Investment Sensitivity of Corn Silage Production Integrated into Feed Supply Service of Dairy Cooperative

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Abstract. The study aimed to identify the sensitivity of investment in commercial corn silage production based on 20 hectares of cropland. The start-up project was prepared through a profit-sharing partnership between the South Bandung Dairy Cooperative and the owner of the land rights. The harvested whole-plant crop (WPC) was processed to produce packaged silage, further distributed to meet the needs of the member of the cooperative. Data on agriculture input and output as well as their prices were gathered through a field survey. The result of data analysis was examined within a focus group discussion attended by the project authority. The project used hybrid corn that could be planted and harvested twice in a year and yields corn silage on average 78 ton/hectare/year. It required an investment fund of IDR1.5 billion for running the project for over ten years. By using social opportunity cost of the capital of 8% a year, financially it gave a positive Net Present Value. The B/C ratio was 1.34, and the IRR was 28.5%. Three variables have to be controlled by the project management because of the sensitive effect on the project feasibility, it consists of the cost of silage distribution, selling price and WPC/hectare yielded.

1. Introduction

The primary dairy cooperative is a business organization that purposes mainly to service members or dairy farmers in producing fresh milk by supporting farm input and milk marketing [1] [2]. Dairy farming is a daily basis production system, hence, managing a cattle feed self-production to meet daily feed requirements is a strategic business for dairy cooperatives. Cropland is an essential resource for feed supply in supporting intensive milk production, while in the cooperative area, access to the required land is limited. It needed attention and supporting policy of local government in solving this crucial issue [3].

The quantity feed demand is related to herd size or the number of dairy cows they held as well as the raw milk they produced. Dairy farmers commonly use concentrate and forage to meet cattle feed requirements, both provided by farmers daily hence the cumulative feed cost on average is high. More than two-thirds of their farm income is returned to be allocated for cattle feed [4].

In the previous years, most dairy farmer gets fed forage from free sources such as grass growth in forestry ground, waste crop or paddy hay. However, the supply of that kind of forage nowadays tends scarce, especially in the dry season. It makes the farmer should cut and carry the forages from the distant sources with a higher cost of transportation. In such a condition, proper feed nutrient quality has not been a priority for the farmer. Meanwhile forage feed availability is the backbone of the dairy ration. It should be a focus of management attention to enhance its quality. Feeding higher digestibility forages tend the herds produce milk higher with lower dry matter ration intake [5]. The success of cattle production and health programs depends on proper feed nutrition intake. Contrary, improper feed, lead to productivity loss and emission problem in cattle digestive system [6].

The cooperative attempts developing alternative feed sources by producing feed corn-based fermented forage (corn silage) are expected to increase feed supply sufficiency for the farmer, both in quality and quantity. Recently the availability of agricultural resources, especially a nearby arable land, is limited, hence the cooperative initiated in cooperation with landowners in a mutually beneficial scheme. By controlling and cropland to produce corn silage, integrating the whole process starts from pre-production up to downstream. It is expected could supporting the value chain (VCs) of the
cooperatives feeding system to makes the linkage among business unit activity more efficient and profitable [7].

Appropriate technology determines successful of investment goals in agriculture production. Agricultural output depends on direct input includes land, labor, seed, and agrochemical as well as a management practice and the choice of technology [8]. The advance in plant breeding technology has been emerging numerous hybrid varieties with high yields and efficiently in converting agricultural inputs. Planting hybrid corn for a commercial purpose requires intensive farm practicing and greater input cost. However, it has advantages in terms of adaption in a wide range of environments, rapid growth and high productivity in producing WPC, hence it becomes an alternative source of nutritious forages for gaining a high milk production.

Cooperative management is responsible for making the business grow in both profitability and capital assets. They should plan investment to develop the current business or expand a new business branch. An investment is an action or process of using some money for profit or increasing asset. It is important to conduct before an analysis economic to help decision-makers obtain exact information based on an objective valuation with considering all relevant issues. From a financial point of view, the feasibility of the investment should be valued from the consideration of the project owner as well as their business partner.

However, running the business faces risk and uncertainty that may change the future prices and costs used to estimate net benefit. It is useful to look at what would happen to net present value (NPV) if the prices and costs were different. By understanding the production process, one can identify several risky variables that affect the project. The project management should understand more information by examining the planned project through sensitivity analysis. The study aimed to assess the impact of changing in different variables on project outcomes. It can be identified or measured by changes in the variables required for project decisions to move from acceptance to rejection [9]. The information is required by the project management for setting up strategies minimizing the impact of future risk and uncertainty.

2. Material and Method

A case study was carried out in a corn silage production unit managed by the South Bandung Dairy Cooperative, aimed to identify the profitability and financial feasibility of the business. The sources of corn processed were yielded from 20 hectares of cropland. The land was prepared through a profit-sharing partnership scheme between the dairy cooperatives, and PT Perkebunan Nusantara as the owner of the land right.

Harvested corn is processed and stored to produce packaged silage, further distributed to meet the needs of the member of cooperatives themselves. Data on production input and output, as well as their prices, were gathered from a survey conducted in the surround location. The result of data analysis was examined through a focus group discussion (FGD) attended by the cooperatives management staff.

2.1. Supply Chain of Corn Silage Based feeding system

The corn silage was produced by the Feed Silage Production Unit (UPS) of the dairy cooperative. Their tasks involved three main production activities (figure-1) which consist of (1) corn planting, (2) harvesting and storage and (3) corn silage distribution to cooperative members. The corn is planted to produce a nutritious feed forage, hence the whole part of the crop or all the edible part is harvested and processed (leaf, stalk, and ear of corn which contains grain).
2.2. Land utilization

Land resources availability for planting forage crops was limited, hence the dairy cooperatives make agreement with the landowner in a long-term agreement through a mutually beneficial partnership. The partnership was based on an MOU and contract letter signed by both the South Bandung Dairy Cooperatives and PT Nusantara Plantation. The Legal aspect was one of the important requirements for increasing domestic savings and investment in agriculture [8]. Contract documents contain the rights and obligations of the two parties, as well as the annual corn silage production program and a profit-sharing scheme that will be evaluated every five years.

2.3. Analysis Method

This study used financial analysis concerning commercial profitability from the cooperative’s point of view. The financial feasibility analysis determined whether or not the investment will generate sufficient cash income to make the principal and interest payments on borrowed funds used to purchase the asset [10].

In the first stage of analysis, the investment project was appraised by using benefit-cost analysis (BCA). This analysis was intended to figure out the project feasibility commercially in current capital cost (interest rate) and market situation which measured by common financial criteria such as the present value of the net benefit (NPV), benefit-cost ratio (net B/C ratio) and the financial internal rate of return (IRR). Further, sensitivity analysis was applied to identify several keys variables that harmed the project feasibility.

NPV is a subtraction value of the sum of discounted annual Benefit and sum of discounted annual Cost,

\[ NPV = \sum_{n=1}^{k=10} B_n(1 + r)^{-n} - \sum_{n=1}^{k=10} C_n(1 + r)^{-n} \]

\[ B/C \text{ ratio} = \frac{\sum_{n=1}^{k=10} B_n(1 + r)^{-n}}{\sum_{n=1}^{k=10} C_n(1 + r)^{-n}} \]

Where NPV shows the net present value. B and C each denote annual benefits and costs, \((1 + r)^{-n}\) denotes a discount factor for year-\(n\), where \(n\) denotes the time period \((n = 1,2\ldots k)\), and \(r\) is the discount rate or the prevail opportunity cost of capital. NPV should be greater than zero to state the project is feasible. When NPV > 0, the internal rate of return (IRR) is greater than \(r\).
Sensitivity analysis assessed the impact of changing values of the different variables on project outcome. There were several key variables in project assessment presumed has a strong impact on the feasibility of the project. It can be identified or measured by changes in the variables required for project decisions to move from acceptance to rejection [9].

In this study, it is compared two NPV for the same project, namely the prevail or accepted project (NPV++) and the altered or rejected project (NPV0). The two variables are different because the project’s NPV changed, further, this difference is used as the numerator for estimating the sensitivity measure of a single variable. The variable measured is consist of:

\[
\begin{align*}
\nu_1 &= \text{corn silage price (IDR.ton}^{-1}) \\
\nu_2 &= \text{yearly corn production (ton.hectare}^{-1}) \\
\nu_3 &= \text{cost of silage distribution (IDR.ton}^{-1}) \\
\nu_4 &= \text{daily wage rate (IDR.manday}^{-1}) \\
\nu_5 &= \text{corn seed price} \\
\nu_6 &= \text{fertilizer price.}
\end{align*}
\]

NPV is an integer, it is assumed that the variable \((\nu_i^0)\) shift to unexpected values \((\nu_i^0 \rightarrow \nu_i^1 \rightarrow \nu_i^2 \rightarrow \nu_i^3)\) that cause the NPV is decline close to zero \((NPV^0)\), even could be negative \((NPV^-)\).

A unique value of variable caused a unique NPV. Hence, if \(\nu_i^1, \nu_i^3, NPV^+, NPV^-\) known, the value of \(\nu_i^2\) for the zero, NPV could be determined. Below are the four different \(\nu_i\) with the connected NPVs.

\[
\begin{align*}
\nu_i^0 &\sim NPV^+ = \text{the previous condition or baseline project.} \\
\nu_i^1 &\sim NPV^+ = \nu_i^1 > \nu_i^0, \text{ NPV > 0, positive NPV, close to 0} \\
\nu_i^2 &\sim NPV^0 = \nu_i^2 > \nu_i^1, \text{ NPV = 0.} \\
\nu_i^3 &\sim NPV^- = \nu_i^3 > \nu_i^2, \text{ NPV < 0, negative NPV, close to 0.}
\end{align*}
\]

\(\nu_i^2\) is an interpolation value between \(\nu_i^1\) and \(\nu_i^3\), calculated as follow:

\[
\nu_i^2 = \nu_i^1 + \left(\frac{NPV^+}{NPV^+ + NPV^-}\right) * (\nu_i^3 - \nu_i^1)
\]

Sensitivity the variable-\(i\):

\[
S_{\nu i} = \left(\frac{\nu_i^2 - \nu_i^0}{\nu_i^2 + \nu_i^0}\right) \times 100\%
\]

\(\nu_i^0\) = the previous value of variable-\(i\)

\(\nu_i^2\) = the conditional variable when NPV = 0, or the project rejected.

The sensitivity is a change in the percentage of a variable (the other are fixed) which causes the project getting worse until the NPV = 0. A smaller \(S_{\nu i}\) indicates that the project is very responsive or at risk of small changes to the related variable.

3. Result and Discussion
Producing corn silage for a commercial purpose was a new business branch for the Cooperative (KPBS). It is a result of the searching and learning process by doing business to find out the best scheme in the development of a forage production system. Interest in the feeding of corn silage for lactating cows increased, many studies showed that processing whole-plant corn silage improves total tract-starch digestion and milk production by dairy cows [11]. Recently many dairy farmers using corn silage for
their cattle feed, some have tried to make silage, however, it was only for trial and discontinues. The high price of raw materials and the unavailability of storage facilities caused farmers to return to traditional practices, except those who have a large number of dairy cows (the current price of whole corn in the range of IDR 600-700 per kg).

3.1. Cooperative Business Strategy

The cooperatives strategy in developing this new business focused on how to provide and sell cheaper corn silage as well as being produced continuously, the price offered should be below IDR 600 per kg. The cooperative initiated to produce and distribute the corn silage. The land should be economies in acreage size, arable, and nearby as possible in order can be operated efficiently. The cooperative are in cooperation with PTP Nusantara, a government company that has control of the cropland around the location of the cooperative. A land utilization partnerships have been agreed with a profit-sharing scheme in the spirit of sustainable agriculture and mutual advantage. The agreement was strengthened in the MOU and contract letter. Using the cooperative's internal resources (management capacity, related capital asset, fund, and silage distribution) are to support the project work more effective. Regarding commercial strategy, the cooperative approved the following production plan decision:

- Production located in the dairy cooperative service area to advantage in the distribution cost of production input and output, effortless getting cattle manure, as well as effective project operation.
- The crop planted on 20 hectares prepared land area, located in Purbasari Avdeling in Kecamatan Pangalengan. It was agreed that the landowner receives as much as 40% of the yearly projected profit and will be evaluated annually.
- The project used hybrid corn that has been examined and performs well locally, growing fast, harvested in 95-100 days after planting (when starch content maximum). The crop production also responds to plant density, fertilizing and pest control. Successful maize silage production can be achieved by starting with high-yielding and well-adapted crops [12].
- By planting 20 kg of corn seed, expected yield 40-ton of WPC a hectare. In the rainy season (six months in a year) the farmer can use the land twice and yield the crop around 80 tons a year. Shrinkage estimated 2.5% makes silage yielded from one-hectare cropland decrease to 78 ton a year.
- Corn silage can be stored for months, therefore it is an advantage for the project selling out the silage in drought season, the price potentially increases due to the lack of forage supply.

There are obstacles faced by management regarding the available land for the project. The land had been unused for years. Many works need to be done for preparing the land. It is ready to be planted such as cutting bushes, land clearing, and soil enrichment. There is no better land available, making investment costs higher.

During the project execution, the management had three major tasks [13] that covered: (1) coordinate to facilitate the needs of different entity units related to the use of corn silage i.e.: crop and silage production, forage distribution, and dairy farming. (2) scheduling the crop production or its availability, linked to silage demand and storage capacity, and (3) controlling the crop quality, processing, storage, and silage delivery.

3.2. Financial and Technical Aspect

Analyzing the feasibility requires reliable technical and economic information. The data was gathered from some research and relevant source of information, involve agricultural input prices, cost of production and technical or production parameter. The data related to relevant financial and commercial aspects such as prices, cost, and the opportunity cost of capital are presented in Table-1.
| Agri-input and output       | Unit prices | Usage measure       | Explanation note                                      |
|-----------------------------|-------------|---------------------|------------------------------------------------------|
| **Crop production**         |             |                     |                                                      |
| land clearing               | IDR 12.5 \times 10^6 ha^{-1} | work contract ha^{-1} | prepared once before the project undertaking         |
| Manures                     | 0.15 \times 10^6 ton^{-1}    | 8 ton ha^{-1}        |                                                      |
| Seed                        | 65 kg^{-1}   | 20 kg ha^{-1} a year| corn hybrid, the land is planted twice a year        |
| Manures                     | 0.2 \times 10^6 ton^{-1}    | 8 ton ha^{-1}        |                                                      |
| Seed                        | 65 kg^{-1}   | 20 kg ha^{-1} a year| corn hybrid, the land is planted twice a year        |
| Manures                     | 0.5 \times 10^6 ton^{-1}    | 25 kg ha^{-1} a year |                                                      |
| Seed                        | 15000 kg^{-1} | 5 kg ha^{-1}        | soil preparation, seeding, fertilizing and harvesting.|
| hired labor:                | 40000 men-day^{-1} | 80 men-day ha^{-1} |                                                      |
| **Post-harvesting and Storage:** |         |                     |                                                      |
| machine operator            | 40000 men-day^{-1} | 10 men-day ha^{-1} | whole plant-crop basis                              |
| Fuel                        | 5150 litre^{-1} | 0.2 liter ton^{-1} | whole plant-crop basis                              |
| bio-starter                 | 5000 kg^{-1}  | 2 kg ton^{-1}       | project asset                                        |
| Facilities and equipment:   |             |                     |                                                      |
| bunker silo                 | 200 \times 10^6 m^3  | 1500 m^3            |                                                      |
| barn                        | 150 \times 10^6   | 1 unit              |                                                      |
| chopper machine             | 22.5 \times 10^6  | 2 unit              | Effectively used in 2 months a year                 |
| bagging machine             | 20 \times 10^6   | 1 unit              |                                                      |
| machine maintenance         | 0.6 \times 10^6   | 4 times year^{-1}   |                                                      |
| conveyor                    | 25 \times 10^6   | 1 unit              |                                                      |
| water tank                  | 1.5 \times 10^6   | 2 unit              |                                                      |
| Others: silo-top, secure cover. | 25 \times 10^6 | 500m^2              |                                                      |
| **Storage and distribution**|             |                     |                                                      |
| ensilaging                  | 12500 ton^{-1}  | 1560 ton year^{-1}  | local market                                         |
| Bagging                     | 30000 ton^{-1}  |                     |                                                      |
| transportation cost         | 50000 ton^{-1}  |                     |                                                      |

**Economy presumption**

- discount rate: 8% year^{-1} the opportunity cost of capital
- output price increase: 6% year^{-1}
- inputs cost increase: 5% year^{-1}
- yearly profit sharing: landowner gain
- yearly profit sharing: project management gain

### 3.3. Investment Cost

The cost of investment prepared to start developing the project in the period of first year. This was the first stage where management handles a lot of trial works as well as develop production facilities in a new location. The works involved preparing land, manuring soil, planting the crop, and agriculture operating input (seed, fertilizer, and fuel). Management also should prepare capital assets such as machinery, buildings, and other production facilities.

The most investment fund paid over this period to meet the needs above, it was required of IDR1.5 billion to fund the project in organizing resources, capital and purchasing agricultural input. It is categorized into the fixed cost or the cost allocated for facilities and capital asset, the other is the variable or operational cost. All crop farming works were handled fully by labor. In the project location, agricultural labor supply was available. It is the best practice applying intensive farming by using local labor as a form of project responsibility to the social environment issue.
Figure 2.
Cost of investment to produce corn silage (IDR million)
based on 20 hectares of cropland.

First year project period takes place over 12 months, from July until June in the following year. Planting crop started in October when the rainy season begins, it would take place for six months. The first-year activities involved the field works such as land clearing, preparing the soil to be planted, planting corn seed, fertilizing, as well as post-harvest works such as filling the silo and store corn silage. In the last six months of the first year period, half of the corn silage produced was sold out, hence the silage storage plan and distribution service to the cooperative's member have to be carried out.

Since the second year, the project's return was allocated to pay all inputs needed for the next season as well as the required business expenditure. Purchasing the input, in most, was provided for buying agricultural inputs, labor, and routine operation. The operational cost varied depending on the corn silage produced and distributed. Based on the production of silage corn gained from the cropland of 20 hectares, the annual operating cost was assumed to be similar during the project analysis period.

3.4. Project Feasibility and Sensitivity

Based on the assumption showed in Table 1, a cash flow analysis resulted in the stream discounted benefit and cost of the project as represented in Table 2. During the first two years, the total expenses could not be fulfilled by the own project return, it leads to the negative annual net benefit. The positive net benefit occurred at first of the 3rd year. Payback year or the period in which cumulative cost was exceeded by cumulative benefits and it was achieved in the 8th year. By using a discount rate of 8%, it was to be applied for ten years project period. It resulted in the NPV of IDR 2,857 million, Benefit-Cost Ratio (Gross B/C ratio) of 1.34 and IRR of 28.5 %. It shows that the project was feasible financially and gave a return to investment relatively high compared to the prevailing opportunity cost of capital. Therefore, the decision-maker could decide following up on the investment plan. For further decision analysis purposes, this result was regarded as a standard achievement that could be used as a baseline project plan.
The investment criteria above were resulted in through analysis without considering changes in the prices and cost counted in the calculation. Meanwhile, every agricultural project that takes place for a forward long-term period faces uncertainty in prices and cost as well as the yield of the crop. Table 3 shows the relative change of different variables that cause the project outcome getting worse or shift form baseline achievement to the zero NPV in which the decision-maker should not accept the project with zero or negative NPV.

Table 2. Yearly cost and benefit of corn silage production based on 20-hectare cropland (IDR million)

| Year | Fixed cost | Operational cost | Cost | Benefit | Discounted (r=8%) | Net Benefit |
|------|------------|------------------|------|---------|------------------|-------------|
|      | (1)        | (2)              | (3)  | (4)     | (5)              | (6)         |
| 1    | 544        | 1,196            | 1,740| 624     | 1,611            | 578         |
| 2    | 1,022      | 1,022            | 2,044| 157     | 1,886            | 858         |
| 3    | 1,094      | 1,022            | 2,116| 157     | 1,942            | 893         |
| 4    | 1,078      | 1,078            | 2,156| 157     | 1,986            | 893         |
| 5    | 1,108      | 1,108            | 2,216| 157     | 2,030            | 923         |
| 6    | 1,386      | 1,386            | 2,772| 157     | 2,403            | 1,025       |
| 7    | 1,172      | 1,172            | 2,344| 157     | 2,197            | 733         |
| 8    | 1,206      | 1,206            | 2,412| 157     | 2,246            | 714         |
| 9    | 1,243      | 1,243            | 2,486| 157     | 2,305            | 673         |
| 10   | 1,281      | 1,281            | 2,562| 157     | 2,366            | 624         |

Silage price \( v_1 \) was the most sensitive variable, a relatively small change in the price, that is a decrease of 8% (the others do not change), causes the NPV was zero or the project rejected. It was counted before get farm price of the silage was IDR 600, a decision that leads the project to sell the silage down to IDR 550. It would cause the project not feasible to be continued. The crop production or corn yielded is the other variable that highly sensitive to the project outcome. To achieve a normal outcome was assumed that one-hectare land on average would produce the WPC of 80 ton a year or equivalent to 78 tons silage. The decision-maker should not accept the project for a decrease in the yield of 14.2% or the yearly production go down to 70 tons/hectare.

The cost of silage distribution had the potential to change in large increases due to variations in internal conditions (silage handling and transportation) and external factors (distance and location accessibility). Corn silage was fermented stuff that should be kept in anaerobic condition to remain the silage remains edible. The management should store, treat, as well as distribute it in care. Hence to deliver the fermented stuff was required skilled operators, vacuum bags with tight sealers, and safe transportation to minimize the physical risk. All the treatment impact on the operational cost. The
external factors potentially change and effect on the transportation cost involved fuel price, traffic obstacle, cost of truck rental as well as delivery distance. The corn silage was bulky hence needed spacious transportation storage that makes delivering costly.

4. Conclusion

The Availability of cropland was an essential resource for a dairy cooperative in developing a sustainable feeding system. It is the strategic policy for a dairy cooperative develops long term cooperation with the owner of potential sources such as state-owned corporation those control plentiful agriculture land. A partnership project that produces corn silage based on a profit-sharing scheme in terms of land use can be technically operated by a dairy cooperative as well as will get financially feasible. Selling price, cropland productivity, and cost of silage distribution were the key factors that financially cause a sensitive effect on the project feasibility.

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