor : Sk. 794 i menhut-ill/2013 tentang pelepasan brbtr ulat sutera (bombyx mori. L),l htrbd ps-01 Jakarta.
[7] Andadari L 2016 Pemilihan jenis hibrid ulat sutera yang optimal untuk dikembangkan di dataran tinggi dan/atau dataran rendah J. Penelitian Hutan Tanaman; 13(1):13-21.
[8] Kaomini M, Andadari L 2009 Sintesis hasil penelitian teknologi peningkatan produktivitas dan kualitas produk ulat sutera Tidak dipulikasikan Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam.
[9] Nurmalina R, Sarianti T, Karyadi A 2014 Studi kelayakan bisnis. Bogor: IPB Press. Retrieved from https://opac.perpusnas.go.id/DetailOpac.aspx.p.

[10] Gray C, Karlina L, Payamans S 1993 Pengantar evaluasi proyek. Jakarta Gramedia Pustaka Umum.

[11] Tiwa F, Walangitan DR, Sibi M 2016 Evaluasi kelayakan proyek berdasarkan analisis kriteria investasi J. Sipil Statik; 4(9).

[12] Andadari L 2016 Pengelolaan dan pemanfaatan galur murni ulat sutra bombyx mori l. In: Busmark M, Santoso E, editors. Membangun hasil hutan yang tersisa. Bogor: Forda Press.

[13] Yokoyama T 1973 The history of sericultural science in relation to industry J. The History of entomology; 267-84.

[14] Andadari L, Kuntadi K 2014 Perbandingan hibrid ulat sutera (bombyx mori l.) asal cina dengan hibrid lokal di sulawesi selatan J. Penelitian Hutan Tanaman; 11(3):173-83.

[15] Andadari L. 2017. Membangkitkan usaha persuteraan melalui pengembangan inovasi pakan dan telur lokal.

[16] Azahra NS, Hendrawan A 2017 Pengaplikasian image alam kabupaten sukabumi pada kain tenun sukabumi pada teknik marbling J. Proceedings of Art & Design; 4(3).

[17] Prawerti D. 1995. Analisis kegiatan agroindustri sutera alam studi kasus pada pt indo-jado sutera pratama sukabumi, jawa barat Bogor: Institut Pertanian Bogor.

[18] Yuniati D, Widiarti A, Suharti S 2020 Pengembangan persutraan alam di kabupaten sukabumi. In: Widiarti A, Yeny I, Minarningsih, Agustarini R, editors. Pembelajaran dunia riset untuk pengembangan hhbk. Bogor: IPB Press.

[19] Pangkey SA, Pratiknjo MH, Tulusan F 2019 Kinerja organisasi uptd balai perbenihan dan persutraan alam dinas kehutanan daerah provinsi sulawesi utara J. Administrasi Publik; 5(80):45-63.

[20] Riyanto E 2018 Penentuan tingkat diskonto dalam penilaian hutan J. Pajak Indonesia (Indonesian Tax Journal); 2(2):39-48.

[21] PUPR 2017 Modul 5 kelayakan finansial Badan Pengembangan Sumber Daya Manusia Pusat Pendidikan dan Pelatihan Sumber Daya Air dan Kontruksi Kementerian Pekerjaan Umum dan Perumahan Rakyat

[22] Constantinescu M 2010 Net present value simulating with a spreadsheet J. of Defense Resources Management (JoDRM); 1(1):33-40.

[23] Djabar M, Utia Rahman N 2020 Kelayakan usaha budidaya ulat sutera (bombix mori l.) berdasarkan aspek finansial kabupaten boulemo provinsi gorontalo J. Gorontalo of Forestry Research; 3(1):31-44.

[24] Hazen G 2009 An extension of the internal rate of return to stochastic cash flows. J. Management Science; 55(6):1030-4.

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