System dynamics modeling on new generation cooperative as an alternative to enhance bargaining position of potato farmers in Bener Meriah district

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Abstract. This study aims to create a New Generation Cooperative (NGC) model in potato supply chain in Bener Meriah District, which is also the subject of research, by applying the system dynamics method to build a dynamic and complex NGC model. This modeling is carried out as an effort to enhance bargaining position at farm level. The result showed that non-formal partnership relationship in potato supply chain is originated from the gap in capital ownership between farmers and intermediary traders, thus giving rise to motivation to control farmers by providing financial loan to farmers. Loan recipient farmers must commit to sell potato only to financial aid traders. This causes the loss of opportunity to sell potato to other parties, which has an impact on the occurrence of pressure on selling price of farmers’s potato. Farmers face asymmetry information, especially regarding the selling price prevailing in the market. On the other hand, formal partnership starts with the industry motivation that is to obtain raw materials, that meet quality requirements on an ongoing basis. In a formal partnership, technology transfer occurs from partners to farmers. Farmers get marketing and price certainty, wider marketing access, and have the opportunity to earn higher profits. Based on the simulation results, data obtained that farmers who are the NGC members get higher revenue, profit, and business efficiency level, than non-partnership farmers.

1. Introduction
Potato plant is one of the commodities in Indonesia that receives priority in vegetable research and development program in order to support food security and diversification. Potato is also vegetable commodity that has high economic value, which is cultivated by about 45 thousand farmers. This is because the potato cultivation business is able to give production between 15-30 tons per hectare and the price is relatively stable [1], and has great potential as a provider of alternative food source. In addition to consumption, potato can be used as raw material for food processing industry [2].

Bener Meriah District is one of Aceh horticulture production center, especially potato. In 2014, potato production level reached the highest level of 76,683 tons. Furthermore, the data shows a decline in production until 2018, which was 10,653 tons [3]. This pattern of decline in production is caused by several things, those are: fluctuations in selling prices, pest disturbances, and clarity of commodity specifications desired by consumers. The selling price of potato often declines before the harvest period so that it cannot provide significant profits for farmers. Then, the risk of pest attack during the growing season causes the quantity of production to decrease. Furthermore, the clarity of commodity specifications that consumers want is not clearly known by farmers, but by traders,
especially those who deal directly with consumers. This situation causes the bargaining power of farmers to be lower than that of traders or buyers.

In current situation, it is known that there has been a change in the marketing of agricultural products, namely with the emergence of new actors who have power in the supply chain of agricultural production. To deal with market changes, smallholders need to form association with new concepts [4]. In order to participate in the supply chain, farmers must join a forum in the form of a cooperative, then form a partnership with private sector. To create a situation where farmers can be connected to a dynamic market, farmers need to be continuously trained and organized, and must be able to connect with sources of financing [5].

The establishment of the New Generation Cooperative is one solution to overcome the problems faced by farmers, especially in terms of selling price stability. NGC is a type of processing cooperative that utilizes a financing structure in order to raise a certain amount of capital through share ownership which is intended to be invested in processing activities that provides added value. Investment shares in NGC are linked to marketing agreements that bind member producers to deliver a certain number of goods (raw materials) of a certain quality to the cooperative's processing plant. On the other hand, cooperatives are also bound to receive goods as long as they comply with agreed quality standards, and are also bound to provide benefits generated by processing activities to members. The contractual agreement also takes into account reasonable deviations that may occur, such as crop failure experienced by producers of cooperative members [6].

This research is conducted to design a model of the New Generation Cooperative in the potato supply chain. The model (NGC) is expected to be one of the proposals for local governments to make policies in order to overcome the impact of fluctuations and low selling prices of potato at the farm level as well as marketing uncertainty faced by farmers in the potato supply chain in Bener Meriah District. The local government must pay attention and make efforts to overcome these problems, especially since the potato commodity has so far made a major contribution to the local economy.

2. Materials and Methods
The New Generation Cooperative is a relatively new type of cooperative, first formed in the Midwest of the United States in 1970, with the aim of tackling the problem of price fluctuations in agricultural commodities that are very detrimental to farmers, as well as to create added value in processed products [7].

Supply Chain Management is a method of creating products to be delivered to end users, which includes various components, namely: raw materials supplier, manufacturing units, warehouses, transporters, retailers, and finally selling [8].

System dynamics is a methodology for studying and managing complex feedback systems [9]. Through this methodology, it can be predicted how the system behaves and a correct understanding is obtained by studying the interrelated relationships between the elements as a whole.

This study uses a system dynamics approach to build a New Generation Cooperative model in a dynamic and complex potato supply chain, namely behavioral patterns that are generated by the system with increasing time [10]. The rationale for the system dynamics methodology is systems thinking, which is a way of thinking in which each problem is seen as a system, namely the overall interaction between the elements of an object within certain environmental limits that work to achieve goals.

3. Results and discussion
3.1. The New Generation Cooperative Scenario as an alternative policy for solving the problem of the impact of potato price fluctuations
The establishment of the New Generation Cooperative is one solution to overcome the impact of fluctuations in vegetable prices, especially potato commodities, which poses a risk to farmers. The main feature of NGC that distinguishes it from traditional cooperatives is the value integration of the producer's capital contribution with the obligation to deposit goods. The amount and price of paid-in shares issued by NGC is determined based on the amount of raw materials required by the processing plant and the amount of capital required to meet 30% - 50% of the total capital requirement through the sale of mandatory paid-up shares.
In the NGC modeling process, author makes a model by adopting the costs required for a potato chip processing plant which has a processing capacity of 1000 kg of potato per day. The amount of investment required to build a potato chip manufacturing plant that must be financed by NGC members is 50% of the total investment cost, and the rest is financed from loans.

Potato can be used as raw material for the manufacture of various processed food products. In this study, the New Generation Cooperative modeled only produces one type of product, namely potato chip. The selling price of potato at the member farmer level is set at IDR 12,000/kg.

Figure 1. Diagram of sub model determination of stock value and obligation to deposit potato to NGC.

The ability of farmers who are members of the NGC scenario to send potato for industrial raw materials is 100 kg/day, but only 25 kg per day can be sent to the NGC processing plant or only 25% of the total potato that can be sent by farmers to the NGC. Shares issued number is 100 units of shares and the number of farmers who are members of the NGC scenario is 100 people. Thus, the average share ownership is one unit share per NGC member farmer, and each farmer can only deposit 25 kg of industrial raw material potato per day.

The initial share price and delivery right share are determined based on the amount of primary product (raw materials) required by an efficient processing facility and the amount of capital required to build the factory. The initial price of each share is calculated from the value planned by the cooperative when the processing plant starts operating, divided by the amount of agricultural products (raw materials) that can be absorbed by the processing plant. In general, NGC adheres to the reference to raise 30-50% of the total capital requirement for factory construction through the sale of mandatory paid-up shares, and the rest is met by bank loan capital.
Potato delivery to NGC must be adjusted to potato processing machine capacity in accordance with members’ commitment to deposit raw materials. If the shipment is lower than machine's maximum capacity, processing will not take place efficiently, on the other hand, if there is an excess of shipments, there will be a number of potato that are not processed so that spoilage occurs which affects the cost increase.

Due to the maximum capacity of the machine for processing potato in the NGC scenario, which is 500 kg per day, only 25% of the total potato produced by member farmers can be absorbed by the factory and part of it is sold to traders at market prices. The difference between potato farmers who are members of the NGC and potato farmers in general is that farmers who are members of the NGC are required to buy shares from the cooperative, each share owned is followed by the obligation to deliver fresh potato in a certain amount as determined by the cooperative, obtain a rational price and get the rest of the business from the sale of processed potato foods.

The NGC model in Figure 3 shows that NGC member farmers finance potato cultivation and buy shares using loan funds from third parties, namely from financial institutions, with an average interest rate of 7.5-10% per season. Loan payments are made in installments following the pattern of harvest intensity. The interest and principal of the loan are agreed to be paid off in 12 installments. The method of payment follows the customs that apply to potato farmers who do not partner with intermediary traders.
3.2. The impact of implementing the scenario

The results of the scenario simulation in Figure 3 provide information that by becoming a member of the NGC for potato processing, the revenue rate of farmers who are NGC members is higher than that of non-partnership farmers. This condition was achieved even though at the beginning of membership, farmers were required to purchase shares accompanied by the obligation to send a number of fresh potato commodity to the potato processing factory owned by NGC.

![Figure 3. Diagram of farmer finance sub-model from NGC members.](image)

![Figure 4. Revenue of NGC potato farmers and non-partnership potato farmers.](image)
By becoming the member of NGC for potato processing, farmers get several advantages: (a) farmers get a rational selling price of potato because the lowest price and the highest price to be purchased by the NGC are determined based on the consensus of the members of the cooperative (potato farmers); (b) farmers will receive additional income in the form of residual income, with an allocation of 40% of the remaining operating results for members. This causes the level of revenue of NGC farmers to be higher than those of non-partnership farmers, as shown in Figure 4. This condition is in line with Nilson's statement that NGC is able to provide relatively large incomes to producers by participating in selling processed products and from selling primary commodities that are sold generated to the cooperative [11].

The result of simulation provides information on the higher profits of NGC farmers compared to non-partnership farmers, as presented in Figure 5. Although the initial costs incurred by NGC farmers are higher due to the purchase of shares, these costs can still be covered by revenues that are relatively larger than the costs, so that NGC farmers gain relatively larger profits than non-partnership farmers.

In addition to a higher level of profit, at the end of the first planting condition, the level of business efficiency of potato farmers who are NGC members is also better than that of non-partnership farmers. In the initial conditions of being a member of the NGC, level of business efficiency of farmer members of the NGC is lower than that of non-partnership farmers, due to the cost of buying shares that must be incurred.

In NGC modeling, it is assumed that potato price is a rational price for farmers but does not harm the factory. Based on the results of interviews and input from various parties who understand this business, a rational selling price of potato is set at IDR 12,000/kg. This price is close to the average price of potato sold by dealers to potato retailers in local market.

In the following planting season, the level of business efficiency of NGC member farmers increase and continue to be above the level of business efficiency of non-partnership farmers. This was achieved because farmers do not have to incur the cost of buying shares which only has to be done once when they joined the NGC. The level of efficiency in the efforts of farmers who are NGC members and non-partnership farmers is reflected in the ratio of revenues to costs incurred (R/C), which can be seen in Figure 6.
The NGC potato processing is one of the best options to overcome the problem of price fluctuations. The cooperative applies the philosophy that all its activities are supervised by members and every action is based on the results of the members’ deliberation, including one in terms of setting the selling price of potato. Following the deliberation mechanism, in the event of price fluctuations, the price applied will not harm farmers who are NGC members.

On the other hand, although the NGC scenario based on the analysis and simulation results are considered to be able to reduce the impact of price fluctuations because it can increase profits and increase cash for potato farmers, it is not certain that this NGC model will be the most appropriate solution for dealing with rural businesses, due to the insight and how people view this as a complex, expensive, and difficult thing to manage and sustain. In other situations, investors and participants may dispute the one man - one vote cooperative philosophy, especially when there is a gap between large and small investors.

Simulation carried out on farmers who are members of formal partnerships as can be seen in Figure 7, provides information that the scenario of farmers who are members of NGC provides a higher level of profit than the scenario of farmers who are members of industrial partners. Thus, the scenario of implementing NGC in the potato supply chain is feasible to be recommended as a policy that can improve farmers’s welfare.
In Figure 7, it can be seen that the profit level of NGC member farmers is initially below the profit level of the industrial partner farmers, however, after the second planting season or after passing 100 days, the NGC member farmer's profit level rises above the farmer's profit level. Industry partners. Based on the simulation results for long-term partnerships, the NGC member farmer partnership model will be more profitable.

Author argues that the establishment of NGC for potato farmers can be proposed as a policy, because the simulation results show higher profit rates in the long term. This happened because most of potato produced by farmers can be absorbed by the NGC at a rational price. By becoming a member of the NGC, indirectly, the position of farmers will be equal to that of partners (NGC), and farmers will always be involved in determining the selling price of potato because farmers are also the owners of the NGC.

4. Conclusion

Based on simulation results of the New Generation Cooperative scenario, it is found that by becoming member of the potato processing NGC, the farmer's revenue rate is higher than that of non-partnership farmers and industrial partnership farmers. Although at the beginning of membership, farmers are required to buy shares accompanied by an obligation to send a number of fresh potato commodity to the potato processing factory owned by NGC, but the simulation results show that over time, farmers who are members of NGC obtain higher levels of revenue and profits as well as higher levels of business efficiency. By becoming member of the NGC for potato processing, farmers get several benefits, including: (a) farmers get rational selling price of potato because the price is determined by deliberation by members of the cooperative; (b) farmers will receive additional income in the form of residual income from the sale of processed food products, with an allocation of 40% of the remaining income from NGC operations for members. This causes the acceptance rate of farmers who are members of NGC is higher than that of non-partnership farmers and industrial partnership farmers. Thus, the scenario of NGC formation for potato processing can be recommended as a solution to overcome the impact of price fluctuations, as well as to improve farmers' living standards.

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