Analysis of financial feasibility of cultivation of bambu ampel kuning (Bambusa vulgaris var. striata) as a bamboo shoot resource

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Abstract. Bamboo shoots are buds in the root system of bamboo that grow and develop into young bamboo culm. The root system of bamboo, which has many internodes and buds produces many shoots but not all of them can grow and develop into bamboo shoots. Bamboo shoots can be used as a horticultural food commodity because they are usually harvested and consumed as a vegetable for several dishes. The purpose of this study is to analyze the financial feasibility of bambu ampel kuning (Bambusa vulgaris var. striata) cultivation as a producer of bamboo shoots based on indicator criteria NPV, Net B/C, IRR, and payback period. Data are collected using field observations, interviews, and discussions with bamboo garden owners covering cultivation techniques, production facilities, and labor. The results show that the NPV value of Rp. 137,097,914.5 is greater than zero, the Net B/C of 2.309 is greater than one, the IRR value of 42% is greater than the interest rate used by 12%, and the payback period in the 5th year of the age of the bamboo shoot-producing business of 15 years. Based on the criteria for financial feasibility indicators, the cultivation of bambu ampel kuning (Bambusa vulgaris var striata) as a producer of bamboo shoots is feasible. We recommended cultivating bamboo shoots in marginal areas.

1. Introduction
Bamboo shoots are young bamboo stems (culms). Some species are edible, nutritious, and popular among many Asian countries because they have been consumed for thousands of years [1]. The clump produces many young shoots, but not all can grow and develop into bamboo culm. The young shoots can be used as a horticultural food commodity because they are usually harvested and consumed as vegetables for several dishes.

All bamboo species produce bamboo shoots. Nevertheless, bamboo shoot contains HCN (cyanogenic glycosides) that contributes to bitter taste [2]. Even though the concentration depends on species, harvesting age, altitude, rainfall, temperature, and shoot portion. Although the taste is slightly bitter, it is easily removed in several ways such as boiling, soaking, drying, and fermentation [3]. Based on the level of taste, bamboo shoots having a very bitter taste are such as Gigantochloa apus, having sweet taste is like Dendrocalamus asper, D. latiflorus, Phyllostachys aurea, and having a slightly bitter, rough taste are like Bambusa vulgaris var. striata, B. vulgaris v. vitata, B. blumeana, B. maculata. One of the bamboo species commonly producing bamboo shoots is bamboo ampel kuning (B. vulgaris var. striata) [4].

Bambu ampel kuning (B. vulgaris var. striata) are cultivated by local people in Banyumeneng village and its surroundings, Meranggen sub-district, Demak Regency. This bamboo species is planted in yards or gardens bordering protected forests, in infertile land, and in the area which is often flooded. Species of Bambusa are tolerant to the flooded areas [5] and people in this area have planted and cultivated the plants to produce bamboo shoots. This condition shows that this bamboo species can transform less productive marginal land into a more productive one.

Bambu ampel kuning cultivation for shoot production can be used for agroforestry development in marginal lands, especially near protected forests, and this could reduce forest encroachment pressure. Apart from marginal lands, bamboo shoot cultivation can also be developed on a stretch of land as a commercial business. Bamboo shoot production on a commercial scale is currently very limited. This is due to a lack of information on bamboo cultivation techniques for bamboo shoot production and the unavailability of business benefits information. This then hinders capital owners to invest in this sector. Therefore, in a commercial business, information on cultivation techniques and economic feasibility in bamboo shoot production is needed. The purpose of this study is to analyze the financial feasibility of cultivating bambu ampel kuning (Bambusa vulgaris var striata) as a bamboo shoot resource. This study refers to criteria proposed by Gittinger [6] for net present value, net benefit-cost ratio, internal rate return, and payback period indicators [6].
2. Materials and methods

2.1. Data collection

Data are collected from Banyumeneng village, Meranggen sub-district, Demak Regency, Central Java Province (figure 1). Based on the soil map of Central Java Province at 1: 250,000 scale [7], the soil in this area is classified as a grumosol which comes from the parent material of old clay sediment. Grumosol soil is influenced by parent material and climate. The drier the soil, the more essential it will be, blacker in color, clearer cracking properties (“nelo”). The main inhibitors found in grumosol soils are little water, lack of soil physical properties, and slight salinity [8]. The soil analysis results in Table 1 show that soil fertility is low, where the organic C and N nutrients are moderate, and the available-P is low. The low soil fertility is outward from the culm size, which is only 3.6 cm in diameter and only 4.1 meters high.

![Figure 1. Location of study](Source: www.google.com)

Table 1. Soil characteristics in Banyumeneng, Meranggen sub-district, Demak, Central Java.

| No. | Item                              | Value     | Appraisal |
|-----|-----------------------------------|-----------|-----------|
| 1   | Soil fraction                     |           |           |
|     | - sand (%)                        | 5.35      |           |
|     | - loam (%)                        | 37.7      | clay      |
|     | - clay (%)                        | 56.96     |           |
| 2   | pH (1:1)                          |           |           |
|     | a. H₂O                            | 8.35      | rather alcalis |
|     | b. KCl                            | 8.05      | rather alcalis |
| 3   | Organic matter component         |           |           |
|     | - C-Organic (%)                   | 1.92      | low       |
|     | - N-Organic (%)                   | 0.17      | low       |
|     | - C/N Ratio                       | 11.65     | moderate  |
| 4   | P-available, Bray 1 (ppm)         | 12.35     | low       |
| 5   | Bases can be exchanged            |           |           |
|     | - Ca²⁺ (me/100 gram)              | 10.97     | low       |
|     | - Mg²⁺ (me/100 gram)              | 3.97      | high      |
|     | - K⁺ (me/100 gram)                | 0.97      | high      |
|     | - Na⁺ (me/100 gram)               | 0.35      | low       |
|     | Total                             | 16.25     |           |
| 6   | Cation Exchange Capacity (me/100 gram) | 14.97 | low |
| 7   | Saturation of bases, (%)          | 100       | high      |
| 8   | Acidity                           |           |           |
|     | - Al³⁺ (ppm)                      | nm        | very low  |
|     | - H⁺ (ppm)                        | 0.07      | very low  |
| 9   | Silicate (%)                      | 37.95     | low       |

Source: Laboratory analysis

Banyumeneng Village borders a protected forest included in the Tuntang watershed, where most of its area is often flooded. The climate in this site is classified as type C with an average number of dry months of 3.6 months, the number of wet months 7.2 months with a value of Q = 50% [9]. The annual average rainfall is 2076 mm, and the rainy days are 90 days. The highest rainfall occurs in January (319 mm), the lowest rainfall is in July (28 mm), and almost every month, there is rain, as shown in Table 2 [10].
Table 2. Average rainfall at Banyumeneng, Meranggen sub-district, Demak, Central Java.

| Month     | Rainfall (mm) | Rain day (days) |
|-----------|---------------|-----------------|
| January   | 319           | 14              |
| February  | 220           | 12              |
| March     | 250           | 10              |
| April     | 238           | 10              |
| May       | 131           | 5               |
| June      | 69            | 3               |
| July      | 28            | 2               |
| August    | 38            | 2               |
| September | 64            | 3               |
| October   | 160           | 7               |
| November  | 260           | 11              |
| December  | 299           | 12              |
| Annual    | 2076          | 90              |

Source: Banyumeneng climatology station in 1998 - 2017

Data on the techniques of cultivation, input needs (production facilities), and labor are collected from field observations and interviews with twelve selected bamboo farmers and owners. In addition, information was collected on inputs and wages for local workers in 2019. A Survey of soil maps is carried out to find out the minutes of the location. It also takes and analyzes soil samples and rainfall data from the Meteorology and Geophysics Agency of Demak Regency. The soil sample is composed collected from four localities in this village. Soil is taken from the top layer to 20 cm in depth using hoe with a dimension of 20 cm width.

2.2. Description of cultivation technique
Data obtained from soil samples and rainfall analysis will be described to generate information on environmental requirements. These data will be used as a reference for environmental conditions recommended for cultivating bambu ampel kuning to produce bamboo shoots. Meanwhile, the results of environmental observations and interviews with bamboo garden owners will be processed into descriptions of the techniques on bamboo ampel kuning cultivation. Bamboo shoot production includes land clearing techniques, plantation preparation, spacing determination, types of seedlings and planting support facilities, planting, maintenance and application of the silvicultural system, harvesting techniques, and production prediction.

2.3. Components of production cost and assumptions
Field observation and interview data are intended to obtain data on input needs (production facilities) and labor. Cultivation activities are assumed to last for 15 years period. The production input required includes the type, volume, and price, while the labor requirement consists of the type of work, volume, and value of wages. All data is tabulated and then production costs, production volume, revenues, and profits are described. The input product price is based on the market price at the time of the survey (2019), including the price of seeds, stakes, water, manure, and labor wages. Meanwhile, ZA fertilizer prices are based on Regulation of the Minister of Agriculture of the Republic of Indonesia Number 47/Permentan/SR 310/11/2018 concerning Allocation and Highest Retail Prices Subsidized Fertilizers in the Agricultural Sector for Fiscal Year 2019, November 30, 2018. In this analysis, the following assumptions are implemented:
(1) the age of the cultivation business is 15 years
(2) the interest rate (discount rate) is 12% per year
(3) production follows the prediction of bamboo shoot production and
(4) production, input prices, and output are stable since year 1.

2.4. Investment criteria
The investment criteria referred to Gittinger [6], namely Net Present Value (NPV), Internal Rate Return (IRR), Net Benefit-Cost Ratio (Net B/C), and Payback Period (PP). Net present value can be interpreted as the current value of the income stream generated by the investment. NPV is the result of deduction from discounted income at discounted cost. Mathematically, the NPV calculation can be formulated as it follows:

$$NPV = \sum_{t=0}^{n} \left( \frac{B_t - C_t}{(1+i)^t} \right)$$
whereas: NPV = Net Present Value (Rp), Bt = Benefit in year t, Ct = Cost in year t, i = interest rate used (12%), and t = year t. The feasibility indicator is: if the NPV is positive (NPV > 0), then the business is feasible to run; conversely, if the NPV is negative (NPV < 0), then the business is not possible to run.

Net Benefit-Cost Ratio (Net B/C Ratio) is obtained by dividing the present value of the benefits flow (PV) by the current value of the cost flow, aiming to determine the ratio between the number of costs incurred in a business to the benefits that it will be obtained. Mathematically, the calculation of Net B/C can be formulated as it follows:

\[
\text{Net B/C} = \frac{\sum_{t=1}^{15} B_t - Ct}{\sum_{t=1}^{15} Ct}
\]

whereas: Net B/C = Net Benefit-Cost Ratio, Bt = Benefit in year t, Ct = Cost in year t, i = interest rate used (12%), and t = 1st year to 15th year. The feasibility indicators are: If the Net B / C is more significant than one (Net B / C > 1), then the business is feasible to run. Conversely, if the Net B / C is less than one (Net B / C < 1), then the business is not feasible to run.

Internal Rate of Return (IRR) is the maximum interest rate that can return the costs invested. Mathematically, the IRR calculation can be formulated as follows:

\[
\text{IRR} = i_1 + \left(\frac{NPV_1 - NPV_2}{NPV_1 - NPV_2}\right) \times (i_1 - i_2)
\]

whereas: IRR = Internal Rate of Return, i1 = interest rates that generate a positive NPV, i2 = interest rate that results in a negative NPV, NPV1 = positive NPV, NPV2 = negative NPV. The feasibility indicator is if the IRR is greater than the prevailing bank interest rate (IRR > DR), then the business is feasible to run. Conversely, if the IRR is less than the overall interest rate (IRR < DR), then the business is not viable to run.

The Payback Period is a period required to cover production/investment expenses using cash flow. Mathematically, the calculation of the payback period can be formulated as it follows:

\[
\text{Discounted payback period} = \frac{I}{Ab} \times 1 \text{ year}
\]

whereas: I = Investment value, Ab = Net discounted cash in. This payback period criterion does not have standard indicators and is relatively dependent on the age of the project and the size of the investment. The business is feasible to run if the payback period of the business is not too long near the end of the project or longer than the life of the project. A relatively short payback period is preferred for investment.

3. Results and discussion
3.1. Description of bamboo shoot cultivation
Bamboo shoot (Figure 2) cultivation starts from clearing bush tripe. This activity is carried out before the rainy season, usually in August-September where the rainfall is still relatively low so that the soil is easy to cultivate. After clearing the land, the next activities are measuring and spacing the plant, installing stakes, making planting holes measuring 60x60x40 cm, and starting planting. Before planting, manure, a type of organic fertilizer derived from cow dung which is usually collected by farmers who raise cattle or cattle breeders, is applied to improve soil physical properties; ZA (NH₄)₂SO₄ fertilizer adds Nitrogen nutrients and helps reduce soil pH from slightly alkaline to neutral.

Figure 2. The bamboo shoot of bambu ampel kuning (B. vulgaris var striata).

From the results of soil analysis (Table 1), it can be perceived that the content of organic matter (C-organic and N-organic) are low, so the application of manure is appropriate because it improves soil physical properties. Farmers in the Pati area add cow dung to increase the bamboo (Bambusa blumeana) culm production [11]. The use of ZA fertilizer in the Banyumeneng area is appropriate because the sulfate in ZA fertilizer will help lowering down the soil pH towards pH-neutral (pH 7). Both types of fertilizers will improve the soil’s physical properties and neutralize soil pH that would increase the availability of nutrients that will be easily absorbed by the plants.
The spacing used for the cultivation of bamboo shoot are 3x3 meters (population 1111 clumps/ha), 3x4 meters (833 clumps/ha) or 3.5 x 4 meters (715 clumps/ha). These commonly three spacings can be understood because the clumps and culm size are relatively small, as is shown in Table 3. Spacing affects plant populations, the efficiency of light use, competition for nutrients, and water use [12]. Fertilization with a large population weight will lead to efficient use of fertilizer because it would achieve light efficiency. In general, 3x3 meters spacing (same in row and column) is more efficient than other spacing. There are several known spacing, including single row, double row, on the square, and equidistance.

Table 3. Clumps and culms characteristics of bamboo ampel kuning for bamboo shoots production.

| Clump sample | Clump circumference (m) | No. of culm/clump (culm) | Clump density (culm/m) | Culm diameter (cm) | Culm height (m) |
|---------------|-------------------------|--------------------------|------------------------|-------------------|----------------|
| 1             | 4.6                     | 8                        | 1.8                    | 3.34              | 4.09           |
| 2             | 4.9                     | 7                        | 1.4                    | 3.56              | 4.14           |
| 3             | 5.9                     | 9                        | 1.5                    | 3.53              | 4.22           |
| 4             | 6.1                     | 11                       | 1.8                    | 3.79              | 4.55           |
| 5             | 7.7                     | 14                       | 1.8                    | 3.66              | 4.33           |
| 6             | 9.4                     | 16                       | 1.7                    | 3.46              | 4.25           |
| 7             | 4.0                     | 6                        | 1.5                    | 3.48              | 4.00           |
| 8             | 4.0                     | 7                        | 1.8                    | 3.65              | 3.88           |
| 9             | 4.2                     | 8                        | 1.9                    | 3.57              | 3.73           |
| 10            | 3.7                     | 8                        | 2.2                    | 3.53              | 4.00           |
| Average       | 5.43                    | 9.4                      | 1.7                    | 3.6               | 4.1            |

While waiting for the completion of land preparation, seed material is prepared in the form of stem cuttings. These cuttings consist of 3 segments with a length of 80-100 cm where each segment has a bud or branch. The branches that are still attached to the culm cuttings are trimmed/cut, leaving 5-10 cm still attached to the cutting book so that they are easy to plant. The planting of seeds is carried out during the rainy season, from October-November. The planting method is still in a traditional way which has been passed down from generation to generation, i.e. the stem cuttings are inserted in the planting hole in an upside-down position where the end of the cuttings is placed underneath and the base of the cuttings is facing obliquely upward to form an angle of ± 30 degrees. After that, the surrounding is filled with excavated soil until all parts of the seedlings are completely covered with soil, compacted by stepping on the neck of the seeds, and poured with water.

Maintenance of seedlings is not necessary because after planting, the rainwater continues to penetrate and the seeds will grow after ± 1 month. The next tending is bush tripe in the planting area. Shrubs still often grow back because there is still open space due to the clump size that is still small. This activity is carried out after the rainy season and is carried out every year starting from the 2nd, 3rd, and 4th years. After the 5th year, the clump is large and covers the entire planting area so that there is no chance for shrubs to grow. After the 4th year, a silvicultural system is applied, i.e. regulating the three structures of culm age groups, namely culm age group of one year, culm age group of two years, and culm age group of three years.

Each culm age group consists of two culms so that there are only 6 culms in one clump, namely 2 culms of 1 year, 2 culms of 2 years, and 2 culms of 3-year ages. The structure and composition can be controlled and maintained and all new shoots can be harvested, but 2 culms are selected and assigned to become the parent culm. Bamboo shoots that are delicious to eat are those that have just emerged, which are indicated by the appearance of new shoots above the soil surface. Such bamboo shoots like that would taste sweet, not bitter. Bamboo shoots are harvested by digging using bamboo shoot crowbars, then cutting them down and collecting them in a basket/container that has been prepared.

Bamboo shoots that are harvested late will extend to the surface of the soil and cannot be consumed because of their bitter taste and coarse fiber. After the bamboo shoots are harvested, the activities continue with weeding the grass around the clump and making a 10 cm deep trench around the clump for sowing ZA fertilizer. When utilizing manure as the fertilizer, it is directly sown on the clump surface. To save maintenance costs, manure is applied every 2 years starting from the 6th to the 13th year. As it is known that manure plays a role in improving the soil’s physical properties which are not easily lost unless exposed to erosion. Meanwhile, ZA fertilizer, which functions as a nitrogen source to increase bamboo shoot production, must be applied annually. Apart from nitrogen, ZA fertilizer is also a source of sulfates which can reduce soil pH in alkaline soils.

The types of fertilizers needed to increase the production of culms or bamboo shoots are urea (45% N) and TSP (47% P2O5) [13]. Meanwhile, cow dung that is collected/piled on clumps of Bambusa blumeana produces large culms. The use of organic and inorganic fertilizers can increase the number of culms [14]. Other researchers report that when manure is mixed with urea fertilizer, it can increase the number of culms of Gigantochloa apus Kurz [15]. Likewise, it is reported that the use of manure from chicken and cow manure can increase the number of culms/ clumps and the culm size of the Gigantochloa robusta [16]. Fertilization can also increase bamboo shoot production [17].
3.2. Production costs
The production cost of cultivation bamboo shoots bamboo ampel kuning (*Bambusa vulgaris v. striata*) is the cost of business activities for 15 years consisting of investment costs, costs of purchasing production facilities, and wages of labor. Since this cultivation business is located on marginal land, it is assumed that the rental value is IDR 15,000,00 / ha for 15 years. Meanwhile, production costs consist of the cost of purchasing production facilities and wages of labor for 15 years.

The production facilities purchased are bamboo seedlings, bamboo stakes, water, and manure at market prices, except for ZA fertilizer. The labor wages are allocated for clearing shrubs, followed by measuring the spacing and the staking, weeding around the stakes, digging planting holes and applying manure and ZA fertilizer, planting, and watering (Table 4).

Table 4. Production facilities and labor of bamboo ampel kuning (*B. vulgaris v. striata*) cultivation for shoot production for 15 years.

| Year | Investment item | Volume | Labor activity | Volume |
|------|-----------------|--------|----------------|--------|
| 1st  | Invest in land leasing | 1 ha | chop down the bush for land clearing | 20 days |
|      | Seedling | 1111 seed | measure spacing and put up stakes | 19,19 days |
|      | Stake | 1111 pc | weeding around stake | 27 days |
|      | ZA fertilizer | 222,2 kg | dig the planting hole and apply manure | 95 days |
|      | Manure | 2200 kg | planting and watering | 38,4 days |
|      | Water | 1111 l | | |
| 2nd  | ZA fertilizer | 333,3 kg | maintenance chop down the bush | 20 days |
|      | Manure | 2200 kg | weeding around the clump fertilization | 47,99 days |
|      | ZA fertilizer | 444,4 kg | maintenance chop down the bush | 20 days |
|      | Manure | 2200 kg | ring wedding fertilization | 24,6 days |
|      | ZA fertilizer | 555,5 kg | application of the silvicultural system and first harvesting the shoots | 30 days |
|      | manure | 2200 kg | | |
| 3rd  | ZA fertilizer | 555,5 kg | weeding around the clump | 27 days |
|      | manure | 3300 kg | fertilization | 24 days |
|      | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 0 kg | weeding around the clump fertilization | 27 days |
|      | ZA fertilizer | 3300 kg | harvest bamboo shoots | 24 days |
|      | manure | 0 kg | | |
| 4th  | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 0 kg | maintenance chop down the bush | 20 days |
|      | ZA fertilizer | 555,5 kg | weeding around the clump | 27 days |
|      | manure | 3300 kg | fertilization | 24 days |
|      | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 0 kg | weeding around the clump fertilization | 27 days |
|      | ZA fertilizer | 3300 kg | harvest bamboo shoots | 24 days |
|      | manure | 0 kg | | |
| 5th  | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 6th  | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 7th  | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 8th  | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 9th  | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 10th | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 11th | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 12th | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
|      | ZA fertilizer | 555,5 kg | fertilization | 24 days |
|      | manure | 0 kg | | |
| 13th | ZA fertilizer | 555,5 kg | harvest bamboo shoots | 60 days |
|      | manure | 3300 kg | weeding around the clump | 27 days |
Table 5. Production costs of bamboo cultivation for shoots production for 15 years.

| Year | Investment and production facilities (Rp) | Labour (Rp.) | Cost (Rp) |
|------|------------------------------------------|--------------|-----------|
| 1    | 22,799.330                              | 17,963.100   | 40,762.430|
| 2    | 1,566.620                               | 8,278.200    | 9,844.820 |
| 3    | 1,722.160                               | 10,978.200   | 12,700.360|
| 4    | 1,877.700                               | 9,990.000    | 11,867.700|
| 5    | 2,427.700                               | 9,990.000    | 12,417.700|
| 6    | 777.700                                 | 9,990.000    | 10,767.700|
| 7    | 2,427.700                               | 9,990.000    | 12,417.700|
| 8    | 777.700                                 | 9,990.000    | 10,767.700|
| 9    | 2,427.700                               | 9,990.000    | 12,417.700|
| 10   | 777.700                                 | 9,990.000    | 10,767.700|
| 11   | 2,427.700                               | 9,990.000    | 12,417.700|
| 12   | 777.700                                 | 9,990.000    | 10,767.700|
| 13   | 2,427.700                               | 9,990.000    | 12,417.700|
| 14   | 777.700                                 | 9,990.000    | 10,767.700|
| 15   | -                                       | 5,400.000    | 5,400.000 |

From Table 4 above, it can be seen that the need for production facilities is different every year, where in the first year it consists of bamboo seedlings, stakes, ZA fertilizer, manure, and water. In years 2 to 8, the input production requirements only consist of ZA fertilizer and manure, except for years 9, 11, and 13, only ZA fertilizer without manure. This is because the residue left by manure in previous years is still considered sufficient to improve the physical properties of the soil. ZA fertilizer is given every year because the nitrogen content is always absorbed to stimulate the growth of shoots into bamboo shoots.

The labor requirement in the first year is relatively large for clearing shrubs, land clearing, measuring spacing, placing stakes, digging planting holes, weeding around the stakes for the preparation of fertilization, planting, and watering. In the second year, the types of work are scrub tripe and weeding around the clump in preparation for fertilization. In the third year, the types of work are scrub tripe, fertilization, and the application of silvicultural system so that there are three culm age groups in the clump, namely group of one year culm age, group of two years culm age and a group of three years culm age. During the silviculture system application, the bamboo shoot is harvested for the first time, but they are still in small size and are ignored.

In the 4th year, the work is still the same as in the 3rd year, scrub tripe, weeding around the clump, fertilization, harvesting bamboo shoots which could be consumed and sold, although the number is not big enough. The size of shoots is getting bigger and the number also increases and reaches normal size when the shoots are entering the 6th year with a production prediction of 8 kg/clump/year. The application of a silvicultural system will result in stable production of 8 kg/clump/year which can be controlled from the 6th to the 15th year when business activities stop.
shoots and are still small in size. The application of the silvicultural system will allow 2 bamboo shoots to grow into adult stems and the rest be harvested as bamboo shoots for consumption. In the 4th, 5th, and 6th years, the size of bamboo shoots is getting bigger due to the growth of root systems that support the ability to absorb food elements. Based on experience, the first production in year 3 is estimated at an average of 4 kg/clump; in the 4th and 5th years the production will increase to 6kg and 7 kg/clump. After the 7th year, the clumps are normal. According to research, the production of bamboo shoots on a normal clump is 5kg/clump. After the 7th year, the clumps production are constant. The production will increase up to 8 kg/clump if fertilization with manure + fertilizer nitrogen is applied [17].

Shoot production started in the 3rd year and will increase in the 4th and 5th years with the predicted production of 4, 6, and 7 kg/clump. After the 6th year, fixed production of 8kg/clump up to the 15th year will be obtained. From the two assumptions, i.e. the initial production of the 3rd year and the fixed production in the 6th year, the average price of fresh shoots is Rp 6,000 / kg (Rp. 3,000-Rp 9,000), the income also increases every year starting from the 3rd, 4th, 5th years. and regular income at all times up to 15 years of business as it is shown in Table 6.

Table 6. Prediction of bamboo shoot production and revenue for 15 years.

| Year | Production | Price ( IDR./kg) | Revenue ( IDR.) |
|------|------------|-----------------|----------------|
| 1    | 0          | 6000            | 0              |
| 2    | 0          | 6000            | 0              |
| 3    | 4          | 6000            | 26.664.000     |
| 4    | 6          | 6000            | 39.996.000     |
| 5    | 7          | 6000            | 46.662.000     |
| 6    | 8          | 6000            | 53.328.000     |
| 7    | 8          | 6000            | 53.328.000     |
| 8    | 8          | 6000            | 53.328.000     |
| 9    | 8          | 6000            | 53.328.000     |
| 10   | 8          | 6000            | 53.328.000     |
| 11   | 8          | 6000            | 53.328.000     |
| 12   | 8          | 6000            | 53.328.000     |
| 13   | 8          | 6000            | 53.328.000     |
| 14   | 8          | 6000            | 53.328.000     |
| 15   | 8          | 6000            | 53.328.000     |

Business profit is the difference between the revenue from selling bamboo shoots and the production cost. From the results of the profit analysis, it can be seen that the profits in years 1, 2, and 3 are still negative because the clumps are still growing and developing so that they do not produce bamboo shoots yet. The clump starts to produce bamboo shoots in year 3 and has generated income even though the cumulative profit is still negative. The cumulative profit starts to be positive after the fourth year and the following years so that the payback period occurs in the 5th year (Table 7).

Table 7. The benefit of bamboo shoot cultivation for 15 years.

| Year | Revenue | Production cost | Benefit | Cumulative benefit |
|------|---------|----------------|---------|--------------------|
| 1    | -       | 40.762.430     | (40.762.430) | (40.762.430) |
| 2    | -       | 9.844.820      | (9.844.820)  | (50.607.250) |
| 3    | 26.664.000 | 12.700.360    | 13.963.640 | (36.643.610) |
| 4    | 39.996.000 | 13.667.700    | 26.328.300  | (10.315.310) |
| 5    | 46.662.000 | 12.417.700    | 34.244.300  | 23.928.990 |
| 6    | 53.328.000 | 10.767.700    | 42.560.300  | 66.489.290 |
| 7    | 53.328.000 | 12.417.700    | 40.910.300  | 107.399.590 |
| 8    | 53.328.000 | 10.767.700    | 42.560.300  | 149.959.890 |
| 9    | 53.328.000 | 12.417.700    | 40.910.300  | 190.870.190 |
| 10   | 53.328.000 | 10.767.700    | 42.560.300  | 233.430.490 |
| 11   | 53.328.000 | 12.417.700    | 40.910.300  | 274.340.790 |
| 12   | 53.328.000 | 10.767.700    | 42.560.300  | 316.901.090 |
| 13   | 53.328.000 | 12.417.700    | 40.910.300  | 357.811.390 |
The economic feasibility analysis is carried out to determine the feasibility of bamboo shoot cultivating whether it is profitable or not. The cash flow of bamboo shoots cultivation for 15 years is presented in Appendix 1; and from Appendix 1, it can be seen the feasibility of the business as it is in Table 8.

### Table 8. Feasibility of bamboo cultivation for shoots production for 15 years.

| No. | Criteria          | Value     | Feasibility indicators | Result  |
|-----|-------------------|-----------|------------------------|---------|
| 1   | Net B/C Ratio     | 2,309     | > 1                    | feasible|
| 2   | NPV               | 137,097,914,57 | > 0                  | feasible|
| 3   | IRR               | 42%       | > 12%                  | feasible|
| 4   | Payback Period    | 5th year  |                        |         |

The NPV results show the NPV of the benefits obtained during the period of reaching IDR 137,097,914.5 (NPV > 0). The NPV indicates that the cultivation of bamboo shoots provides an additional benefit of IDR 137,097,914.5. Based on the investment criteria on NPV, this business is feasible to run.

The value on the B/C Net is 2,309, this indicates that the net profit earned will increase by IDR 2,309 million per additional investment cost of IDR 1 million. A net value of B/C is greater than one means that any increase in cultivation costs will result in benefits that are greater than the added costs. Based on the Net B/C analysis, the cultivation of bambu ampel kuning shoots producing bamboo shoots is feasible.

IRR analysis is used to see how much the return on the invested effort. The IRR represents the discount rate that yields an NPV equal to zero as a percentage unit. The investment criteria are done by comparing the IRR value with the interest rate. IRR of 42 percent means that the return on invested capital is 42 percent. The IRR value of 42% is greater than the interest rate used which is 12%, so the cultivation of bambu ampel kuning which produces bamboo shoots is feasible.

Payback period analysis measures how fast the investment in the cultivation of bamboo shoots is. The first profit occurs in the 3rd year of harvesting but it has not been able to cover production costs. The cumulative profit has been able to cover production costs is in the 5th year of harvesting. The payback period occurs in the 5th year of harvesting. Currently, the 5th year return on capital investment, including the lease of land and other bamboo planting investments, has reached the break-even point. Based on the criteria for the payback period, the investment is still in the cultivation period for 15 years, so the cultivation of bambu ampel kuning for shoots production is feasible.

The finding shows that bamboo shoot production is feasible. It is recommended as a commercial-scale business in less utilized marginal land, particularly in rural areas. Cultivation of bamboo shoots has placed *Bamboo vulgaris* as an inferior bamboo into a commodity with high economic value. On the other hand, this bamboo is proven to have been able to adapt to unproductive marginal land and be able to turn it into productive land.

The production of bamboo shoots has not experienced significant problems. However, bamboo shoot cultivation needs to be upscaled. For future development, the production of bamboo shoots can be increased in several ways. Increasing production of bamboo shoots needs to be encouraged through research, technology, and policy support. Research continues to be carried out to improve the production and quality of bamboo shoots and includes anticipating pests and diseases on bamboo shoots. Some common potential pests are wireworms, shoot weevils, and noctuids that cause significant damage and interfere with the productivity of bamboo shoots recently in other areas [18]. However, it is important to anticipate them. Technological facilitation can be realized through the diversification of bamboo shoot products to provide added value. Utilization of bamboo shoots can be developed into several other products such as fresh bamboo shoots, bamboo shoots based on powder, canned bamboo shoots, dried bamboo shoots, including development as a source of medicines [19]. The government can encourage the use of unproductive land along the sides of rivers or in areas that are often flooded as areas for developing bamboo shoot production. It also opens a wider market for bamboo shoots marketing, including the abroad market.

### 4. Conclusion

The results of the analysis indicate that the cultivation of bambu ampel kuning as shoot resources is economically profitable, with a return on investment that can be achieved in the 5th year. It is a promising business and recommended to be developed in a marginal or less productive areas, particularly in the rural areas. Supporting the government in many ways in terms of encouraging policy, technology, and marketing are essential to reach expected expenditure in upscaled business.

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Annex 1. Cash flow of bamboo (*Bambusa vulgaris* var *striata*) shoot cultivation (1)

| Description                                      | 1<sup>st</sup> year | 2<sup>nd</sup> year | 3<sup>rd</sup> year | 4<sup>th</sup> year | 5<sup>th</sup> year | 6<sup>th</sup> year | 7<sup>th</sup> year | 8<sup>th</sup> year |
|--------------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Production cost                                  |                      |                      |                      |                      |                      |                      |                      |                      |
| land investment                                  | 15.000.000           | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| seedlings                                        | 5.555.000            | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| Stakes                                           | 277.750              | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| ZA fertilizer                                    | 311.080              | 466.620,0            | 622.160,0            | 777.700,0            | 777.700,0            | 777.700,0            | 777.700,0            | 777.700,0            |
| Manure                                           | 1.100.000            | 1.100.000            | 1.100.000            | 1.100.000            | 1.650.000            | -                    | 1.650.000            | -                    |
| water                                            | 555.500              | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| bush tripe for land clearing                     | 1.800.000            | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| measure spacing and put up a stake               | 1.727.100            | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| weeding around the stake                         | 2.430.000            | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| dig the planting hole and apply manure planting  | 8.550.000            | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| water                                            | 3.456.000            | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| bush tripe for maintenance                       | -                    | 1.800.000            | 1.800.000            | 1.800.000            | 1.800.000            | 1.800.000            | 1.800.000            | 1.800.000            |
| weeding around the clump                         | -                    | 4.319.100            | 4.319.100            | 4.319.100            | 4.319.100            | 4.319.100            | 4.319.100            | 4.319.100            |
| fertilization                                    | -                    | 2.159.100            | 2.159.100            | 2.159.100            | 2.159.100            | 2.159.100            | 2.159.100            | 2.159.100            |
| harvest bamboo shoots                             | -                    | 2.700.000            | 5.400.000            | 5.400.000            | 5.400.000            | 5.400.000            | 5.400.000            | 5.400.000            |
| Sum of production Costs (a)                      | 40.762.430           | 9.844.820            | 12.700.360           | 13.670.700           | 14.170.700           | 10.767.700           | 12.417.700           | 10.767.700           |
| Revenue                                          |                      |                      |                      |                      |                      |                      |                      |                      |
| production of bamboo shoots/clumps (kg)          | 0                    | 0                    | 4                    | 6                    | 7                    | 8                    | 8                    | 8                    |
| production of bamboo shoots/ha (kg)              | 0                    | 0                    | 4444                 | 6666                 | 7777                 | 8888                 | 8888                 | 8888                 |
| price of bamboo shoots/kg (Rp)                   | 0                    | 6000                 | 6000                 | 6000                 | 6000                 | 6000                 | 6000                 | 6000                 |
| Total Receipts/ha (b)                            | -                    | -                    | 26.644.000           | 39.996.000           | 46.662.000           | 53.328.000           | 53.328.000           | 53.328.000           |
| Benefits                                         |                      |                      |                      |                      |                      |                      |                      |                      |
| Profit (b-a)                                     | (40.762.430)         | (9.844.820)          | 13.963.640           | 26.328.300           | 34.244.300           | 42.560.300           | 42.560.300           | 42.560.300           |
| Cumulative profit                                | (40.762.430)         | (50.607.250)         | (36.643.610)         | (40.315.310)         | 23.928.990           | 66.489.290           | 107.399.590          | 149.959.890          |
| Net B/C Ratio, NPV, IRR                          |                      |                      |                      |                      |                      |                      |                      |                      |
| DF at DR 12%                                     | 0.89                 | 0.80                 | 0.71                 | 0.64                 | 0.57                 | 0.51                 | 0.45                 | 0.40                 |
| present value of the benefit                     | -                    | -                    | 18.978.908,53        | 25.418.181,06        | 26.477.271,94        | 27.017.624,43        | 24.122.878,96        | 21.538.284,78        |
| present value of cost                            | 36.395.026,8         | 7.848.230,2          | 9.039.865,4          | 8.686.070,4          | 7.046.136,5          | 5.455.251,9          | 5.617.136,9          | 4.348.893,4          |
| present value                                    | (36.395.026,8)       | (7.848.230,2)        | 9.939.043,1          | 16.732.110,6         | 19.431.135,5         | 21.562.372,5         | 18.505.742,1         | 17.189.391,3         |
| the amount of benefit is discounted              | 241.848.637,7        | 7.848.230,2          | 9.939.043,1          | 16.732.110,6         | 19.431.135,5         | 21.562.372,5         | 18.505.742,1         | 17.189.391,3         |
| discounted total cost                            | 104.750.723,2        | 2.309                | -                    | -                    | -                    | -                    | -                    | -                    |
| NPV                                              | 137.097.914,5        | 0.80                 | -                    | -                    | -                    | -                    | -                    | -                    |
| IRR                                              | 42%                  | 42%                  | 42%                  | 42%                  | 42%                  | 42%                  | 42%                  | 42%                  |
| PP                                               | 5<sup>th</sup> year  | 5<sup>th</sup> year  | 5<sup>th</sup> year  | 5<sup>th</sup> year  | 5<sup>th</sup> year  | 5<sup>th</sup> year  | 5<sup>th</sup> year  | 5<sup>th</sup> year  |
Annex 1. Cash flow of bamboo (*Bambusa vulgaris* var *striata*) shoot cultivation (2)

| Description                                                                 | 9th year | 10th year | 11th year | 12th year | 13th year | 14th year | 15th year |
|------------------------------------------------------------------------------|----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Production cost                                                             |          |           |           |           |           |           |           |
| land investment                                                             | 777,700  | 777,700   | 777,700   | 777,700   | 777,700   | 777,700   |           |
| seedlings                                                                    |          |           |           |           |           |           |           |
| Stakes                                                                       | 1,650    | 1,650     |           |           |           |           |           |
| ZA fertilizer                                                                | 777,700  | 777,700   | 777,700   | 777,700   | 777,700   | 777,700   |           |
| Manure                                                                       |          |           |           |           |           |           |           |
| water                                                                        |          |           |           |           |           |           |           |
| bush tripe for land clearing                                                |          |           |           |           |           |           |           |
| measure spacing and put up a stake                                          | 430,000  | 430,000   | 2,430,000 | 2,430,000 | 2,430,000 | 2,430,000 | -         |
| weeding around the stake                                                    | 2,160,000| 2,160,000 | 2,160,000 | 2,160,000 | 2,160,000 | 2,160,000 | -         |
| dig the planting hole and apply manure                                      | 5,400,000| 5,400,000 | 5,400,000 | 5,400,000 | 5,400,000 | 5,400,000 | 5,400,000 |
| bush tripe for maintenance                                                  |          |           |           |           |           |           |           |
| weeding around the clump                                                    | 6000     | 6000      | 6,000     | 6,000     | 6,000     | 6,000     | 6,000     |
| fertilization                                                               |          |           |           |           |           |           |           |
| harvest bamboo shoots                                                        |          |           |           |           |           |           |           |
| production of bamboo shoots/clumps (kg)                                      | 8        | 8         | 8         | 8         | 8         | 8         | 8         |
| production of bamboo shoots/ha (kg)                                          | 8,888    | 8,888     | 8,888     | 8,888     | 8,888     | 8,888     | 8,888     |
| price of bamboo shoots/kg (Rp)                                               | 6,000    | 6,000     | 6,000     | 6,000     | 6,000     | 6,000     | 6,000     |
| Total Receipts/ha (b)                                                        | 53,328,000| 53,328,000| 53,328,000| 53,328,000| 53,328,000| 53,328,000| 53,328,000|
| Benefits                                                                     |          |           |           |           |           |           |           |
| Profit (b-a)                                                                 | 40,910,300| 42,560,300| 40,910,300| 42,560,300| 40,910,300| 42,560,300| 47,928,000|
| Cumulative profit                                                            | 190,870,190| 233,430,490| 274,340,790| 316,901,090| 357,811,390| 400,371,690| 448,299,690|
| Net BC Ratio, NPV, IRR                                                       |          |           |           |           |           |           |           |
| DF at DR 12%                                                                 | 0,36     | 0,32      | 0,29      | 0,26      | 0,23      | 0,20      | 0,18      |
| Present value of benefit                                                     | 19,230,611,41| 17,170,188,76| 15,330,525,68| 13,687,969,36| 12,221,401,21| 10,911,965,37| 9,742,826,22 |
| Present value of cost                                                        | 4,477,947,1| 3,466,911,2| 3,569,792,0| 2,763,800,4| 2,845,816,3| 2,203,284,8| 986,559,8 |
| Present value                                                                | 14,752,664,3| 13,709,277,5| 11,760,733,7| 10,924,169,0| 9,375,584,9| 8,708,680,6| 8,756,266,4 |
| The amount of benefit is discounted                                          |          |           |           |           |           |           |           |
| Discounted total cost                                                        |          |           |           |           |           |           |           |
| Net B/C                                                                       |          |           |           |           |           |           |           |
| NPV                                                                          |          |           |           |           |           |           |           |
| IRR                                                                          |          |           |           |           |           |           |           |
| PP                                                                           |          |           |           |           |           |           |           |