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Financial Analysis of Beekeeping Practices at *Acacia crassicarpa* Plantation Forest in Riau Province, Indonesia

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Abstract

One environmental service provided by A. crassicarpa plantation is extrafloral nectar which has been widely used for beekeeping since 2019. Nevertheless, nowadays between apiaries practiced unfair competition since there were price fall led by oversupply and low demand after covid pandemic ended. Thus, evaluating the cost structure, profitability, and its feasibility value are critically required. The study's objectives were to 1) evaluate cost structure, revenue and profitability and 2) to conduct a feasibility analysis of each apiary type. This study was conducted from in 2019 to 2022 at the Siak Regency, Riau, Indonesia. Structure interviews combined with desk studies were carried out to collect the data. Data were analyzed based on cost structure, revenue, profitability, and feasibility analysis. All types of apiaries were feasible since they could cover variable and fixed costs. However, it revealed that all types of apiaries experienced minus in profitability in the fourth of financial year. In general, variable cost relatively increased to the level of 50% of total cost in the fourth year. In contrast, fixed cost was relatively declined to less than 50%. Apiaries managed two rits had a better performance in cost structure to face the competitive market followed by apiaries managed three rit. Meanwhile, apiaries managed rit one experienced such a difficult challenge to survive.

Keywords: *Acacia crassicarpa plantation, beekeeping, financial analysis*

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Introduction

The role of plantation forests has increased in the last few decades, one of which is to meet the demands of the pulp and paper industries. The dependence on artificial forest schemes has increased due to a significant decline in timber production from natural forests since the late 1980s (Warman, 2014). In addition, almost one-third of global log timber production is contributed by forest plantations (Jürgensen et al., 2014). According to a study by Payn et al. (2015), plantation forests increased by 67.7% to at least 280 million ha in 2015 compared to the 1990s, and fast-growing industrial forest plantations contributed 54 million ha (Indufor, 2012). Furthermore, Indonesia, a country with the rapid growth of industrial fast-growing forest plantations, has 5.1 million ha from a total of 188.2 million ha of forest area (Hendroyono et al., 2020).

The existence of industrial forest plantations is dominantly addressed to meet the raw material for pulp and paper industries. In Indonesia, the number of forest areas designated for industrial plantation forests has ssignificantly increased. For instance, in Riau Province, where the two biggest pulp and paper industries were located, the area of industrial plantation forests increased from 1.18 million ha in 2002 to 1.21 million ha in 2005 and up to 1.6 million ha in 2015 (Dinas Kehutanan Provinsi Riau, 2014; Rama, 2019). Also, With a prominent concession area, the industrial plantation forest provides a significant contribution to the government in the form of tax and non-tax state revenue, such as land and building tax, value-added tax, income tax, various retributions such as forest management business permit fee (IUPH), provision of forest resources (PSDH), reforestation fund (DR), and substitution of stands value (Wahyudi, 2012).

In contrast, another thought of industrial plantation forests in Riau revealed that they do not have any real contributions to local people living in the concession area. A study conducted by FWI (2015) stated several studies have shown that the existence of industrial plantation forests in Riau has not contributed significantly to the welfare of local communities living in the surrounding concession area.

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Moreover, many tenure issues occur between local communities and concession holders. On the other hand, many studies mentioned that this industrial plantation forest provides several ecosystem services and goods and usually supports local communities' livelihoods (Bauhus et al., 2010; Baral et al., 2014; Nambiar et al., 2015). Conversely, Riau Province has almost 60% of its industrial plantation forest concessions area in peat land (Jikalahari, 2005; Dinas Kehutanan Provinsi Riau, 2014).

Peat land, especially shallow peat, is one type of log-over area (LOA) designated for pulp and paper industrial plantation development. One plant species that is widely used in this type of land is *Acacia crassicarpa,* a fast-growing tree species that is adaptable to peatland and widely used as raw material for pulp and paper in Southeast Asia (Harwood & Nambiar, 2014; Sugesty et al., 2015; McKinnon et al., 2018; Nambiar et al., 2018). In addition, *A. crassicarpa* was considered an exotic plant species by various studies even though it has many problems on the environmental side, such as slow litter decomposition and suppression of local vegetation species (Pribadi & Junaedi, 2021; Junaedi et al., 2022). Research, innovation, and technologies have been developed to support its performance as a potential plantation forest species which includes silviculture techniques, genetic improvement through breeding strategies, vegetative propagation, and environmental protection (Mc Kinnon et al., 2018; Nirsatmanto & Sunarti, 2019).

Nonetheless, the support for the supply of raw materials for the pulp and paper industry has not been followed by an increase in the welfare of most of the local communities around the plantations, leading to conflict (Mutolib et al., 2017). According to Pirard et al. (2016), acacia plantations lack of services, low advantages, and benefits obtained by local communities indicate a high dissatisfaction rate. Moreover, 44% of respondents stated that acacia plantations had at least four negative impacts. In Pinang Sebatang Barat Village, Riau Province, which is closely surrounded by acacia plantations, 89% of respondents mentioned that the existence of acacia plantations harmed access to natural resources and their livelihoods, especially compared to teak and pine plantations in the same aspect measurement (Pirard et al., 2016).

Many non-wood resources and environmental services could be utilized by people living around the *A. crassicarpa* plantation. One of those benefits is the abundant availability of extrafloral nectar produced by *A. crassicarpa* that could be used to support sustainable beekeeping (*A. mellifera*). The amount of nectar potency of *A. crassicarpa* in varied ages resulted about 47.74 liter day^{-1} ha^{-1} and 73.76 liter day^{-1} ha^{-1} in 12 months and 50 months, respectively (Pribadi & Purnomo, 2013a; 2013b). Before 2019, the ecosystem benefits provided by the *A. crassicarpa* plantation had not been utilized. Since then, many beekeepers established apiaries, most from Java Island. The shortage of melliferous plants on Java is a major factor that drives the migration from Java to other islands, such as Sumatera (Widiarti & Kuntadi, 2012). Another reason is that the demand number of honey increased during the pandemic of covid-19. Since thousands of apiaries have been established in the surrounding area of *A. crassicarpa* plantation, this beekeeping euphoria led to many problems. Most apiaries exhibit three types of beekeeping based on the number of managed beehives.

However, most apiaries exhibit unhealty competition since the price fall led by oversupply and low demand. The honey production of up to one ton every two weeks for each apiary created an unbalanced honey price. Free market is common structure practiced in Riau. In a free market structure, an economic system where the production, distribution, and pricing of goods or services are determined primarily by the interactions of individuals and businesses in the marketplace, without significant government intervention (Mulyana, 2019). Most apiaries sold their honey at a low, illogical price, and delayed harvest to cover the production cost. This phenomenon happened since there is unbalance supply and demand. Establishing associations to determine the minimum honey price had already been declared. However, it did not seem to work as it should and led them to be suspicious and act negatively toward other apiaries.

In addition, the business system/model commonly practiced by most apiaries was a management and investor profit-sharing system. Profit-sharing is an agreement made by both parties (apiaries managements and investors) to share the profits, marked by a cooperative contract. If there is a profit, the earnings will be distributed among them. Conversely, if there is a loss, both parties will bear it. Honey produced is sold using two methods, which are direct sales to consumers and dominantly through middleman.

As a result, studies on the feasibility aspects of this beekeeping practice should be carried out. This study was not only to determine the feasibility of many types of apiaries but also to evaluate each apiary type's cost structure and revenue. Furthermore, this study could be employed by legal regulators to standardize the honey price to overcome this unhealthy competition. Hence, the objectives of this study were to evaluate the cost structure and product revenue of many types of apiaries that are generally practiced by beekeepers in Riau Province by conducting a financial and feasibility study.

Methods

Location and time The study was carried out at apiaries took place at Siak Regency, Riau Province (Mandiangin, Sei Mandau, and Dayun) (Figure 1). In Madiangin and Sei Mandau, there were not least than 50 apiaries that run their beekeeping business. Meanwhile, there were only eight apiaries that operated in in Dayun. They number of bees were varied from one to three rit. All apiaries were located between *A. crassicarpa* plantation managed by Arara Abadi Co. Ltd., and Riau Andalan Pulp and Paper and oil palm plantations are owned by locals and bordered by an artificial water canal. All apiaries used *A. mellifera* for their bee. Field data collection was conducted from 2019 to 2022.

Data type and approach The approach used in this study was to carry out the cost structure and feasibility of apiaries established at *A. crassicarpa* and oil palm plantations to develop sustainable and long-term economic activities that would significantly benefit local people. The type of data

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collected during this study was primary and secondary data. Primary data was collected from beekeepers and some people from its management through a direct interview, including variable costs, fixed costs, honey production, and honey-selling price, and market chain. All questions about feasibility studies collected from websites and published online, particularly regarding operational cost and parameters used in operational beekeeping units, were explored and tabulated as interview guidance.

For primary data, we divided parameters into two factors, namely fixed cost (such as bee colonies, honey extractors, veil, gloves, brush, management, etc.), variable cost (such as sugar, labor cost, medications etc.), and total income (such as honey). The questions about beekeeping's operational cost, such as bee populations, honey yields and prices, harvesting practices, honey processing, disease symptoms, and treatment, about beekeeping were formulated to standardize all information gathered from the field. For sensitivity analysis, we set the rate of interest based on the data announced by Bank Indonesia in 2021. Meanwhile, the honey selling price was adjusted at USD3.49 kg^{-1} based on the average honey price during the data gathered. Meanwhile, secondary data was gathered by collecting and searching for any information related to the primary data, such as monograph data.

Respondents selection This study was conducted around three types of apiaries which were categorized based on the number of beehives they managed, i.e., one rit (168 beehives), two rits (336 beehives), and three rits (504 beehives). For each rit, three apiaries were selected in this study. Hence, in total, there were nine apiaries chosen in this study. For each rit, there was three apiaries that were selected in this study. Hence, in total there were nine apiaries were chosen in this study. Here we used combination between convenience and snowball sampling refers to the practice of selecting respondents based on their accessibility, willingness, and desire to participate. Moreover, snowball sampling applied depends on previous respondent recommendations. The first respondent are chosen using any kind of sampling, and they then recommend others who meet the requirements. The data was collected through respondents' interviews and observations for each apiary. Also, we purposively chose key informants to gather more information regarding the apiaries that owned one, two, and three rits. Key informants were local people or heads of the village whose land was rented for apiaries, so they knew almost all the information regarding the apiary process.

One or two people in charge managed the typical apiary selected here as management and a beekeeper. In this study, all apiaries were not typically similar to a group of farmers that usually consisted of many people with equal rights, duties, and responsibilities. Hence, all resources and properties in apiaries belonged to management. There was no participation level in the number of beehives owned as in a common farmer group. Thus, the number of respondents was limited to management and beekeepers (Cohen et al., 2000; Palinkas et al., 2015). The management is responsible for running the business, such as determining the location, selling honey, preparing all equipment, and paying labor.

Meanwhile, a beekeeper has a direct duty in caring for the honey bees, such as medical treatments, hive manipulation, determination of harvest time, and some technical issues related to beekeeping. Besides, seasonal laborers were occasionally hired when harvesting time only (12 days a month) so they are not considered respondents. Hence, each apiary has only two or three respondents (12 people from management and one from beekeeper). In other words, we interviewed people with a direct role in their apiary. Since each apiaries have only one beekeeper regardless number of

Figure 1 Three locations where data was collected, i.e, Mandiangin, Sungai Mandau, and Dayun.

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rits managed, we interviewed nine beekeepers during this study.

Meanwhile, since it already had a legal entity from management, we chose a director and a treasurer. Nevertheless, in some cases, a director also acts as the treasurer. Hence, we interviewed at least 18 people representing all types of apiaries.

Furthermore, field studies were conducted by inspecting and interacting with beekeepers and their managements from three apiary types selected. Next, we limited respondents by selecting apiaries that already had legal entities. Direct observation activities around the apiaries were conducted, particularly on variable and fixed costs. A semi-structured interview method was adopted to assess drivers such as training and information regarding the operational cost of running the beekeeping.

Analysis and data management *Cost structure, revenue, and profitability* The determination of cost structure is based on identifying any costs resulting from beekeeping activities. It was divided into fixed and variable costs. Fixed costs were used for land rental, fuel, housekeeping, equipment, honey process building, and beehives. In the meantime, variable costs covered food supplements, medications, and labor. For the description and analysis of apiary management, the following variables were considered, i.e., the type of apiary management and technical assistance. The elements considered for analyzing the technical coefficients and the production process were as follows: the number of beehives, labor, food supplements, disease control (*varroasis*), production, and frequency of production, among others. In specific, for labor and input cost were calculated considering the following variables, i.e., the number of day laborers that has a responsibility as housekeeper (usually they do not have responsibilities in caring the beehives), transportation, harvesters (seasonal workers that were usually paid only when harvesting period), beekeepers (workers that have duties in caring and maintaining the bees).

Financial feasibility analysis Financial feasibility analysis is one aspect of a business feasibility study. According to Khotimah and Sutiono (2014) and Noodle et al. (2014) study of business, feasibility is a research project of business plans that is not only used and analyzed by a business before it is created but when a business is routinely operating to reach the maximum profit in an unlimited of years also. Financial aspects are examined to calculate the funds needed to operate and establish a business.

Net present value (*NPV*) NPV is one of the investment criteria widely used to determine the feasibility of a proposed project. NPV is a present differentiation value of cost and benefits on a particular discount rate. The NPV equation is as shown in Equation *[1]*.

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+\mathrm{i})^t} \qquad [1]$$

Note: NPV = net present value, Bt = benefit in the years of t, Ct = cost in the years of t, i = discount rate, and number of years.

Business is feasible when the NPV has a positive value (NPV > 0).

Internal rate of return (*IRR*) IRR is a discount rate that contributes to the NPV of all cashflows from a certain project that equals zero. The IRR equation is as shown in Equation *[2]*.

$$IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} * (i_1 - i_2) \qquad [2]$$

Note: IRR = internal rate of return to be needed, i_1 = internal rate (discount rate) of the early period, i_2 = internal rate (discount rate) of next period, NPV_1 = NPV derived from i_1, NPV_2 = NPV derived from i_2.

Net benefit cost ratio (*B/C Ratio*) B/C ratio is the indicator of positive discounted benefit divided by the cost that is formulated as shown in Equation *[3]*.

$$B/C = \frac{\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}} \qquad [3]$$

Note: B/C = benefit cost ratio, Bt = benefit in year of t, Ct = cost in year of t, i = discount rate, t = number of years.

In this equation, Net B/C is the ratio of positive discounted net benefits to negative discounted net benefits. The numerator side is positive discounted net benefits with negative discounted net benefits indicate that the calculation results show a financially favorable outcome. Meanwhile, the denominator is negatively discounted net benefits indicate that after considering the time discount rate, the present value of the expected benefits is lower than the costs incurred or the initial investment required.

Payback period (*PP*) The payback period is a tool used to determine the time/years required to recover the amount of invested money on annual cash inflows generated by the investment value (Suliyanto, 2010). The payback period equation is as shown in Equation *[4]*.

$$PP = T_{p-1} + \frac{\sum i_1 - \sum Bic_{p-1}}{B_p} \qquad [4]$$

Note: PP = payback period, T_{p-1} = year before there was PP, i_1 = the investment amount has been discounted, Bic_{p-1} = amount of benefits that have been discounted before PP, and Bp = number of benefetis on PP.

The data collected was managed based on its purposes. Data were tabulated by dividing the parameter based on a fixed cost, variable cost, and total amount of income predicted according to the age of the acacia plantation that is up to four years before it is harvested). Moreover, here we use variation in the number of beehives managed in each unit as one, two, and three rits. This number of beehives in each unit of apiaries is based on the ability of trucks to transport beehives that were sent from Java island. A cost analysis was performed by Beltrán et al. (2021) with the methodology commonly used by the United States Department of Agriculture (USDA) that referred to the standards of recommendation declared by the Working Group on Cost and Returns of the American Agricultural Economics Association

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(AAEA). Here, we conducted a financial cost only that includes only fixed and variable costs. Meanwhile, the opportunity cost was not included since it is commonly used in calculating economic cost (Beltrán et al., 2021). Also, all processed data was analyzed using cost and benefit analysis in the form of NPV, IRR, B/C ratio, and Payback Period based on the number of beehives in each apiary unit.

Results and Discussion

The data tabulation was arranged based on the number of colonies managed by most apiaries in Riau Province, Indonesia. The terminology of apiary is commonly used by many beekeepers to describe a beekeeping practice (usually using *A. mellifera*) to produce honey (Sturges, 1925; FAO, 2021). In this study, there are three groups of apiaries that most beekeepers commonly practice, and this term is continually used in this study, i.e., one *rit* (a named for an apiary that owned and managed 168 beehives, two *rit*s (a named for an apiary that owned and managed 336 beehives, and three *rit*s (a named for an apiary that owned and managed 504 beehives). The term "*rit*" refers to the maximum of one truck that can accommodate the maximum number of beehives in a single run (from Java Island to Sumatra Island). Furthermore, the logic behind the determination of four years for the project is that the rotation schedule of *A. crassicarpa* plantation, which is harvested when it reaches four years after planting, and the maximum age of the honeybee queen before getting grafted and replaced.

Apiary management The beekeeping production units in Riau Province are classic standard beehives similar to apiaries practiced on Java Island. Likewise, most beekeepers built the hive with support (mostly made of iron, wood, etc.), a floor, and a metal lid cover. Since most beekeepers do not apply the super box commonly used for honey production, every beehive consists of a brood chamber (Langstroth type) and honey frames. The maximum total frame in one beehive is eight to nine. Nonetheless, most beekeepers only put seven to eight frames in every beehive. Most beekeepers did honey harvesting every 10 to 14 days and collected three to five kg of honey per beehive on average. Harvesting delay and sugar treatment were done when the condition was unsuitable, i.e., rain for over three consecutive days.

Moreover, the medicinal treatment for *varroasis* was also routinely practiced to suppress mite development. Hristov et al. (2021) mentioned that *Varroa destructor* is the main honeybee pest and, together with pesticides, was blamed as the major factor in declining of the honeybee population throughout the world. Nonetheless, this treatment usually contaminates the honey itself, particularly when nectar flow occurs (Bogdanov et al., 1997; Bergero et al., 2021).

Conversely, there are many types of apiary management in Riau Province. Generally, most apiary management usually set one rit as the minimum number of beehives they desire to manage and avoid managing less than one rit. The first type of an apiary is fully managed and owned by a single management. They handled all parts of beekeeping that covered variable, fixed, and marketing costs. People with many capitals usually own this type of apiary. Another type is an apiary that collective people form. Since one rit is highly costly, an apiary that used this system opened investment chances for people interested in buying and establishing their apiary. The terminology for this type of apiary is investors and managers. The managers guaranteed to maintain and keep those beehives to produce honey by offering a profit-sharing scheme based on the agreements that had been signed. This scheme is quite popular in many industrial plantation forests in Riau and became the favorite scheme of investment during the pandemic era.

Cost structure The data related to production and disbursement cost were estimated according to the number of beehives by each apiary and based on the information gathered from the surveys and interviews. Since the financial analysis was used, the percentage structure of total cost is mainly composed of variable cost and fixed cost. Interestingly, the variable costs for one rit in the first year was 32.30 ± 1.27% and this number kept continually increase almost double in the second, third, and fourth year. Even though the total cost declined almost twice compared to the first year, percentage of variable cost was high. In the second year, percentage of total variable cost increased to 36.77 ± 0.075% and this trend was continually to the third and fourth year that resulted 41.37 ± 0,08% and 47.73 ± 0.075%, respectively (Table 1). In addition, rit two and three exhibited similar trend to rit one. Nevertheless, in the fourth of financial year, it was rit two that had the highest percentage of variable cost (48.83 ± 0,075%).

The ability of beekeepers to propagate or split and make new colonies in case the colonies they bought in the first year died or devastated by predator, such as honey bear gave significant benefit for apiaries since it reduces the cost of beehive purchasing in the next year. This method is commonly practiced by many apiaries since it is inexpensive and do not require sophisticated equipment and methods (Olmstead & Mccallum, 2019). In the labor cost that covered seasoned labors and beekeepers cost, it was revealed that labor cost, showed a rise throughout all the financial years and covered the major component in variable cost in the first year of one rit (63.09%) and kept rising to 67% at the end of the financial years. This trend was similar to rit two and three. In contrast, beekeepers` cost revealed that either rit one, two, or three had similar tendency where the cost was arise in the first to third year and decline in the fourth year (Table 1).

Nonetheless, fixed costs started to decline in the second to the fourth financial year. In the first year, fixed costs were 65.59 ± 1.20% of the total cost and gradually declined to 48.69 ± 0.023% at the end of the financial year for rit one. The decline was due to the high contribution of beehives, building process, and equipment depreciations which significantly contribute to the total fixed cost as 98.1% (Table 1). Here, we used data provide by ATO Depreciation Rates in 2021 that mentioned a beehive has 13 years effective time. Hence, the formulation of depreciation value for each year was all cost of beehives 'purchasing divided by 13. Hence, the apiaries did not necessarily invest in new beehives by purchasing but simply manipulate and split the beehives.

Also, it was found that rit two had the lowest cost of labor and beekeepers percentage than any other rits observed. In average, rit two had 62.67% and 8.23% of labor and beekeepers costs respectively. Determination of labor cost is based on daily labor cost that was usually practiced in the area. For instance, most apiaries applied 10–20% of total honey production per harvesting period as the basic salary for the beekeepers only and for the helpers were not included (Figure 2). It showed that *rit* two had more efficient in a term of labor and beekeepers cost than other *rit*s.

In the meantime, in *rit* the three, the variable cost in the first year was 34.25 ± 1.27%. Similar to the one and two *rit*s, the percentage variable cost in the second, third, and fourth financial year was over 50% (Table 1). In contrast, the total fixed cost declined in the second year (59.03 ± 0.07%) compared to the first year (65.75 ± 1.26%). Similar to *rit* one and two, depreciation of building process, beehives, and equipments contribute 97% of total fixed cost. In the second and following years, apiaries preferred to manipulate and split beehives to compensate for the destroyed/dead ones. As a result, most apiaries could reduce the cost of beehives by up to 95%.

Similarly, in the case of labor cost both seasoned labor and beekeepers were also noticed in the three rits. In the first year, labor in variable cost was 72% of the total variable cost. This cost increased in the next following financial years, 77.35% in the second year, and 78.74% in the third year. However, in the last year, the percentage was slightly decline to 78.09% (Table 1).

According to the result, the production cost of apiaries was estimated to mainly consist of fixed cost in the beginning, particularly in the first and second year. In contrast, variable costs started to dominate the cost in the last financial years for all apiaries types. In general, for all apiaries types and all financial years, variable costs covered the range of 34.25 ± 1.27% to 51.31 ± 0.075%, while fixed cost represents the proportion of 48.69 ± 0.023% to 65.75 ± 1.26% of the total cost. This finding contrast to many studies that reported a contribution of 77.9% for variable costs and 22.1% for fixed costs in a common beekeeping practice (Aboud, 2014; Bekuma, 2018; Aydin et al., 2020; Beltrán et al., 2021). Regardless of the type of apiary, it revealed that the percentage of variable costs increased in the rest of financial years. The increase in seasoned labor cost and decline in beekeepers cost had become a major factor that led to this phenomenon. Even Aydin et al. (2020) stated that labor cost contributes 51.4% of total production cost although it was categorized as family labor. In other words, labor cost (seasoned labor and beekeepers) had significant contribution to the variable cost.

Another cost, such as fuel contributed 1.1%, 1.4%, 1.9%, and 2.6% of total production cost in apiary one for four financial years. Interestingly, rit three had the lowest percentage of fuel cost that ranged between 0.4% in the first year to 0.9% in the fourth year. A study by Aydin et al. (2020) reported that fuel took 11.29% of the total cost since they practiced migratory beekeeping. Stationary beekeeping that was practiced by all apiaries in Riau, was presumably suppressed the cost of fuel. This comparative benefit was caused by the existence of extrafloral nectar from *A. crassicarpa* plantation that is commonly planted as pulp and paper material (Pribadi, 2020). Extrafloral nectar secreted by *A. crassicarpa* keeps producing nectar until four years old (Pribadi & Purnomo, 2013c; 2015). In other words, it never stops producing nectar. The never-ending nectar supply combined with oil palm plantation that produced enormous and good quality pollen (31% of crude protein) (Hassan, 2011) resulted in a reduction in the fuel cost since there was no need to practice migratory beekeeping. The stationary beekeeping practice in *A. plantation* reduce the fuel and food supplement cost more than ten times than the migratory beekeeping.

Furthermore, compared to other studies, production cost was also reduced by the cost of food supplements. The food supplement was required when beehives experienced a food shortage, particularly nectar or honey in their colony. As a result, food supplements, particularly sugar, are critically required to save the colonies (Abou-Shaara, 2017). Requirements of sugar, as the production cost is varied, in a study conducted by Adalina (2008) reported that sugar feeding during the rainy season took 27–35% of variable cost. Meanwhile, in Turkey, sugar feeding has a proportion of

Table 1 Production cost (USD) of an apiary that managed one, two, and three *rit*s

Apiary types (*rit*)	F	Variable costs					
		FS	M	L	Be	TVC	PTVC (%)
1	1	840.02 ± 10.95	2,449.00 ± 31.93	9,926 ± 79.75	2,519 ± 0.35	15,734.02 ± 152.18	34.41 ± 1.27
	2	848.40 ± 11.05	2,693.91 ± 33.95	10,918 ± 79.38	2,771 ± 0.29	17,231.31 ± 172.97	39.56 ± 0.075
	3	856.84 ± 9.85	2,696.33 ± 34.16	12,012 ± 79.39	3,048 ± 0.22	18,613.17 ± 149.38	45.02 ± 0,08
	4	865.45 ± 12.90	2,698.80 ± 34.08	12,211 ± 79.37	2,450 ± 0.35	18,225.25 ± 139.61	51.31 ± 0.075
2	1	3,359.20 ± 16.59	6,158 ± 41.93	18,172 ± 103.58	2,519 ± 0.36	30,208.20 ± 259.03	36.60 ± 1.26
	2	3,360.02 ± 19.14	6,158.32 ± 44.25	19,992 ± 113.31	2,771 ± 0.30	32,281.34 ± 285.16	40.14 ± 0.26
	3	3,360.29 ± 18.41	6,158.57 ± 44.46	21,988 ± 123.97	3,048 ± 0.21	34,554.86 ± 245.55	45.04 ± 0.07
	4	3,360.39 ± 19.79	6,158.60 ± 44.08	22,187 ± 135.67	2,450 ± 0.36	34,155.99 ± 271.11	50.63 ± 0.075
3	1	5,039.00 ± 93.2	7,432.00 ± 108.7	26,699 ± 176.76	5,039 ± 0.75	44,209.00 ± 647.76	34.25 ± 1.27
	2	5,039.28 ± 99.57	7,431.35 ± 111.0	35,919 ± 267.25	5,542 ± 0.62	53,931.63 ± 693.32	40.97 ± 0.05
	3	5,039.28 ± 97.75	7,432.19 ± 111.2	38,671 ± 257.03	6,097 ± 0.45	57,239.47 ± 595.40	44.91 ± 0.071
	4	5,039.29 ± 101.2	7,433.03 ± 110.8	38,698 ± 260.31	5,005 ± 0.72	56,175.32 ± 640.40	49.32 ± 0.075

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Table 1 Production cost (USD) of an apiary that managed one, two, and three *rit*s (*continued*)

Apiary types (*rit*)	F	Fixed cost							TC
		LR	Fe	ED	HB	B	TFC	PTFC (%)	
1	1	210.02 ± 0.047	280 ± 0.62	541.72 ± 0.35	4,618.5 ± 0.01	19,534.16 ± 0.1	25,184 ± 145.69	65.59 ± 1.20	38,399.4 ± 17.13
	2	241.22 ± 0.048	322 ± 0.52	541.48 ± 0.28	3,079 ± 0.2	17,906.32 ± 0.01	22,090 ± 20.48	60.44 ± 0.075	36,550.3 ± 15.31
	3	278.11 ± 0.049	370 ± 0.39	541.18 ± 0.19	1,539.5 ± 0.05	16,278.48 ± 0.01	19,007 ± 15.01	54.98 ± 0.021	34,572.4 ± 12.39
	4	300.50 ± 0.049	426 ± 2.69	540.91 ± 0.77	0	14,650.64 ± 0.01	15,918 ± 22.96	48.69 ± 0.023	32,693.3 ± 26.86
2	1	964.00 ± 0.044	280 ± 0.85	541.72 ± 0.35	7,109.25 ± 0.015	39,068.31 ± 0.21	47,963 ± 197.91	63.40 ± 1.25	75,652.5 ± 27.10
	2	971.42 ± 0.047	322 ± 0.71	541.48 ± 0.29	4,739.50 ± 0.012	37,440.47 ± 0.018	44,015 ± 18.92	59.86 ± 0.25	73,525.2 ± 24.42
	3	972.85 ± 0.047	370 ± 0.53	541.18 ± 0.19	2,369.75 ± 0.1	34,184.78 ± 0.018	38,439 ± 13.90	54.96 ± 0.26	69,945.4 ± 45.11
	4	973.81 ± 0.047	426 ± 2.95	540.91 ± 0.77	0	30,929.09 ± 0.02	32,870 ± 21.69	49.37 ± 0.26	66,575.8 ± 36.01
3	1	1,927.64 ± 2.69	350 ± 1.2	853.43 ± 0.55	11,763 ± 0.012	60,311.00 ± 0.33	75,205 ± 295.67	65.75 ± 1.26	114,375 ± 35.17
	2	1,936.50 ± 2.23	402 ± 0.98	853.01 ± 0.43	7,842 ± 0.3	58,683.16 ± 0.031	69,717 ± 9.71	59.03 ± 0.07	118,106 ± 35.39
	3	1,937.60 ± 1.66	463 ± 0.8	852.58 ± 0.30	3,921 ± 0.2	55,509.16 ± 0.031	62,743 ± 9.11	55.09 ± 0.05	113,886 ± 28.83
	4	1,938.75 ± 2.69	532 ± 4.02	852.16 ± 0.50	0	52,335.16 ± 0.031	55,658 ± 10.69	50.68 ± 0.05	109,828 ± 35.59

Remarks: R = *rit*(s); F = financial years; FS = food supplements; M = medications; L = labor (harvesters and transporters), Be = beekeepers; TVC = total variable costs; PTVC = percentage of TVC to TC; TC = total cost; LR = land rental; Fe = fuel; ED = equipment depreciation; HB = honey process building; B = beehives; TFC = total fixed costs; PTFC = percentage of TFC to TC.

Note: Determination of labor cost is based on the usual condition commonly practiced by most apiaries. Equipment (ED) consists of the extractor, mini spinner, uncapping bench, sedimentation tank, wax recuperator, honey supers, brood chambers, and mating nuc boxes.

Figure 2 Two types of labor commonly practiced in the apiary are beekeeper (left) and helpers/seasonal labors (right).

12.74–60% of variable costs (Aydin et al., 2020).

In Mexico, the percentage of sugar feeding varied between 53–60% depending on the number of beehives managed (Beltrán et al., 2021). Widiarti and Kuntadi (2012) stated most beekeepers in Java Island believed that the decrease in beekeeping in Java Island due to a lack of extension and enlargement of honeybee forage plants (87.50%), and 50% of respondents considered that sugar price that commonly used for food supplement needed to be subsidized. This study was in contrast with the previous studies in that the requirement for sugar feeding was 5.7%, 10.04%, and 10.63% of the variable cost in the one, two, and three *rit*s, respectively. It means that practicing beekeeping at the *A. crassicarpa* plantation consequentially reduces the cost of sugar feeding by more than three times that of the practices on Java Island.

Based on these results, it can be assumed that there is a tendency for all types of apiary to experience a decrease in fixed costs coupled with an increase in variable costs. The *rit* types that experienced an increase in variable costs exceeding 50% were *rit* one and *rit* two. In fact, it is predicted that variable costs will increase and dominate total costs in the next financial years. When a business has more variable costs than fixed costs, it indicates several things. First, the business could have high profit potential since it has production costs that are directly related to sales volume. If the business has high sales, then the profit per unit of product can be higher as variable costs can be more distributed and decrease per unit of product. Second, the business has flexibility in responding to market changes due to it can provide flexibility in adjusting production to fluctuating market demand. When demand is high, production can be increased to meet demand, and conversely when demand decreases, production can be reduced to avoid wasting costs. Nevertheless, this situation also has several number of disadvantageous. First, the business is vulnerable to market fluctuations since the businesses with higher variable costs are vulnerable to fluctuations in market demand or changes not only in raw material prices but also in purchasing and market demand. The second is more difficult to control costs due to when variable costs are not easily managed well, the business can experience financial instability.

Cost analysis is a valuable tool for those who deal with beekeeping to address the challenge of lower honey prices caused by oversupply in the market. When there is an oversupply of honey, the market becomes more competitive, and prices may decrease, thus affecting the profitability of the beekeeping business. Conducting a comprehensive cost analysis helps to deal with this challenging situation and make informed decisions to improve their financial position. To manage the problem, the first thing that most apiaries did was to evaluate the various cost components involved in honey production, particularly labor cost. Most apiaries acted to cut their beekeepers' salary and practice delaying in harvesting time to reduce cost of seasoned labor in the fourth year (Table 1).

Revenues and profitability Honey is sold by the management in two ways: retail and wholesale. The harvest is removed, packed in 35 liters/50 kg drums, and transported off to be processed by intermediaries known as packers; most major management sell on the wholesale market/bulk to the middleman. Alternatively, there is not many apiaries establish a local market and sell retail.

In order to evaluate the income flow, revenue and profitability are required to be determined. Revenue, often known as sales or turnover, is the total amount of money earned by a company from its core operations during a certain time period. Revenue is an important financial indicator that represents a company's top-line performance before subtracting any expenses or charges (Chandra & Ro, 2008; Nguyen et al., 2020; Schouten, 2020; Topitzhofer et al., 2020; Abro et al., 2022). Meanwhile, profitability is a measure of the earnings generated by a business or company from its business operations. Profitability measures the efficiency and success of a business in generating enough revenue to cover all costs and earn a profit (Geamanu, 2011; Winarko & Jaya, 2018; Sadia et al., 2021; Abro et al., 2022). In general, in the first year of rit one, the total honey production reached 11,397.75 kg or a beehive produced up to 5.68 kg month^{-1} honey in average. Meanwhile, *rit* two and *rit* three resulted 22,795.5 kg and 39,078 kg in the first year respectively. Even though, all *rit*s types had an incline in the second and third year, they experienced decline production in the fourth year, except for rit three that had already decline since it was in the third year (Table 3). In the fourth year, most apiaries exhibited delaying in harvest to minimize production cost (seasoned labor and beekeepers). The other reasons are the honey price that sharply dropped and the managements still had huge number of unsold honey in their warehouse. Moreover, in the third year to fourth year, there were decline of honey price as 38.5% linear with honey production. This phenomenon is unique, according to Geamanu (2011); Winarko and Jaya (2018); Sadia et al. (2021), it was stated that when the goods production was reduced by producer, the price will go up and in contrast, when the goods production was incline, the price will decline.

As the managements acquired more beehives, the income generated increases its share of the total income. Nonetheless, when the income was calculated with the total cost, it showed a unique phenomenon. In the first year, *rit* one obtained total inflow (TI) of USD1,674.22 and increased to 26,764.17 in the second year and dropped to USD5,918.07 in the third year. In the last year, the decline got worse since it had negative income (-USD7,955.46) (Table 2). This trend happened in other types of apiaries and *rit* three experienced the biggest negative in total inflow as -USD27,145.45 (Table 2). In the meantime, apiary type of rit two experienced the highest level of profitability in the second year compare to *rit* one and three that had 0.73 and 0.82, respectively. Apiary rit two also exhibited better profitability than any other apiaries types since it had the lowest loss (-0.18) compare to *rit* one and three that experienced -0.24 and -0.25

Table 2 Honey production and total income of three types of apiaries

Apiary types (rit)	F	Honey production (kgs)	Average price selling in observed year (USD)	Total income (USD)	Total cost (TVC+TFC) (USD)	Total inflow (USD)	Profitability
1	1	11,397.75 ± 71.39	5.00 ± 0.04	40,073.64 ± 29.48	38,399.42 ± 17.13	1,674.22 ± 20.71	0.04
	2	11,511.73 ± 82.09	5.50 ± 0.73	63,314.50 ± 27.82	36,550.33 ± 15.31	26,764.17 ± 21.57	0.73
	3	11,568.72 ± 69.96	3.50 ± 0.17	40,490.51 ± 23.88	34,572.44 ± 12.39	5,918.07 ± 17.11	0.17
	4	11,505.97 ± 80.04	2.15 ± -0.24	24,737.84 ± 11.13	32,693.3 ± 26.86	-7,955.46 ± 19.15	-0.24
2	1	22,795.5 ± 97.54	5.00 ± 0.51	113,977.50 ± 17.16	75,652.48 ± 27.1	38,325.02 ± 20.88	0.51
	2	25,348.82 ± 116.12	5.50 ± 0.90	139,418.53 ± 21.71	73,525.21 ± 24.42	65,893.32 ± 23.25	0.90
	3	25,556.04 ± 109.15	3.50 ± 0.28	89,446.12 ± 20.77	69,945.42 ± 45.11	19,500.70 ± 31.08	0.28
	4	25,543.26 ± 112.64	2.15 ± -0.18	54,918.00 ± 22.61	66,575.8 ± 36.01	-11,657.80 ± 29.55	-0.18
3	1	39,078.00 ± 348.80	5.00 ± 0.71	195,390.00 ± 42.65	114,375.09 ± 35.17	81,014.91 ± 36.71	0.71
	2	39,081.91 ± 350.10	5.50 ± 0.82	214,950.49 ± 26.53	118,106.3 ± 35.39	96,844.19 ± 31.21	0.82
	3	38,495.68 ± 332.60	3.50 ± 0.18	134,734.88 ± 16.50	113,885.81 ± 28.83	20,849.07 ± 22.67	0.18
	4	38,457.18 ± 282.71	2.15 ± -0.25	82,682.94 ± 26.32	109,828.39 ± 35.59	-27,145.45 ± 29.20	-0.25

in the last year. Studies conducted by Sanford (1992), Suzan and Nabilah (2020), Farida and Setiawan (2022) mentioned that when profitability is greater than zero, the company is making a net profit after deducting all expenditures from total revenue. In this case, the apiaries earned more money than it spends, resulting in a positive profit margin. In contrast, when profitability is less than zero, the company is losing money, suggesting that its total costs exceed its entire income. In other words, apiaries` income is insufficient to pay its expenditures, resulting in a negative profit margin. It can be caused by a variety of circumstances, such as high production cost (Bond et al., 2021; Albarrak & Gray, 2023), low selling prices (Amulen et al., 2019; Hilmi, 2019; Bixby et al., 2021), and oversupply (Hilmi, 2019; Bixby et al., 2021; de Groot et al., 2021). Hence, this condition is similar to what happened in all apiaries types in the fourth year that experienced low selling price, oversupply (although they have reduced harvesting frequency), and suppress production costs by cutting the beekeepers' cost.

It was found that all three types of apiaries depended only on honey production as the only source of income. Since the practices began in 2019, most apiaries do not have any intentions to make any diversifications of harvest/products when there are other products besides honey, such as beeswax, pollen, and beehives, that could contribute to their income (Waykar & Alqadhi, 2016). Moreover, as apiaries acquire more beehives and only depend on honey production, the income generated from honey production inclines with its percentage of the total income. Therefore, the fluctuation highly influenced their honey price income and put most apiaries in a vulnerable position. Beltrán et al. (2021) stated that in Mexico, honey production contributed 97.2%, 87%, and 88% to total income in apiaries which managed 20–50 beehives, 51–199 beehives, and more than 200 beehives, respectively.

On the other hand, in financial terms, the three types of apiaries were considered feasible since all showed the ability to cover variable and fixed costs, although all three experienced minus profit in the first year (Table 1). Moreover, the two rits apiary had the highest profitability ratio of the other two types of apiary. It also had the lowest minus profitability compared to the one and three *rit*s (Table 2).

The honey price is set at a level of USD3.49 kg^{-1} based on the average honey price available on the marketplace in Riau Province, Indonesia, during the second semester of 2020. This scheme of beekeeping was new in this area. Thus, the honey price had very fluctuated. Also, all apiaries only produce one type of honey, namely *A. crassicarpa* honey. A beehive could produce 35 kg of honey every two weeks, and there was almost no shortage season except when it rained for more than three consecutive days. Usually, mall beekeepers that managed less than 50 beehives set a higher price than beekeepers that owned more than 200 beehives. They obtained lower profitability due to lacking marketing channels, technical management problems, and limited governmental support (Bekuma, 2018; Gratzer et al., 2019; Beltrán et al., 2021). Nevertheless, no honey price difference between the three types of apiaries was noticed in this current study. Hence, apiaries with more beehives generated more income than those with fewer beehives. This finding was not conformed to the previous studies that reported honey price was inversely proportional to the number of managed beehives (Aydin et al., 2020; Beltrán et al., 2021).

The more beehives the apiary would obtain, the more profit. However, more investment in beehives, whereas the low honey price, could also disadvantage the apiaries. The fluctuating honey prices that tend to decline and low demand are other problems that must be addressed.

Based on the information gathered from the study, it was clear that the cost of labor was more important than equipments (increased capacity of the extractor, mini spinner, uncapping bench, sedimentation tank, wax remover) and beehives equipment (honey supers, brood chambers, mating nuc boxes) is more required as an apiary acquires more rits. that beekeepers' labor cost was highly expensive. Since there were not many available trained and trusted beekeepers, many apiaries usually give special offers to attract beekeepers to work with their apiaries. In general, the cost of beekeepers reached up to 20% of net income. Meanwhile, the equipment cost was relatively constant, and apiaries even tended to set a minimized machinery and equipment. This finding was inconsistent with the study by Beltrán et al. (2021), in which the cost of devices, e.g., uncapping tools, extractors, funnels, benches, knives, etc., increased with the number of beehives. Also, all apiaries do not perform product diversification, meaning they only rely on honey production. Since there is no differentiation between honey prices resulting from each rit, the only way to generate more income is to add the number of beehives, which might increase the cost of labor and equipment. Most apiaries sell their honey to middleman due to low demand in retail and they required to earn money to cover cost production, especially to pay lseasoned labor and beekeepers. Consequently, the enhancement number of beehives in conditions with low honey prices must be considered.

Sensitivity analysis The *rit* three apiaries had the highest average of NPV which was USD74,775.22 ± 184.44 (Table 3). The lowest NPV was shown by rit one which was only USD-3,836.92 ± 134.29 (Table 3). NPV is one of the strong criteria commonly used to determine whether a project is profitable by considering the rate of interest which

Table 3 Sentivity analysis of three types of apiaries.

Apiary types (*rit*)	NPV	IRR (%)	B/C ratio (yoy)				B/C ratio (overall)	Payback period
			1	2	3	4		
1	-3,836.92 ± 134.29	0.19% ± 0.00	0.98 ± 0.04	1.61 ± 0.04	1.08 ± 0.05	0.70 ± 0.05	1.10 ± 0.01	3.99 ± 0.12
2	43,186.59 ± 518.24	72.34% ± 0.01	1.46 ± 0.04	1.83 ± 0.05	1.23 ± 0.04	0.80 ± 0.04	1.34 ± 0.03	1.80 ± 0.064
3	67,565.22 ± 168.91	89.19% ± 0.02	1.64 ± 0.05	1.74 ± 0.05	1.12 ± 0.03	0.72 ± 0.05	1.31 ± 0.02	1.77 ± 0.058

Note: Price of honey to calculate B/C ratio is in level of USD3.49 kg^{-1} and 10% of discount rate based on the average of honey price during data was collected.

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puts the inflation rate as the base. Therefore, the value of real money is always different every year and needs to be considered. In order to be categorized as profitable, the value of NPV must be positive, the more positive the NPV, the more profitable a project (Ebrahimi & Keshavarz, 2015).

The NPV analysis assesses the future projection in the long run (four years) and appraises whether the project has a viability potency or not. The principal indicators of capital budgeting techniques that are commonly used are NPV, IRR, profitability index (PI), and payback period (PP) (Islam et al., 2016; Abdurofi et al., 2021). The value of NPV of *rit* two and three apiaries showed positive and in contrast, only *rit* one resulted negative NPV. It means that the time value of money or during the desired project appraisal is considered higher than the present value for *rit* two and three. In this context, these type of apiaries generated profit and the desired project is financially viable. Moreover, it is confirmed that owning and managing more *rit*s gives more benefits during the financial years than managing fewer *rit*s.

Even though the IRR was found to be low compared to the previous studies, the level of IRR of this recent study was higher than the interest rate level of most banks in Indonesia, either private or national banks, that set a rate of interest below 10% (BI, 2021). Meanwhile, other studies mentioned practice the beekeeping had a range of IRR as 45.7–218.37% (Islam et al., 2016; Amulen et al., 2019; Abdurofi et al., 2021). IRR is a financial instrument that describe the return value toward an infestation and indicates that the project would be highly resistant to any financial deformation and decline the risk factors inherent in the predicted projects (Khotimah & Sutiono, 2014; Abdurofi et al., 2021). It revealed that only *rit* one that had IRR less than 1% and other two *rit*s resulted IRR more than 50%, which was 64.30 ± 0.01% for rit two and 79.64 ± 0.02% for *rit* three. An IRR less than one indicate that the cash flows from the project are insufficient to repay the initial investment, resulting in a negative NPV. This means that the project is not financially or profitably viable. Moreover, this also showed s a negative return. A study conducted by Abdurofi et al. (2021) found that the IRR of beekeeping in Sarawak, Malaysia was 131% thus was assumed to be less risky and was efficient in the handling of resource allocation. In other words, apiaries which managed two and three rits were more efficient and less risk than apiaries managed one rit.

All the apiaries exhibited a higher than 1 Benefit-Cost ratio (B/C ratio), which meant the projects were feasible since they could collect more benefits than the outgoing cost. The B/C ratio compares every income collected from an operation of a project to every outgo cost that covers fixed and variable costs (Al-Ghamdi et al., 2017). It turned out that rit two had the highest B/C ratio, as 1.39 ± 0.03, than other rits (Table 3). This finding solely assumes the level of viability of the project, which means that an apiary that manages two *rit*s may earn USD1.68 per USD1 invested in the project, which means that this project is lucrative.

This study also calculated the B/C ratio per year to assess the dynamic level of this variable for each year. Interestingly, in the first year, all types of apiaries experienced a less than 1 B/C ratio, which meant that those apiaries suffered a loss in the first year. All types of apiaries started to acquire a B/C ratio greater than 1 in the second to the fourth year except for the three rits that showed a B/C ratio less than 1 (loss) in the third and the fourth year. Therefore, managing two rits obtained more benefits than the one and three rits shown by the best B/C ratio. However, this finding had not confirmed the study by Islam et al. (2016) that stated the IRR and B/C were linearly correlated with the number of beehives. Thus, the highest IRR was obtained by the largest number of beehives.

Another parameter, namely Break Even Point, revealed that an apiary managing two rits has the lowest BEP than any other rits in one of financial years. Moreover, these apiary units made USD2.89 kg^{-1} of honey compared to one and three apiary units, earning USD3.09 and USD2.94 kg^{-1} of honey, respectively (Table 3). The break-even point is when the company does not profit or suffer losses (Jamaludin, 2020). Moreover, according to Rizki and Sukoco (2019), break-even point analysis is the main return value or production level where a company does not practice losses but does not profit. Furthermore, the interesting one is when the observation was conducted every year; it revealed that BEP for all apiaries type was doubled in the first year than in the second, third, and fourth years. Nevertheless, it was found that rit three had the lowest BEP in the first year by resulting USD2.93 kg^{-1} of honey compared to apiaries which managed one and two rits that earned USD3.37 and USD3.32 kg^{-1} of honey, respectively. Having lower BEP showed that the production process runs efficiently in managing all resources. Hence, they could set lower prices and increase the benefit margin to compete.

This study also found that all apiaries experienced lower honey prices after the first year (Table 3). In addition, the demand for honey declined when the pandemic of covid-19 decreased. Most of apiaries sell their honey in bulk since it earned money faster than retail. This condition positioned those apiaries in the weak position due to lack of bargaining position. Most middleman set their own purchasing price without determining the type of apiaries. Thus, there was no differentiation of purchasing honey price between apiaries. It also revealed that the purchasing price experienced decline that starting in the second year.

xxThe last parameter used in this study is the payback period. That turned out that an apiary that managed one *rit* showed the fastest return of investment value (two years and four months) than any other rits that required two years and nine months, both for apiary which managed two and three *rit*s. The PP indicated that apiaries managed two and three rits could recoup their investment in less than two years of operations. In contrast, apiaries managed one rit took almost four years of operations to meet their investment. The PP indicated that all apiary types could recoup their investments in less than three years of operations. The PP defines the period required for investments to recover all early outlays, either savings or profits (Ardalan, 2012; Sulianti at. al., 2013; Abdurofi et al., 2021). Moreover, depending on the type of capital invested, most agricultural projects require more than five years to recoup their investments (Abdurofi et al., 2021). Hence, this project seems an alternatively viable selection to recover the invested modals.

Based on cost structure, revenue and profitability, and feasibility analysis of the three types of apiaries, all types offered a financially viable and attractive investment for future projection. Nevertheless, the two rits apiaries showed better performance than the other two types. Even though all apiary types experienced negative profit in the last year, the two rits apiary showed the highest level of profitability ratio in the first the third year. The two rits also had better performance in NPV, IRR, B/C ratio (either in annual or overall), and BEP (either in annual or overall) than the other two types of apiaries. The next apiaries that had better performance were rit three. Even though, it had values that were not slightly different to rit two, the percentage of variable cost in the end of financial year that still less than 50% placed this apiary after rit two. *Rit* one was being as the last option since it experienced the lowest value in revenue, profitability, and feasibility analysis.

Conclusion

In the first year, the production cost of all apiaries was mainly composed of fixed cost. Nevertheless, in the fourth year, rit one and two had exhibited variable cost more than 50% total cost. Meanwhile, fixed cost experienced linear decline for all apiaries types from first to fourth year. The cost of labor (both seasoned labor and beekeepers) took the highest expenditure in variable costs for all apiaries type. Beekeepers` cost in all apiaries types had similar tendency where the cost was arise in the first to third year and decline in the fourth year. In the case of feasibility analysis, apiaries managed two rit had better performance followed by three rit. Meanwhile, rit one experienced the lowest performance (had minus value in NPV, IRR <1, and four years of payback period). Moreover, in the calculation of revenue and profitability, rit three had the highest total inflow followed by rit two and three. Nevertheless, the rit two had the highest in profitability average followed by rit three and rit one. Even though all apiaries experienced negative profitability in the fourth year, rit two had the lowest loss than other apiaries type. Hence, it is assumed that apiaries managed two rit have better performance to face the competitive market followed by three rit. Meanwhile, apiaries managed rit one experienced such a difficult challenge to survive. .

Recommendation

In the meantime, manage this condition, apiaries are advised not to open any investment forms, such as adding more beehives in order to maintain the honey price, particularly for apiaries which manage small number of beehives. In a situation of low demand and price drop businesses need to adopt many new strategies, such as cost optimization, market research, costumers retention programs, collaborations, and focus on long term perspective. Also, Moreover, apiaries should start diversifying products, such as bee pollen, propolis, royal jelly, and education tour to increase their income. In other words, apiaries should not depend on honey production only but find other products that have more value than honey itself. Last but not least, since apiculture in Riau depends on *A. crassicarpa* plantation, regulations are required to assure the industrial plantation forests not to change their plants to other species, such as *Eucalyptus* sp. that has been planted on mineral soil (southwest Riau) to change *A. mangium* and led to decline honey production in that area (Pribadi, 2016).

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