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Development of Value Creation Model in the Innovation System Framework for Sustainable Agri-food

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To overcome fluctuations in strategic agri-food production and prices, it requires comprehensive, integrated and sustainable policies. The research aims to develop an upstream and downstream intervention model of agri-food within an innovation system framework, using the System Dynamics approach. The intervention produced several behavioural changes on level farmers; (1) Breeding bulb seeds participation and Good Agricultural Practices reduces plants' growing risk to 43%; yield processing, increasing market access, renewing the MoU, reduce market risk to 83%; (2) The use of True Shallot Seed (TSS) reduces production costs by 19.4% while increasing productivity significantly; (3) Cropping patterns Minimize the production fluctuations. The behaviour of cash and profit in all three scenarios increased steadily. The behaviour of price formation on a structured market showed a stable pattern in the Government's reference price. Innovation systems integrating upstream and downstream sectors will create business efficiency while ensuring sustainability. Upstream innovation systems unmatched with downstream will not survive due to unreachable economic incentives.

Keywords: *agricultural innovation system, upstream and downstream policies, shallot, system dynamics, price stability.*

Introduction

Agricultural development in developing countries faces challenges and obstacles related to food security, food price volatility, food safety, and sustainability issues. In addition, there is also an increase in opportunities for domestic and global agricultural market demand (McCullough et al., 2008). However, the actors along the supply chain still face a significant obstacle being the difficulty of meeting the quality standards of agricultural products (Perdana & Kusnandar, 2012). This dynamic context requires the agricultural sector to keep innovating and contributing to sustainable socio-economic development (Kilelu et al., 2013). Multidimensionality and complexity to ensure sustainable and inclusive food security requires think systems (Monasterolo et al., 2016).

This study applies the concept of Agricultural Innovation Systems (AIS) to the horticulture sector especially shallot. Based on the Ministry of Agriculture of the Republic of Indonesia, shallots including strategic commodities that have a big contribution to food security and the formation of inflation (Mardianto et al., 2019). AIS includes the main actors (agricultural technology knowledge and providers, users, and intermediaries institutions who facilitate their interactions); potential for interaction between actors; agricultural policies and informal institutions, and practices that support or hinder the process of innovation (The World Bank, 2012). The development of shallot productivity in Asia tends to fluctuate with an average productivity of 18.12 tons/hectare/year. The most considerable productivity in Asia is Korea at 64.76 tons/hectare/year, while Indonesia ranks 34th with average productivity of 9.43 tons/hectare/year, far below the average productivity of Asia (Yanuarti & Afsari, 2016). Shallots are also sensitive to changes in inflation figures. The influence of climate causes supply disruptions (Pribadi et al., 2019), which have an impact on the price fluctuations. Price fluctuations also occur due to downstream factors, such as distribution and trading, that have not been well managed (Indonesian Ministry of Agriculture, 2016).

Resolving complex problems in the agricultural sector requires the various stakeholders' involvement (Knickel et al., 2009; Vogelezang et al., 2015). The policy of agricultural innovation by involving multidisciplinary groups is set in a network towards sustainable agriculture (Beers & Geerling-eiff, 2013; Hermans et al., 2015). Innovation is not only about technology, but it also encompasses social and institutional change and is systemic and co-evolutionary (Leeuwis & Ban, 2004). In addition economic, social and environmental aspects have contributed to the sustainability of the innovation system (Safaie et al., 2019).

The AIS in Indonesia has not formed a uniform reciprocal interaction between actors within and between the systems (Fitria, 2004). The innovation system in the agricultural business still tends to be done partially and has not found an innovation system practice that integrates all types of innovation oriented from upstream to downstream (Trisnasari et al., 2019). Other reviews reveal that most scientific disciplines have developed methods to overcome partial problems from various complex problems, often ignoring the consequences that occur in other systems and so a system thinking approach is needed (Turner et al., 2016). Further research on the adoption of shared value creation in the coordination process is needed to provide benefits both for the participating actors and for the final consumer (Handayati et al., 2015).

To find a solution for the problem of shallots, it is necessary to have an in-depth study of policy models within an innovation system framework. This study aims to: 1) analyse the behaviour of upstream and downstream of shallots in the real-world today, 2) develop a policy model of upstream and downstream of shallots within an innovation system framework, 3) find the best alternative scenarios in the shallot innovation system. The novelty about this research is the comprehensive coverage of the on farm and off farm sides, involving actors between networks, and applying the System Dynamics methodology.

System dynamics is a methodology to understand how systems change in time, the way variables of the system change in time indicates the behaviour of the system (Wahid, 2013). System dynamics are able to do cross-sectoral research and predict the behaviour of the system going forward so that it is possible to determine policy scenarios (Ghiffari et al., 2016). Model development is useful for knowing patterns of behaviour and relationships between variables that determine the suitability of the model with real behaviour (Axella & Suryani, 2012).

Framework

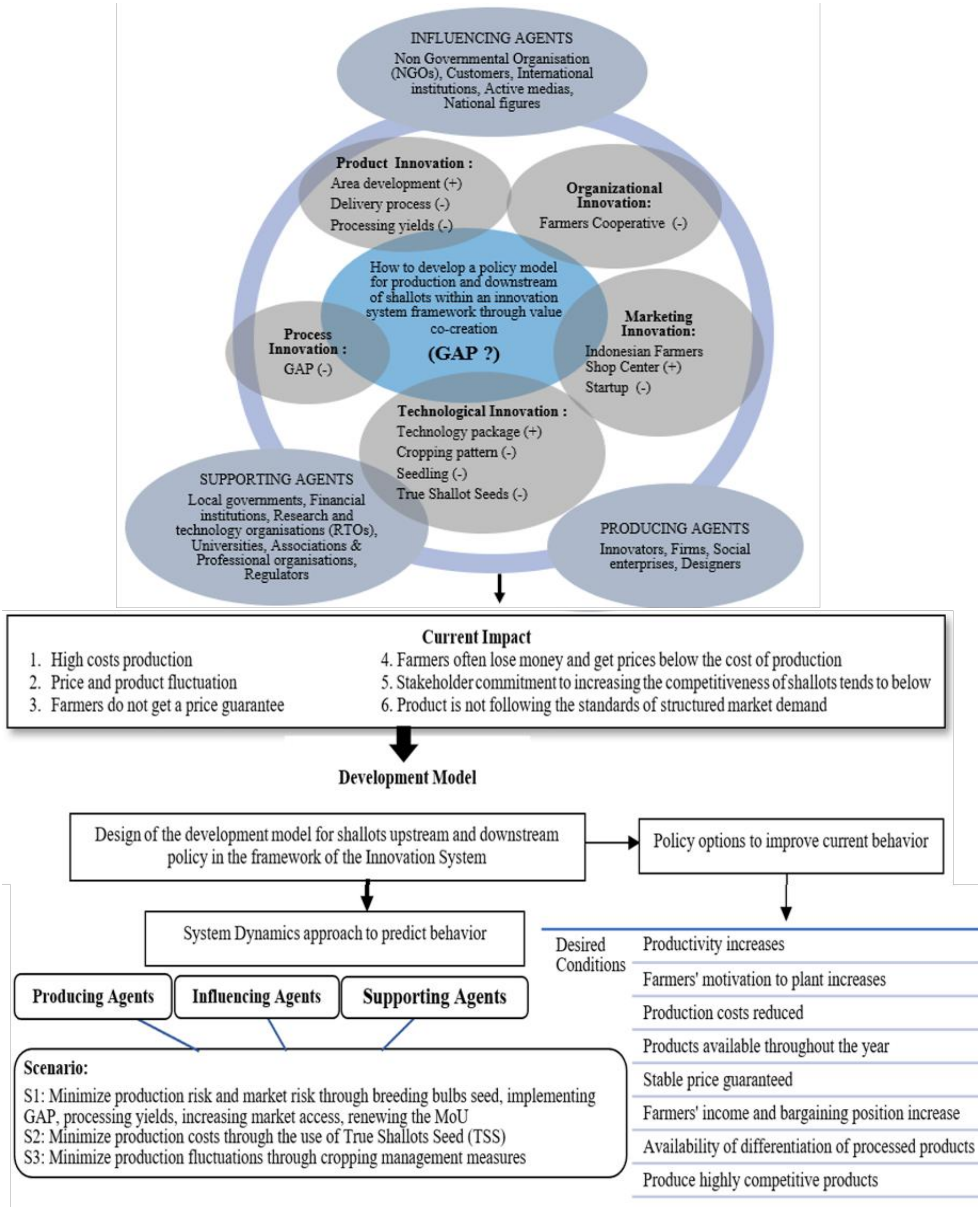


Figure 1. Research Framework

The research framework appears in **Figure 1**. The characteristics of a business system is a complex and dynamic problem. Complexity occurs due to the interaction of various actors. The development of the policy model aims to create an effective, efficient, fair, and responsive agribusiness system in the aspects of quality, quantity, and timely delivery. To achieve this, the principle of interdependence between elements is necessary. The process of co-creation between innovation agents can determine the right change. The results obtained are a new agreement framework that illustrates how upstream and downstream policies should operate within an innovation system framework to improve future competitiveness.

Materials and Methods

Materials

Research respondents were determined purposively based on the involvement of agents in the innovation system. Agents include production agents; farmers, industrial players, and intermediary traders. Supporting agents include governments, service facilities, certification center, research institutions, universities, and financial institutions, who support the system through policies, quality control and safety, finance, and knowledge transfer. Influencing agents include media, consumers, NGOs, and national figures (Chairatana, 2000), who put pressure on demand (Intarakumnerd et al., 2002). Data sources include primary data obtained from observations, FGDs, and deep interviews, while secondary data obtained through literature studies (journals, books, research results, data archives). In the System Dynamics, data collected are numerical data, written data, and mental models (Sterman, 2000). Numerical data are parameters found in the physical structure and decisions of the system under study. Written data is the relevant literature used in research. Mental models are the rules underlying the decision making by the stakeholders in the research under study (Tasrif et al., 2015). Multi-stakeholder interview and FGD process produce numerical data and mental models.

Methods

The system dynamics method is very appropriate for formulating comprehensive policies in overcoming the complexity of the problem. The dynamics system model can not only manage complex connections between each element at different levels but also handle dynamic processes with feedback in a system. It can also predict complex system changes under different scenarios, which are very useful in examining and recommending policy decisions (Persada et al., 2018). This model was created using Vensim PLE 7.3.5 software. System dynamics model is built through the following stages (Sushil, 1993); problem identification and definition (shown in the framework), system conceptualisation, structure and formulation models (shown in the model), simulation and validation, policy analysis and improvement.

System Conceptualizing

1. Structuring the problems through Causal Loop Diagrams (CLD)

Specific behaviour patterns and system structures can be described with CLD. Positive cause-effect circles produce "growth" behaviour, known as the "R" type Reinforcing loop. Whereas the negative cause-effect circumference results in the attainment of "goal-seeking" behaviour. Negative causal circle is also a balancing process with the notation "B" (Heryanto et al., 2013). The blue loop is a problem in the real-world, while the red loop is a solution plan that will be simulated.

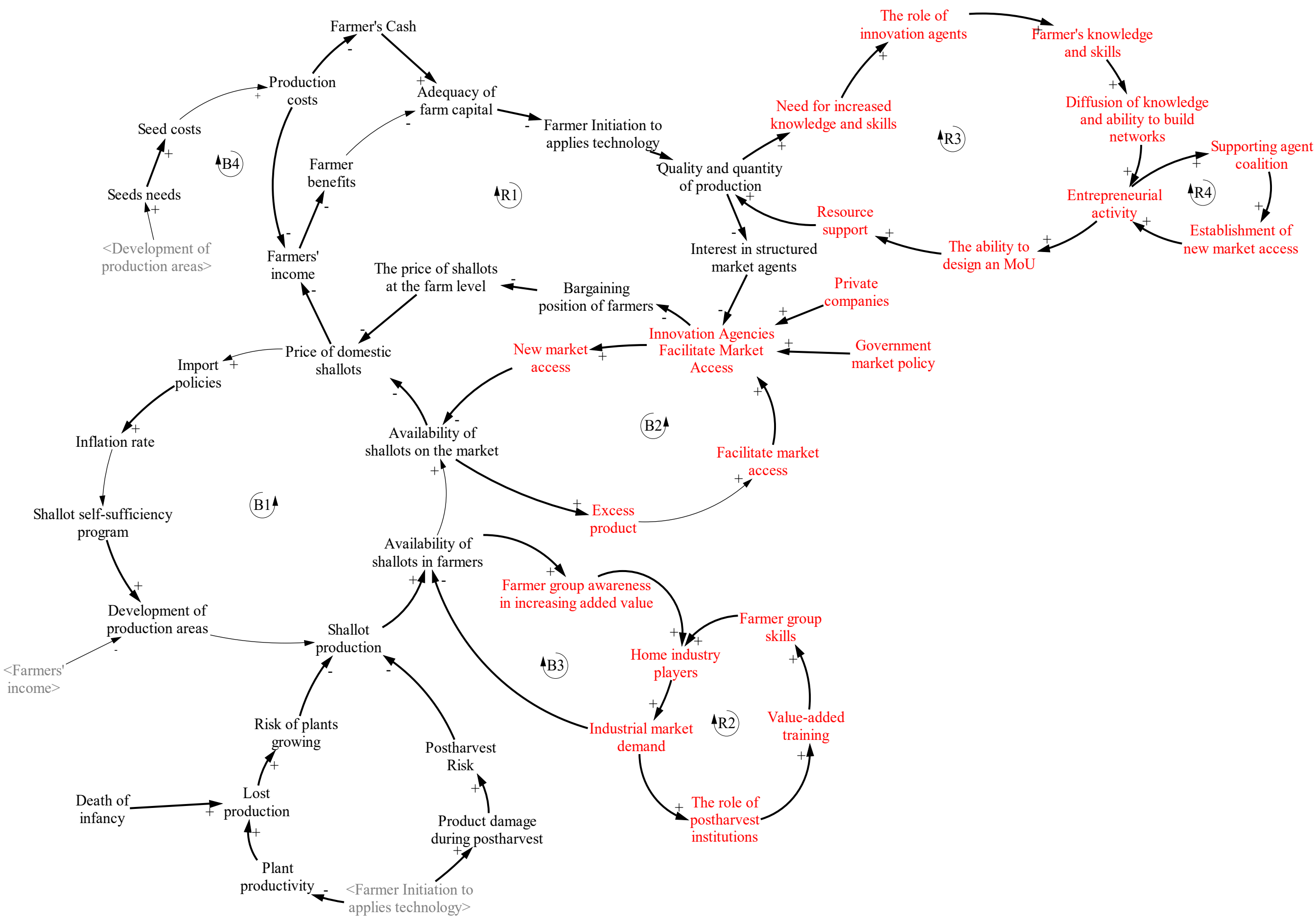


Figure 2. Causal Loop Diagram of Shallot Production Innovation System

Loop B1; the high price of domestic shallots has triggered import policies. Imports increase inflation, so the government tries to stop imports with production policies. As investments increase, production increases and domestic prices fall. *Loop R1*; Domestic prices fall, resulting in farmers' decreasing profits and income. The lack of capital adequacy results in farmers' low initiative to implement technology so that the quality and quantity of yields decline, which has an impact on the declining of the structured market demand. *Loop B2*; Abundant availability of shallots requires the facilitation of new market access. The expectation is to open access to new structured markets so that production surpluses can be handled well. *Loop B3*; Product surplus can be an opportunity for farmers to increase product added value. The number of home industry increased, and the products demand the industrial market increased. *Loop R2*; Industrial market demand causes an increase in the role of the Micro Small and Medium Enterprises Office and the Post-harvest Research Center on yield processing technology. Efforts were made through training programs to increase the added value of products. Thus, the number of home industry increased, and industrial market demand increased. *Loop B4*; planting shallots increases the need for seedlings and production costs. As a result, farmers' income and profit declined. The lack of capital adequacy results in the low initiatives of farmers to apply technology so that the product quality and quantity decline, and the interest of structured market agents also declines. Domestic shallot prices are going down, farmer acceptance is declining, and as a result, the planting motivation is decreasing. *Loop R3*; the demand for quality and quantity of production adds to the need for increased knowledge and skills and thus requires an increase in the role of creator agents and innovators. The learning process will increase farmers' knowledge and skills, and increase the ability to build networking, so that entrepreneurial activity increases. These activities increase the support of resource allocation from various relevant agencies and will ultimately increase the quality and quantity of production output. *Loop R4*; entrepreneurial activities increase the opportunities for the formation of new market access. New market access will motivate more entrepreneurial activities.

2. Build sub-model diagrams

The innovation system provides an analytical framework to study technological change as a complex process of action and interaction among various actors in generating, exchanging, and using knowledge (Edquist, 1997; Freeman, 1995; Lundvall, 2007). This research adopted the function of the innovation system (Hekkert et al., 2007). **Figure 3** shows how the innovation system works in the real-world. The innovation system function forms a closed loop, signaling a reciprocal relationship between functions (Lamprinopoulou et al., 2014). The flow starts with the need to solve the problems of production, technology, processes, markets, and institutions that ultimately form the accumulation of knowledge. Knowledge-creating actors include R&D institutions and tertiary institutions. Agricultural instructors and universities disseminate knowledge through workshops, training, and courses. Dissemination activities will boost to increase entrepreneurial activities for farmers, industry players, and traders. Entrepreneurial activities have a positive impact on the support of coalition agents such as capital institutions, central banks, central and local governments. Support can be in the form of capital, technical guidance, market cooperation, and production facilities. Support increases opportunities for structured market access, such as marketing partnerships with government and private companies. Positive market demand will determine the next production policies and encourage entrepreneurial activities. Production policies have an impact on investment decisions, both material, financial, and human resources. Investment eventually returns to require further R&D so that it returns to the initial cycle of the knowledge accumulation process. The cycle does not have to be positive and amplifying. A negative correlation may be formed when changes in one function cause a decrease in the performance of other functions.

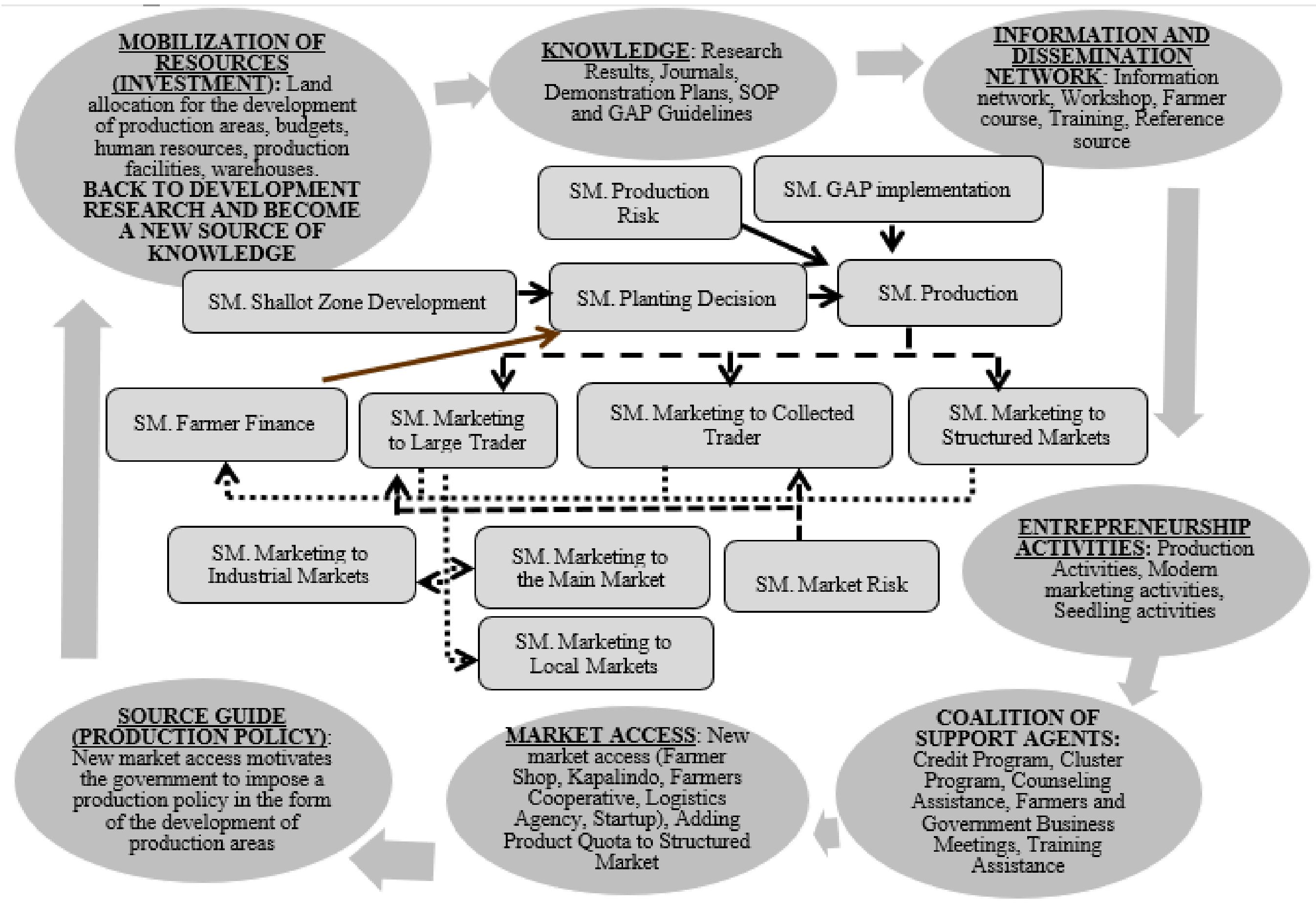


Figure 3. Correlation diagram between Sub Models, adapted from (Hekkert et al., 2007; Hermans et al., 2018)

This study shows the interrelationships between real-world conditions created in the shallot supply chain sub-model and integrates them into the innovation system model. The model combines innovation system theory with real-world phenomena making it a research novelty and at the same time, a differentiator with others research.

Results and Discussion

Simulation Models (real-world behaviour)

Real-world phenomena are events that can be felt. These events will produce behaviour over time (BOT) that is formed from the structure of problems in CLD. BOT contains past elemental behaviour and estimation of elemental behaviour in the future if it does not make changes (Sulistyowati, 2012).

The behaviour of planting decisions

The desired plant by the government is showed by a red line, which increases consistently by the increasing needs. While the actual planting desired by farmers appears on the blue line with a horizontal but fluctuating trend. Production development policy can improve planting decisions as indicated by the green line with an upward trend following the planting trend desired by the government. However, farmers' planting decisions cannot match the investments that the government wants because of economic factors, such as market demand and price guarantees.

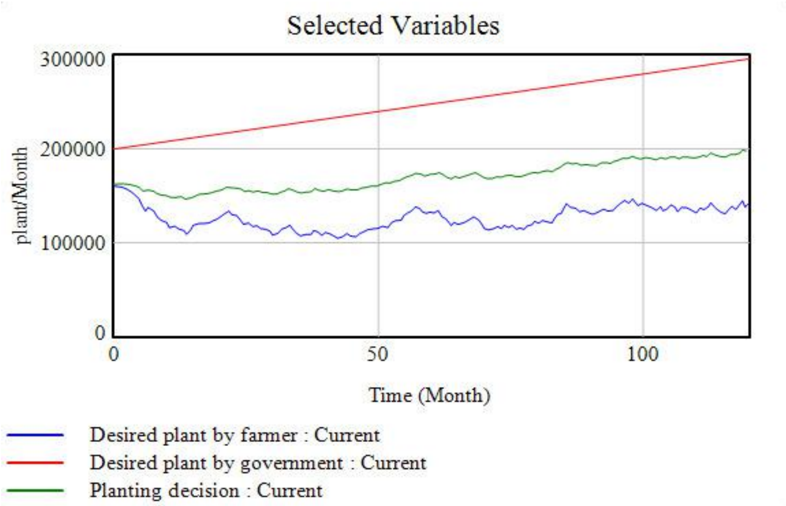


Figure 4. Planting Decision Behaviour

Production behaviour

Production behaviour appears on the red line with a slight upward trend but remains volatile. The influence of the season is still evident in production trends. The motivation of farmers in implementing technology recommendations does not seem to affect the increase in production significantly. Actual production trends have not been able to keep up with the trend that the government desires.

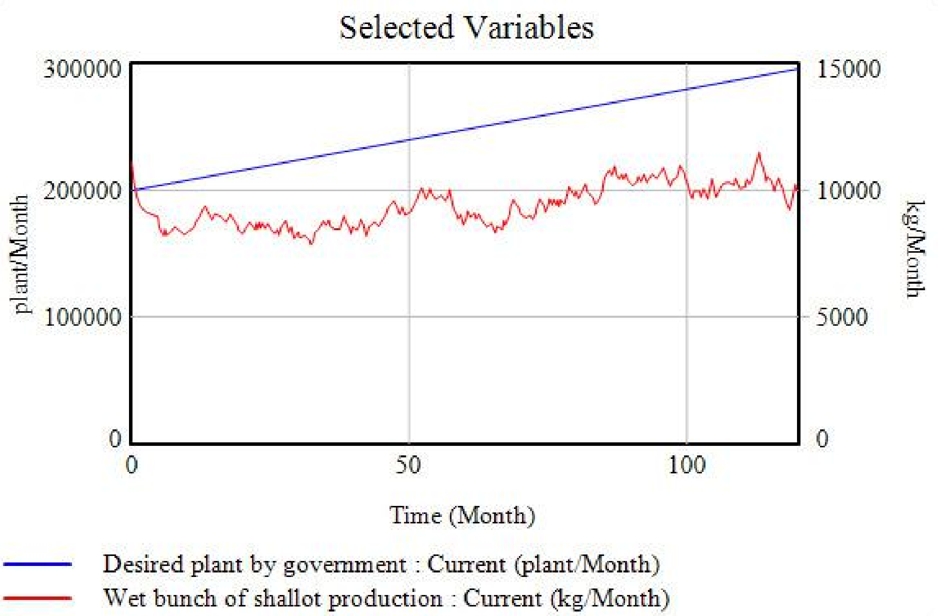


Figure 5. The behaviour of wet shallot production

Production and market risk behaviour

Production risk behaviour is proportional to planting trends. The higher the amount of planting, the higher the failure risk to grow. Market risk behaviour experiences an increasing trend. Farmers get a standard price when selling products to a structured market but with a limited quota. Conversely, farmers get fluctuating prices when selling products to conventional markets even when on season, farmers often get product prices below the cost of goods sold.

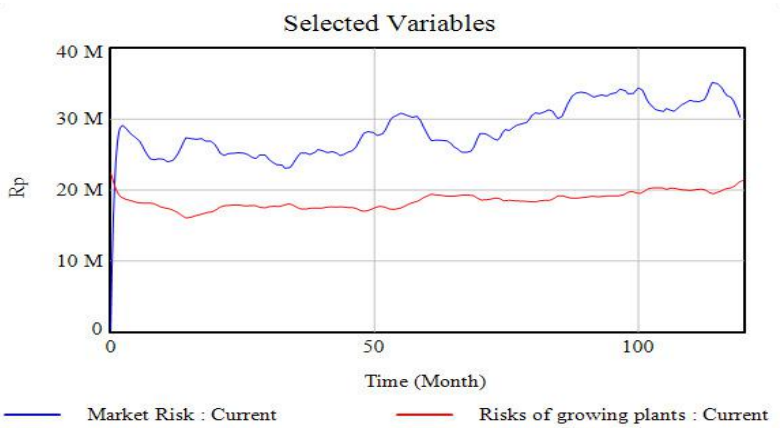


Figure 6. Growing Plant Risk Behaviour and Market Risk

Farmer's financial behaviour

Farmer's financial behaviour in terms of cash, receivables, and profits has the same pattern even though the position is different in magnitude. The trend forms a horizontal line with a slight insignificant increase, indicates that shallot production has not yet brought a significant increase in farmers' financial conditions.

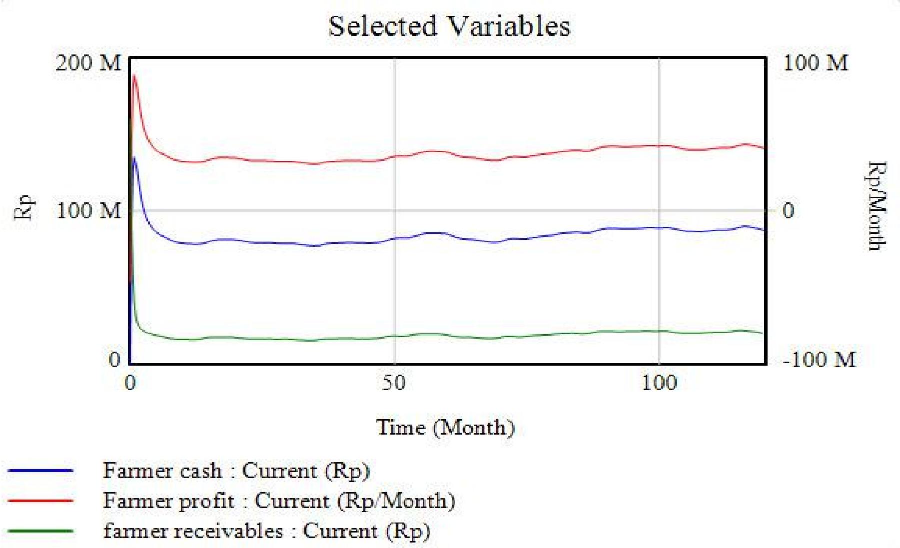


Figure 7. Farmer's financial behaviour

Policy Analysis and Improvement

System dynamics analysis provides information about the behaviour exhibited by each scenario in a specific period to see its sustainability as consideration for policymakers. This study develops the upstream and downstream models of shallots through the three policy scenarios.

1. **Scenario 1**

- **Minimize crop growing risk by breeding bulb seeds and applying GAP**

Most farmers still rely on imported bulb seeds as they are more practical and have guaranteed quality, and as a result, the production costs become expensive. Thus, the innovation system plays a role in conducting socialisation, coaching, and assessing captive breeding. Basically, the breeder group is a farmer group that is fostered by the Seed Supervision and Certification Center to produce certified superior bulb seeds, so that the capacity of farmers' expertise increases, and the contribution of superior bulb seeds increases.

The production process must refer to the Good Agriculture Practices (GAP). GAP utilises pest, disease, and weed control to a safe level, that is, the economic cost limit for farmers and also minimum harm to the operator, others around him, and the environment. In complete description, the application of GAP aims at;1) increasing productivity, 2) improving yield quality and consumption security, 3) increasing production efficiency and competitiveness, 4) efficient use of natural resources, 5) maintaining land fertility and sustainable production systems, 6) encourage mental attitude that is responsible for health, personal safety, and the environment, 7) increasing opportunities in the international market, 8) consumer safety guarantee (Yogyakarta Agriculture Office, 2012). GAP is not only about productivity but also caring for the environment. They should be educated to have a better understanding of environmentally friendly products (Deliana, 2012). Production risk behaviour is shown in **Figure 8**. The scenario reduces production risk from a range of IDR 17 million to 9,54 million.

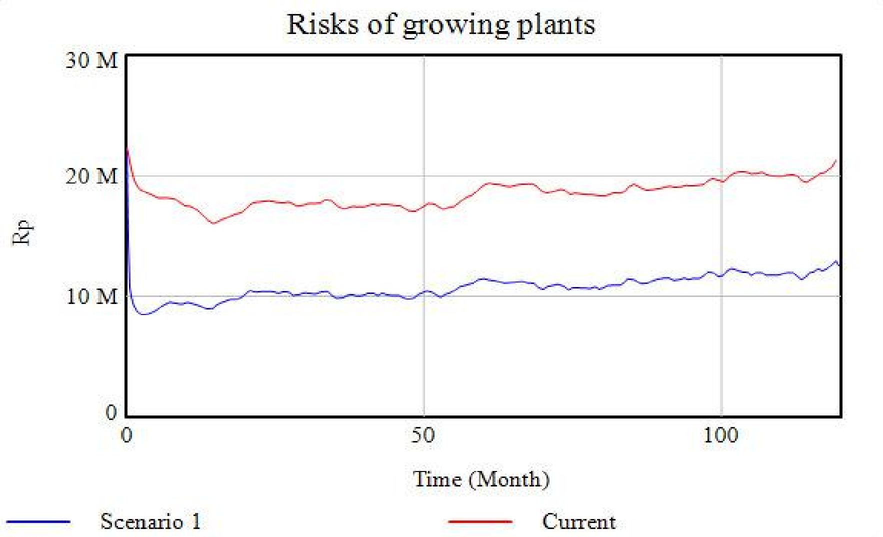


Figure 8. Growing Plant Risk Behaviour

- **Minimize market risk:**

Market risks are common during the primary harvest season. An abundant supply that is not accompanied by proper management will be detrimental to farmers because the price formed is meager even under the cost of goods sold. Steps are needed to Minimize this.

(1) Increasing processing yields activities

Efforts to Minimize market risk are given through intensive guidance and training on processed shallot products from related institutions in order to increase the industrial market demand and provide added value to the industry players.

(2) Increasing market access

Traditional markets absorb 90% of the product, while structured markets only absorb around 10%. The crop prices in traditional markets are made purely from the market mechanisms. There is no price guarantee to protect farmers. The intervention is done by increasing structured market access, including partnerships with farmer cooperatives, and agribusiness startups. The two receive the harvest and carry out the post-harvest function until the product is ready to deliver. The startup is preferred by millennial young people who have the latest creativity and innovation. Startups hold the principle of *end to end* with quality assurance, affordable prices for consumers, and profitable for farmers. The presence of a structured market is expected to be able to break the long distribution channels. However, this requires the commitment of farmers to provide quality products. The commitment is built from the ability, willingness, and trust of farmers to make changes so that they can receive benefits (Natawidjaja et al., 2008).

(3) MoU renewal between Government, Private partners, and farmers

In fact, now farmers have collaborated with Indonesian Farmers Stores and private companies as product suppliers. However, both of them only absorb about 10% of the product. Prices received by farmers occasionally do not follow the initial agreement of the contract. The innovation system has a role in improving the MoU by reviewing the agreement on the type, quality, quantity, and price of the product. A joint mapping on the consumer needs and opportunities to increase product quotas from farmers is required. Market risk behaviour is in **Figure 9**. Joint interventions reduce market risk from around IDR 26 million to 4.24 million.

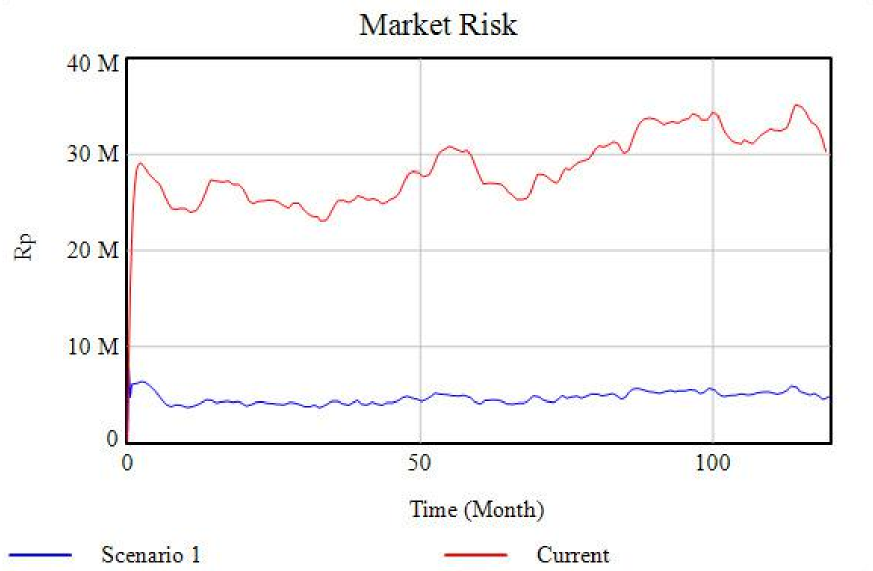
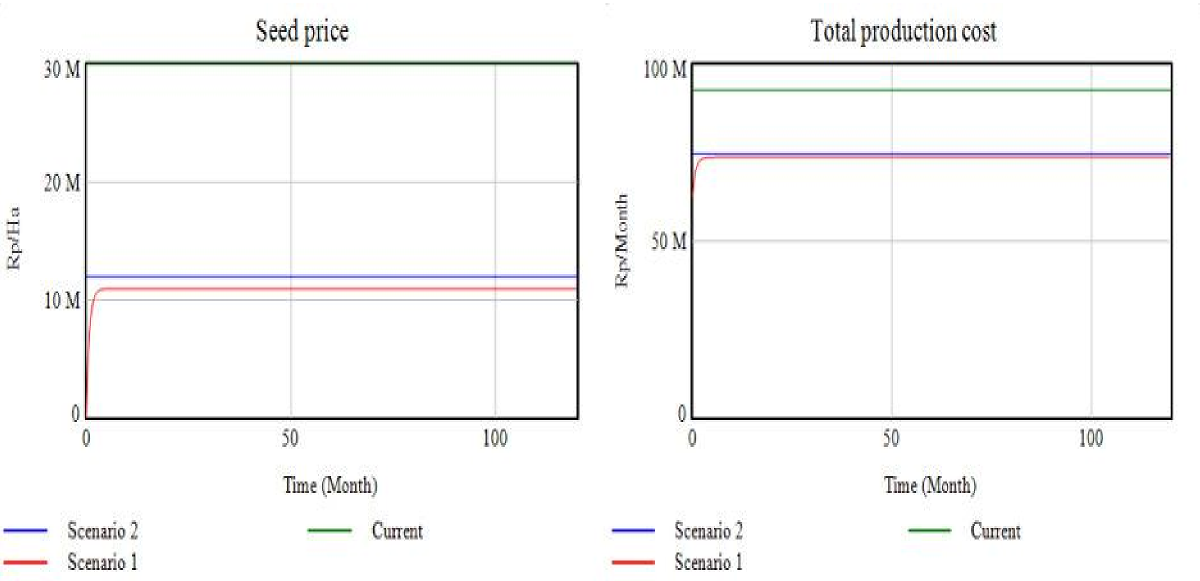


Figure 9. Market risk behaviour

2. Scenario 2 (Scenario 1 + Use of True Shallot Seed)

- **Minimize production costs through the use of TSS**

The use of TSS is one solution to meet the needs of quality seeds. All this time, the shortage of bulb seeds fulfilled from shallots for consumption or imported ones. Meanwhile, the continuous use of the shallot bulb seeds can reduce the quality due to the accumulation of bulb-borne pathogens such as bacteria, fungi, and viruses, which result in decreased plant productivity (Prayudi et al., 2014).



(a) (b)

Figure 10. (a) Seed Prices Behaviour, (b) Production Costs Behaviour

The behaviour of seed prices and production costs is shown in **Figure 10**. TSS saves seed costs. With the needs of 4-5 kg of seeds/ha and the price of seeds of IDR 2 million/kg, the cost of seeds and nurseries is IDR 12 million/ha. The price of bulb seeds reaches IDR 35.000/kg with a requirement of 1,2 tons/ha, so bulb seeds cost needs to reach IDR 42 million/ha or 30%-40% of the total production cost. In total, TSS can reduce production costs from IDR 92,7 to IDR 74,7 million (down 19,4%). Savings can also be achieved through breeding bulb seeds. Breeding costs for the bulb seeds/ha is IDR 11 million. Breeding bulb seeds can reduce production costs by 21,5% or decrease from IDR 92,7 million to IDR 72,8 million. The advantages of TSS; cheaper transportation costs, the long storage life, resistant to disease, the potential for production reaches 20-25 tons/ha while the bulb seeds only 10-15 tons/ha.

3. **Scenario 3 (Scenario 2 + Cropping Patterns)**

- **Minimize the production fluctuations is through cropping patterns management**

One effort to overcome price fluctuations is to regulate production periods through the application of appropriate cropping patterns. Characteristics of productive and efficient shallot cultivation are fertile land, dry season, and irrigation. Conversely, in the rainy season, shallot farming becomes inefficient because it is vulnerable to disease risk and has a low yield quality. Therefore, the regulation of cropping patterns must be accompanied by the application of off-season technology, which can support the quantity and quality of yields. Production behaviour is in **Figure 11**. Minimisation of production fluctuations appears on the straight line indicating no significant production fluctuations if farmers apply the right cropping patterns.

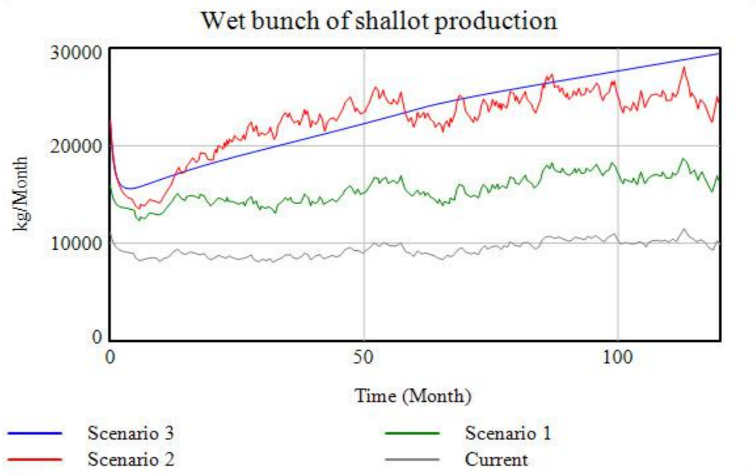


Figure 11. Production Behaviour Through Apply Cropping Patterns

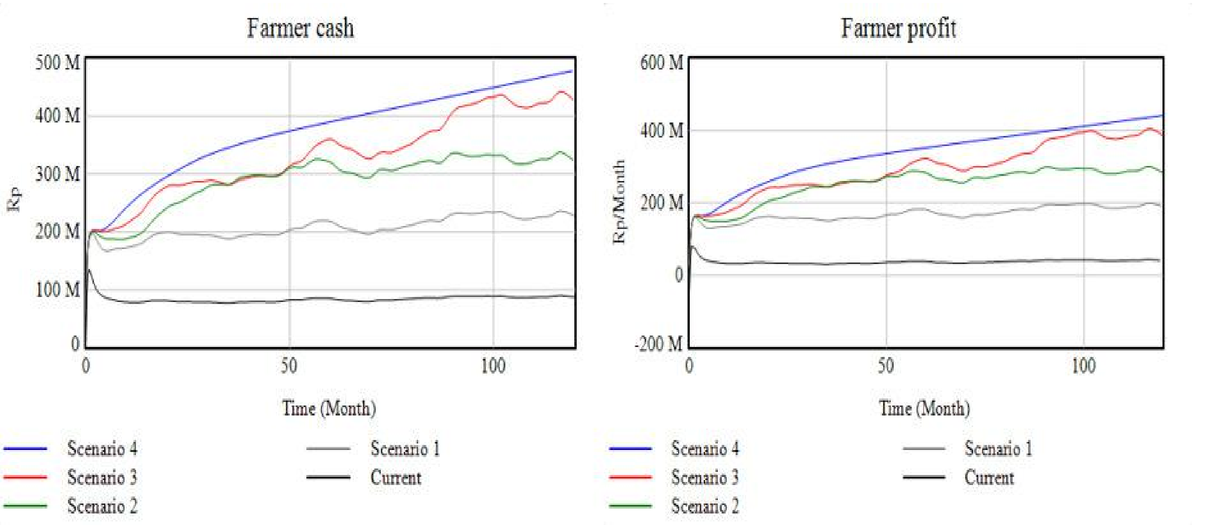
The Impact of Intervention Scenarios on Production Behaviour

Figure 11, at the same time shows a comparison of production in scenarios 1, 2, and 3. Productivity is currently only 10,2 tons/ha, productivity using seedlings reached 15,6 tons/ha, and productivity by TSS reaches 22,9 tons/ha. The assumption is that farmers plant throughout the year with a monthly time on an area of one ha and have applied the GAP principle.

The Impact of Intervention Scenarios on Farmers' Financial Behaviour

- **Farmer's cash and profit behaviour**

In **Figure 12**, cash and profit behaviour with the highest position is in scenario 3. The trend of a steady increase in the form of a straight line upward is the impact of reduced product availability fluctuations. With cropping patterns, farmers can plant throughout the year, so that product availability is stable.

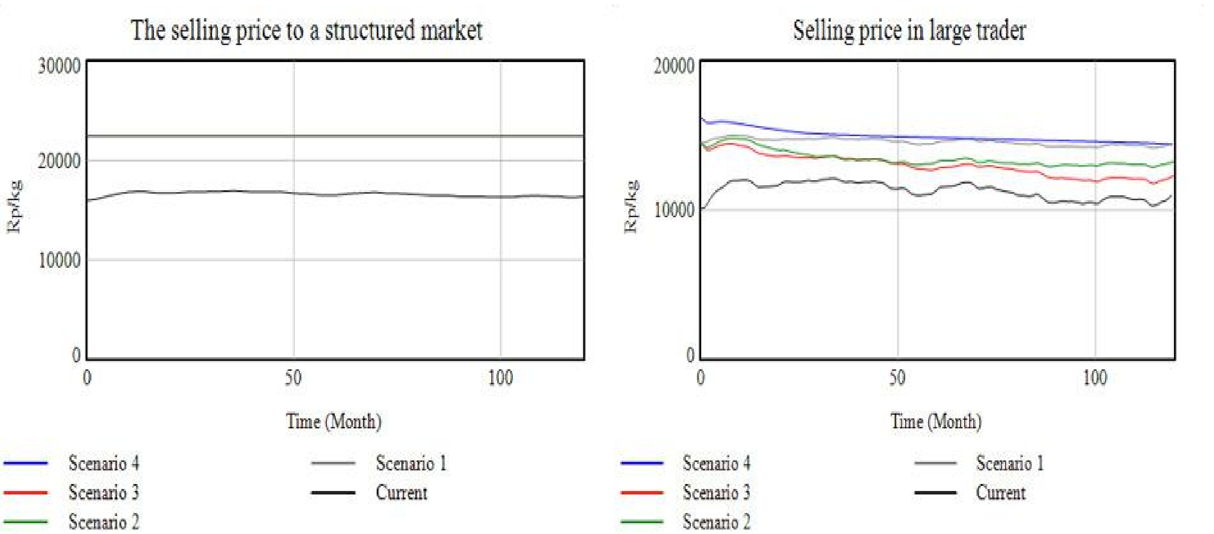


(a) (b)

Figure 12. Two financial behaviours: (a) Farmer's cash behaviour, (b) Farmer's profit behaviour

- **Price formation behavior**

The behaviour of price formation of a ripe bunch of shallots on a structured market (**Figure 13a**) from 3 scenarios shows a stable pattern in the Government's reference price range of IDR. 22.500. While the price formation of a big bunch of shallots at large traders (**Figure 13b**) has not shown compliance with the Government's reference price of IDR. 18.000. However, new prices still provide benefits because they are above current prices. In the long run, there is a downward trend due to increased supply that is not accompanied by stock management.



(a) (b)

Figure 13. The behaviour of shallot price: (a) in a structured market, (b) in the large trader

A summary result of intervention model simulation upstream and downstream of shallots is shown in **Table 1**.

Table 1. Result of Intervention Model Simulation Upstream and Downstream of Shallots

Scenario	Impact	Actual Behaviour	Simulation Behaviour	Unit
Scenario 1:				
• Breeding bulb seeds, applying GAP, processing yields, increasing market access, MoU renewal	- Minimize crops growing risk	17.000.000	9.540.000	IDR
	- Minimize market risk	26.000.000	4.240.000	IDR
	- Increased production	10,2	15,6	Ton/Ha
	- Increased farmer's cash	76.800.000	191.000.000	IDR
	- Increased farmer's profits	34.400.000	152.000.000	IDR
	- Price stability	16.600	22.500	IDR/Kg
Scenario 2:				
• Scenario 1 + Use of True Shallot Seed	- Minimize production costs	92.740.000	74.740.000	IDR/Month
	- Increased production	10,2	22,9	Ton/Ha
	- Increased farmer's cash	76.800.000	264.000.000	IDR
	- Increased farmer's profits	34.400.000	230.000.000	DR
	- Price stability	16.600	22.500	IDR/Kg
Scenario 3:				
• Scenario 2 + Cropping Patterns	- Minimize the production fluctuations	Fluctuating horizontally	Increased stably	
	- Increased production	10,2	24,4	Ton/Ha
	- Increased farmer's cash	76.800.000	272.000.000	IDR
	- Increased farmer's profits	34.400.000	239.000.000	IDR
	- Price stability	16.600	22.500	IDR/Kg

Considerations Selecting Scenarios

Research results (Rahmadona et al., 2017) concluded that shallot farming in Majalengka District showed weak competitiveness. Farmers are not efficient in using domestic resources. To increase the competitiveness of shallots, farmers must use quality seeds, having high productivity, and improve cultivation techniques through the application of SOPs and GAPs. In the 2016 Bank Indonesia pilot project on agricultural financing schemes through the application of the Value Chain Financing concept, explaining that financing of agricultural value chains can only be done on the condition of a structured commodity value chain. Thus, price fluctuations and uncertainties, which are the main risks in agriculture, can be calculated and mitigated by agricultural actors and banks. Other efforts must follow the restructuring process in financing the agricultural value chain in the form of a) technological engineering assistance through the application of cropping patterns and GAP, b) marketing assistance to the modern market, c) assistance in developing collective systems; d) assistance to build communication between farmers, financial institutions, value chain actors and the government (Bank Indonesia, 2016).

Some agricultural experts, such as the Department of Agriculture, Agricultural Extension Workers, Research Institutions, Seed Certification Institutions, and structured market partners, have provided their suggestions based on their expertise, experience, and previous studies, as explained in the previous paragraph. The expert system and the results of the study are the basis for determining scenario priorities. Corrective action can not only consider one side of production, but must also improve the downstream sector starting from post-harvest, industry, and marketing. Potential improvements are already available in the local area. Majalengka District has a wealth of natural resources, land suitability and climate, has a lowland area and a plateau that has the opportunity to apply appropriate planting patterns, the potential for quality seed production, the potential for structured market demand, and the existence of a warehouse building storing agricultural products. This potential certainly requires stakeholder assistance in implementing modern and sustainable technology. Scenario 3 is a whole scenario that is highly recommended because it seeks to improve the system as a whole from upstream to downstream so that it produces positive behavioural impacts as expected. These positive behaviours include increasing production and productivity, decreasing production risk and market risk, stabilising prices at producer and consumer levels, and increasing farmers' cash and profits in the long run.

Learning Points

The development of the shallot upstream and downstream model must be able to produce an efficient and sustainable system in managing interrelated risks. So, multi-stakeholder integration is needed in implementing the innovation system. It should be noted that the innovation system scheme has absolute conditions that underlie coordination between institutions, that is, motivation, incentives, and linkages (Metcalfe, 1995), so the principle of justice must be maintained. Practically, the system dynamics can be used as a scientific learning tool. While methodologically, system dynamics is able to predict the behaviour of the system within a certain time period so that improvements and anticipations can be made.
Implementation of a comprehensive innovation, both technology, products, markets, institutions, and processes, will provide strength in the upstream and downstream sectors. Innovation agents collaborate to run a series of innovation system functions. The concept of collaboration is information sharing, decision synchronisation, and alignment of incentives (Simatupang et al., 2004). To improve the sustainability and resilience of the food system, great emphasis must be kept on estimating the carrying capacity of the region, land use planning to improve supply and demand connections, as well as production, distribution, and market efficiency (Systems et al., 2016).

Conclusions

The current horticultural development policy can improve the decision of production, but cannot match the government's wishes because technology has not yet been met and markets have not been guaranteed. Production behaviour is still fluctuating due influenced by seasons. Production risk behaviour is quite high because the technology is not optimal. Market risk behaviour has an increasing trend due to the absence of market guarantees and prices for products. Farmers' financial behaviour in terms of cash and profits shows a horizontal trend, indicating that production has not significantly affected the financial position of farmers. This proves that the shallots agribusiness innovation system has not formed mutual interaction between actors. The upstream policy has not yet been fully supported by downstream policies. This study develops the upstream and downstream models of shallots through several scenarios. Scenario 1, through breeding bulb seeds, GAP application, yield processing, increasing market access, and renewing the MoU. Scenario 2, through action scenario 1 and the use of TSS. Scenario 3, through scenario 2 and the application of the cropping patterns.

Interventions carry out several behavioural changes. Increasing farmer participation in breeding bulb seeds and implementing GAP reduces the risks of crops growing from around IDR 17 million to IDR 9,54 million. Yield processing activities, additional market access, and the renewal of the MoU reduce the market risks from around IDR 26 million to around IDR 4,24 million. The use of TSS reduces the production costs by 19,4% from IDR 92,7 million to IDR 74,74 million. Breeding bulb seeds reduces production costs by 21,5% from IDR 92,74 million to IDR 72,8 million. Cropping patterns regulation minimizes production fluctuations with a steady upward trend. The highest productivity of 24,4 tons/ha appears in the TSS usage (scenario 3). The highest cash and profit behaviour appears in scenario three with a steady rising trend. The behaviour of price formation on a structured market from three scenarios showed a stable pattern in the Government's reference price, while the price formation of shallots at large traders has not shown compliance with the Government's reference price. However, new prices still provide benefits because they are above current prices. In the long run, there is a downward trend due to increased supply that is not accompanied by stock management.

Expert systems, the results of previous studies, and the results of this study form the basis for determining scenario priorities. Scenario three is a whole scenario that is highly recommended because it seeks to improve the system as a whole from upstream to downstream so that it produces positive behavioural impacts as expected. These positive behaviours include increasing production and productivity, decreasing production risk and market risk, stabilizing prices at producer and consumer levels, and increasing farmers' cash and profits in the long run. The sustainable innovation system must integrate the upstream innovation system and the downstream innovation system to create business efficiency while ensuring the sustainability of the actors. The production innovation systems which are not accompanied by downstream innovation systems will not survive because after all, farmers need economic incentives in the form of guarantees in the downstream sector.

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