Coffee Agro-industry Conceptual Model
Using System Dynamics in Lampung Province, Indonesia

Model Konseptual Agroindustri Kopi
Menggunakan Sistem Dinamis di Provinsi Lampung, Indonesia

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Abstract
The consumption trend of coffee downstream products is increasing every year. However, the high variation in the quality of raw materials on the upstream side impacts agroindustrial activities. The limited capacity of processed coffee production indicates that coffee processing activities are not optimal. High competition and individual business activities cause the upstream and downstream linkage of the coffee industry to be limited. The research objective is to analyze the conceptual model of coffee agro-industry development based on the complexity of problems faced by the actors. Primary and secondary data are used as the basis for compiling the conceptual model of the coffee agro-industry using Vensim Software PLE 9.3.5x64. The conceptual sub-models built are farmers, intermediary traders, and processors. Coffee agro-industry is developed by improving the quality and continuity of raw materials, processing capacity, and the actors’ skills. Quality and production are connecting variables of the three submodels built. The quality of raw materials produced by farmers will improve the quality of processed coffee. Improving the quality of raw materials is not only from using superior seeds but also from the technical skills of the actors involved. Increased processing capacity can increase the absorption capacity of the coffee agro-industry.

Keywords: coffee, dynamic model, intermediary traders, processors, farmers

INTRODUCTION
Agro-industry development is related to encouraging mutually sustainable upstream-to-downstream activities. Agro-industry also plays a vital role in commodity processing activities (Wiryaningsih et al., 2021). Commodity processing activities in an agro-industry depend on the availability of raw materials.
The coffee agro-industry is continuously developing. Raw materials for processed coffee in Indonesia are currently dominated by robusta coffee, which reaches 83%; the remainder is arabica coffee (Gabungan Eksportir Kopi Indonesia, 2020). Indonesia is one of the world's primary coffee producers, producing 7% of the world's total coffee production (International Coffee Organization, 2020). Indonesia exports 47.7% of total coffee production to the United States, Malaysia, Italy, Egypt, Japan, and Germany. Indonesia is also the country with the second most significant level of domestic consumption in the world after Brazil (Direktoral Jenderal Perkebunan, 2021). The coffee production in Indonesia is still lower than other main producing countries such as Brazil, Vietnam, and Colombia, which have produced 35.84%, 19.22%, and 6.94% of the world's total coffee production in 2022 (International Coffee Organization, 2023). Indonesia's coffee production in 2022 reached 794,800 tons (Badan Pusat Statistik, 2023), with 790,000 tons from smallholder plantations and the rest from large plantations. Indonesian coffee production is spread across several regions, with five main production centers in South Sumatra Province, Lampung Province, North Sumatra Province, Aceh Province, and Bengkulu Province (Badan Pusat Statistik, 2023).

Based on the Decree of the Minister of Agriculture Republic of Indonesia No. 472 of 2018 concerning the Location of National Agricultural Areas, Lampung Province is one of the national coffee development areas spread across five districts. These areas are Tanggamus Regency, West Lampung Regency, Way Kanan Regency, North Lampung Regency, and West Pesisir Regency. The distribution of coffee area and production in Lampung Province can be seen in Figure 1. Lampung Province is the second coffee production center after South Sumatra, with robusta coffee production much higher than arabica coffee production (Badan Pusat Statistik, 2023). The area of farmers' plantations planted with robusta coffee is 99.77% of the total coffee plantation area, while the rest is planted with arabica coffee. The total coffee production level in Lampung Province in 2022 reached 118,139 tons (Badan Pusat Statistik Provinsi Lampung, 2023b). The area of robusta coffee plantation in 2021 reached 156,395 Ha (Badan Pusat Statistik Provinsi Lampung, 2023a), with a percentage of mature plants (TM) reaching 89.5% and a productivity level reaching 864 kg/ha. This level of productivity is still much higher than national productivity, which only reaches 840 kg/ha.

![Figure 1. Map of Robusta Coffee Area Distribution and Production in Lampung Province in 2020 with Geographic Information System (Dinas Perkebunan Provinsi Lampung, 2022)
Agro-industry development in Lampung Province is still facing various problems. Farmers are generally small-scale, so the green bean stock must be sold directly to intermediary traders, even at low prices. This condition is due to the family’s urgent needs, so efforts to hold green bean stocks until the selling price is high are rarely done (Dradjat et al., 2007). Special treatment is not carried out on the green bean sold. The farmers ease to obtain a cash economy is also a particular reason for farmers to immediately sell green beans to collecting traders (Rosiana, 2020). Intermediary traders in this study consisted of small collecting traders, large collecting traders, buying centers, and cooperatives. Cooperatives are considered intermediary traders in this research because cooperatives sell coffee from farmers to the coffee processing industry. The level of profit obtained by farmers is much lower than that of other supply chain actors, such as collectors, processors, and exporters, thereby reducing farmers’ motivation to grow coffee (Sriwana et al., 2022). This condition has an impact on the sustainability of the coffee agro-industry because farmers are critical holders in supply chain activities in the coffee agro-industry, and the production of coffee beans becomes raw material for the coffee industry, which generates foreign exchange for the country (Sriwana et al., 2017; Direktorat Jenderal Perkebunan, 2021).

Another problem in developing the coffee agro-industry in Lampung Province is the low quality of coffee beans (Supriyati & Suryani, 2006). The quality of coffee beans not only impacts the supply side but also the demand side. On the supply side, farmers will get a higher selling price if the quality of the coffee beans meets the standards set by the buyer. On the demand side, appropriate quality coffee beans will increase consumer preferences in fulfilling their needs (Rosiana et al., 2017b). Various things, including plant age, cultivation treatment, and post-harvest treatment, influence variations of coffee bean quality produced by farmers. Quality differences determine the difference in selling prices at the farmer level. Most coffee farmers’ produce is sold to collectors (Simorangkir & Rosiana, 2022). Quality variations at the farmer level also impact the quality variations at the collector level. Another problem at the intermediary trader level is that the coffee received by intermediary traders is unstable because the availability of coffee at the farmer level is also unstable. Farmers sell to intermediary traders (small collecting traders, large collecting traders, buying centers, and cooperatives), a combined farmer group called Gapoktan, and the coffee processing industry. The low-quality red cherries and green beans at the farmer level will impact the activities of subsequent institutions that buy and process them. One example of low-quality coffee from farmers is red cherries with 17-20% water content or green beans with around 14% water content. This condition causes the buyers of coffee beans from farmers to dry them so the coffee beans’ water content reaches the minimum water content quality requirements set. The selling price of coffee at the farmer level is determined based on the general conditions: maximum 12.5% water content, coffee beans cleanliness from foreign objects, broken beans, and dark beans (Dradjat et al., 2007). Therefore, improving the coffee bean quality is needed to increase farmers’ income (Aklimawati et al., 2014). Farmers’ income can also be increased by implementing the zero-waste coffee plantation concept, reducing waste from the processing of red cherry to green beans in an integrated manner to increase the processing added value (Septarianes et al., 2020). The coffee waste (husks) can be used for animal feed (Septarianes et al., 2020).

The problems that arise in processing coffee beans into ground coffee are the low quality of raw materials and limited workforce capabilities (Oka et al., 2021). The coffee processing industry in Lampung consists of small-scale processing industries (home industries), medium-scale industries, and large-scale industries (factories). Small-scale industries are generally not registered with the Department of Industry. Medium-scale industries are generally registered with the Department of Industry. Large-scale industries are generally registered with the Department of Industry and have trademarks. According to Lampung Provincial Government Cooperative and Small and Medium Enterprises, the problems faced by small and medium enterprises (SMEs) coffee processing, in general, are low-quality raw materials, high raw material prices, limited access to capital, and low market access (Dinas Koperasi Usaha Kecil dan Menengah Pemerintah Provinsi Lampung, 2022). The product’s production capacity indicates that coffee processing activities are not yet optimal at the SME level (Arruzzi, 2017). The high level of competition and individual business activities cause the upstream and downstream linkage of the coffee industry to be very weak. The problems that arise for every actor involved, starting from farmers, intermediary traders, and processors, are complex and interconnected. This condition makes identifying behavior and assessing value chain problems challenging (Lie & Rich, 2016). System dynamics can capture feedback, behavior, and governance in value chain analysis (Muflikh et al., 2021). This research...
aims to analyze the coffee agro-industry development model in Lampung Province based on the complexity of the problems that arise for each actor involved. The analysis starts from raw material providers (farmers), intermediary traders (collectors), and processors. The analysis uses a system dynamic conceptual model based on reciprocal relationships (feedback).

**METHODS**

**Collecting Data Method**

The research location was determined considering that Lampung Province is Indonesia's main production center for robusta coffee. The district chosen was West Lampung Regency because this district is the largest coffee production center in Lampung Province, with a production level reaching 49.4% of the total production in the province. The conceptual preparation of the coffee agro-industry model in Lampung Province was conducted using primary and secondary data. Primary data was obtained through interviews and field observations of farmers, intermediary traders, and processors.

The farmer respondents' determination was conducted using a purposive sampling technique based on information from field agricultural extension officers called Penyuluh Pertanian Lapang (PPL), located in Sekincau District, West Lampung Regency. The sample of farmer respondents in this study was 44. Searches and subsequent interviews were conducted with intermediary traders and processors using the snowball sampling method, with information obtained from respondents who had been previously interviewed. The sample of intermediary trader respondents was eight, consisting of five small collector traders and three large collector traders. Small collecting traders buy directly from farmers and resell to large traders/exporters/processors, while large collecting traders sell directly to exporters/processors. The sample of processor respondents is two. Processors are parties who carry out value-added activities (processing activities) on a small or large scale. Primary data obtained from all sample respondents was used to determine the coffee agro-industry chain in Lampung Province.

Secondary data collection was sourced from the Lampung Province Plantation Service, Lampung Province Cooperative, and Small and Medium Enterprises Service, Statistics Indonesia, Directorate General of Plantations Ministry of Agriculture of the Republic of Indonesia, Ministry of Industry of the Republic of Indonesia, Association of Indonesian Coffee Exporters and Industries (AEKI), and the International Coffee Organization (ICO). Primary and secondary data were used to prepare a conceptual model for the coffee agro-industry using Vensim PLE 9.3.5x64 software.

**Conceptual Model Development Using System Dynamics**

Identifying the needs and problems of all actors involved in the coffee agro-industry in Lampung Province is needed to build a conceptual model. This process is carried out comprehensively through several stages. The literature study focuses on the needs and problems of all actors involved in the coffee agro-industry in Lampung Province: farmers, intermediary traders, and processors. Observations and interviews regarding needs and problems were carried out directly with all these actors. The primary needs and problems are determined based on literature studies, observations, and interview results. The identification results show that each actor involved in the coffee agro-industry in Lampung Province has different needs and problems. This result then became the basis for building a conceptual model for developing the coffee agro-industry in Lampung Province.

The conceptual model development stage was carried out after identifying the needs and problems of coffee agro-industry players in Lampung Province. The needs and problems that arise at the farmer, intermediary traders, and processor levels are connected by building a model using a causal loop diagram. The model-building stage begins with the system identification stage. The model is built from three sub-models: the raw material provider/farmer conceptual sub-model, the intermediary trader conceptual sub-model, and the processor conceptual sub-model. The relationship between the three sub-models is shown by variables that can be quantified and reflect the problems and needs of coffee agro-industry stakeholders. These relationships are interrelated to form a coffee agro-industry model system. Causal loop diagrams were created using Vensim PLE 9.3.5x64 software. The variables used as a basis for decision-making in providing policy recommendations for developing the coffee agro-industry in Lampung Province are shown in Table 1.
Actors involved in the coffee agro-industry in Lampung Province, from raw material providers, intermediary traders, and processors, need to be analyzed to build the model. This analysis is identified in the formed agro-industrial chain, and the needs and problems arising from each actor are identified. The agro-industry conceptual model is then built using a causal loop diagram on the three sub-models that comprise the agro-industry model.

**Coffee Agro-industry Chain in Lampung Province**

Agro-industry is an industry that uses agricultural products as its primary raw material (Timisela et al., 2021). The industry produces agricultural products in the agricultural business. The development of the coffee agro-industry in Lampung Province involves many actors depicted in the agro-industrial chain, and each has a role in developing the coffee agro-industry (Figure 2). Farmers, as the main producers of coffee, sell their harvest in red cherries and green beans. The price of green beans from farmers with varying quality is lower than those from farmers who meet buyer standards based on SNI. Green beans that do not meet the buyer's standards based on SNI are sold with around 14% water content, have defects (mixed with black and brown coffee beans, coffee cascara, coffee beans parchment, broken coffee beans, and young coffee beans, hollow coffee beans, spotted coffee beans), and mixed with dirt (twigs, soil, gravel). The price for dry coffee beans from farmers with moisture content >12% in August 2022 is IDR 22,000–IDR 23,000/kg. The small collectors bear transportation costs for selling coffee beans from farmers to small collectors. These traders generally live around the production location. Small collecting traders are intermediaries, usually reselling to prominent collectors or exporters. Farmers who sell to prominent collectors deliver their harvest mostly directly to the warehouse owned by the prominent collector, with transportation costs borne by the farmer. Farmers who are members of cooperatives can also sell to Gapoktan or cooperatives. These farmers must meet the criteria set by the cooperative, including red picking criteria. Red picking is the term for harvesting coffee cherries by only picking red ones, carried out 5-10 times with a harvest interval of generally 14 days (Rahardjo, 2021). Red picking is an effort to maintain the coffee beans quality. Not all farmers become members of cooperatives for various reasons, including the criteria for coffee produced by farmers not meeting the coffee bean quality requirements. One of the cooperatives that determines quality is the cooperative joint venture called...
Koperasi Usaha Bersama (KUB), which sells coffee beans to buying centers belonging to coffee bean processing factories. Other cooperatives sell coffee beans to individual consumers or processors.

Each party involved in the coffee agro-industry chain carries out marketing functions. These marketing functions include exchange, physical, and facility functions (Asmarantaka et al., 2017). The exchange function is the activity of physical movement of commodities; for example, farmers carry out coffee bean sales activities, while small/large traders and exporters carry out sales and purchase activities of coffee beans. The physical function is commodity handling activities, such as transportation and sorting activities carried out by all parties and processing activities carried out only by the processor. The facility function is a function to facilitate exchange and physical functions. All parties assume risk, financing, and market information in the facility's function.

Quality determines domestic and foreign marketing activities in the coffee agro-industry chain. Robusta coffee varieties are generally exported in green beans. Small-scale coffee processing (home industries) market their products in the Lampung area. Medium-scale industries generally market their products in the Lampung area and its surroundings. Several medium-scale processing industries market their products abroad in limited quantities. Large-scale industries (factories) market their products abroad. The main problems at the processing industry level are limited capacity and quality consistency.

Buying centers are part of large-scale processing industries (factories) that function to sort the coffee bean quality from farmers. The price of random-quality coffee beans differs from the price of sorted-quality coffee beans. Random coffee bean is a term for coffee beans from unsorted cherries (a mixture of red, green, and yellow cherries) (Anhar et al., 2018). Sorted-quality coffee beans are coffee beans that only come from red cherries, not mixed with defective beans and impurities, and the quality follows Indonesian National Standards (SNI). According to the Ministry of Industry of the Republic of Indonesia, coffee quality is a factor in determining the price of processed coffee products (Kementerian Perindustrian Republik Indonesia, 2017). The price of processed coffee made from a mixture of red cherries and green/yellow cherries is lower than processed coffee made from whole red cherries. This quality coffee bean affects the coffee aroma and taste resulting from the roasting process.

The synergy between stakeholders involved in the coffee agro-industry in Lampung Province is needed to develop the agro-industry. Most robusta coffee exported from Lampung is still in green beans (99.5%) (Rosiana et al., 2019). The added value of coffee agro-industry products in Lampung Province will increase if robusta coffee beans are processed domestically, supported by the involvement of coffee agro-industry stakeholders.

Figure 2. The Flow of Coffee Agro-industry Actors in Lampung Province

Identification of the Main Needs and Problems of Coffee Agroindustry Actors in Lampung Province

The systems approach begins by identifying the needs and problems of each party involved, such as farmers, intermediary traders, and processors. Needs identification is carried out to describe the factors needed by each party to support coffee agro-industry activities. Identification of problems for each party is also carried out because each party faces different problems. The needs of farmers, intermediaries/small/prominent collectors, and processors in general, as well as the main problems of coffee agro-industry players in Lampung Province, can be seen in Table 2. According to Abdulla et al., 2015 and Brzezina et al. (2016), problem formulation can determine behavior, so it becomes an essential part of system modeling.

Table 2. Identification of the Main Needs and Problems of Coffee Agro-Industry Actors in Lampung Province

<table>
<thead>
<tr>
<th>Actors Involved</th>
<th>Farmer</th>
<th>Intermediary Trader</th>
<th>Processor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs Identification</td>
<td>a. Quality seeds</td>
<td>a. Quality of raw materials according to SNI standards</td>
<td>a. Quality of raw materials according to SNI standards</td>
</tr>
<tr>
<td></td>
<td>b. Good selling price for coffee beans</td>
<td>b. Continuity of raw materials</td>
<td>b. Continuity of raw materials</td>
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<td></td>
<td>c. Postpone the sale when prices are low</td>
<td>c. A pattern of mutually beneficial trade relations with agro-industry and exporters</td>
<td>c. Market guarantee</td>
</tr>
<tr>
<td></td>
<td>d. Income increases</td>
<td>d. Increased production capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Quality increases</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f. A pattern of mutually beneficial trading relationships with intermediary traders</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g. Access capital assistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Low coffee bean prices</td>
<td>b. Availability of raw materials is not continuous</td>
<td>b. Availability of raw materials is not continuous</td>
</tr>
<tr>
<td></td>
<td>c. Postpone selling is complex when prices are low</td>
<td></td>
<td>c. Limited market access</td>
</tr>
<tr>
<td></td>
<td>d. Low profits compared to intermediaries and processors</td>
<td></td>
<td>d. Low production capacity</td>
</tr>
<tr>
<td></td>
<td>e. The quality of coffee beans varies (low quality)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f. Farmers’ low bargaining position when making transactions with intermediary traders</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g. Limited access to capital</td>
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</tbody>
</table>

Conceptual Model for Coffee Agro-industry Development

System identification is made by connecting the relationship between needs and problems. Sterman (2000) states that interrelated elements in a system can be depicted with a causal loop diagram. According to Abdulla et al. (2019) and Faeid et al. (2018), causal relationships using causal loop diagrams between elements can identify behavior that describes actual conditions. Modeling of the coffee agro-industry development system was then carried out based on empirical conditions in the field, theory, and logic. The conceptual model for developing the coffee agro-industry was carried out in three sub-models: the raw material provider/farmer conceptual sub-model, the intermediaries/collector conceptual sub-model, and the processor conceptual sub-model.

Conceptual Sub-model of Raw Material Providers/Farmers

The level of productivity and land area greatly influences coffee bean production at the farmer level. Coffee productivity is influenced by climatic factors, the intensity of pest and disease attacks, and the equitable use of superior (Dradjat et al., 2007; Meiln et al., 2017; Prasetyo et al., 2017). Coffee grafting technology using superior clones can increase coffee productivity (Evizal & Prasmatiwi, 2020). The level of productivity in Lampung Province in 2020 reached 847 kg/ha, even higher than Indonesian coffee productivity, which only reached 806 kg/ha. The availability of superior coffee seeds in Lampung Province is still limited, so productivity can be optimized by increasing each village's nursery.
area/superior seeds nursery. According to Sub Directorate of Plantation Crop Statistics, the area of coffee plantations in Lampung Province in 2022 is 155,166 Ha, consisting of 139,224 Ha with mature crop status, 8,166 Ha with immature crop status, and 155,166 Ha with damaged crop status (Sub Direktorat Statistik Tanaman Perkebunan, 2023). This condition means that the potential for land expansion is still very possible to be implemented as an agro-forestry program. Lamefa et al. (2020) state that one of the main strategies for developing coffee is through expanding coffee plantations.

Increasing coffee production will impact increasing stock at the farmer level so that farmers can implement a postpone selling system when the price of coffee beans is low. Farmers can usually store coffee beans for up to 6 months without a decrease in quality if they can control the quality during storage. This quality control is performed by keeping the warehouse clean so that the coffee beans are not contaminated by foreign objects and providing pallets as a base for packaging the coffee beans so that the water content does not increase. The internal factor that can be controlled is the coffee beans' quality. Controlling the coffee beans' quality can be improved if farmers' risk management skills are improved by providing technical training. Farmer development activities increase the coffee agro-industry's development (Lamefa et al., 2020). Farmers can also utilize coffee production waste by processing it into compost or animal feed. The results can be sold to increase the farmer's side income. The results can be sold to increase the farmer's side income. Rochmah et al. (2021) state that using coffee grounds waste into liquid organic fertilizer (POC) can improve farmers' welfare.

The conceptual sub-model of raw materials emphasizes coffee bean production at the farmer level and farmer profits. Increasing farmers' profits through the central business (selling coffee beans) and side businesses (selling compost/animal feed from coffee waste) will encourage increased farmer motivation in cultivating coffee. Interrelated relationships with each other in the raw material provider sub-model will encourage the improvement of the coffee agro-industry on the upstream side. This statement confirms that an integrated production system will increase industrial readiness by increasing benefits and productivity (Hasan et al., 2019). Partnership collaboration between agro-industry players and farmer groups is another effort in developing the coffee agro-industry (Zahrosa et al., 2016). The raw material provider submodel can be seen in Figure 3.

**Figure 3.** Raw Material Provider Sub-model (Farmers)

Information:

- Causal relationships is Reinforcing (R)
- Causal relationships are non-Reinforcing (R)
Intermediary Trader Conceptual Sub-model

Farmers in the coffee agro-industry development in Lampung Province are the primary producers who sell coffee beans to intermediary traders. Intermediary traders are farmer consumers in this research: small collecting traders, prominent collecting traders, buying centers, and cooperative institutions. Intermediary traders do not carry out the processing stage. Intermediary traders only buy coffee beans from farmers and then sell them to other consumers. Consumer demand at the processor and exporter level determines the coffee bean volume at the intermediary trader level. The availability of coffee beans at intermediary traders depends on the quantity and quality of coffee beans available at the farmer level. The quality of coffee beans sold by farmers positively affects the selling price of coffee beans at the intermediary level.

The quality and quantity of coffee beans also determine the profit level of intermediary traders. Intermediary traders have to incur costs in handling coffee beans from when they are purchased from farmers until sold to consumers. Costs that intermediary traders must incur include transportation costs from farmers to consumers of intermediary traders. If the costs incurred by intermediary traders are higher without an increase in income, the profits will be lower.

Intermediary traders face various product marketing risks, including price and market risks. Price risk is caused by the quality of coffee beans purchased from farmers. Intermediary traders can only sell their products at low prices if the quality of the coffee beans purchased from farmers is low (because the water content and impurities exceed consumer standards). Another risk faced is the risk of uncertain markets. Intermediary traders must seek market certainty based on experience, networks, and consumer trust in selling coffee beans. The intermediary trader sub-model can be seen in Figure 4.

![Figure 4. Intermediary Sub-model](image-url)

**Figure 4. Intermediary Sub-model**

Information:
- Causal relationships are Reinforcing (R)
- Causal relationships are non-Reinforcing (R)

Processor Conceptual Sub-model

The processing conceptual submodel is generally built to increase agro-industry's absorption capacity in small-scale, medium-scale, or large-scale (factory) processing industries. Processors require coffee bean raw materials sourced from intermediary traders. Processing capacity at these three scales...
can influence the production of processed coffee (ground or roasted). The quality of processed coffee is influenced by the quality of the raw materials, the processor's ability to carry out processing, and risk management. Accurate processing will produce coffee with a taste that consumers desire so that consumers are willing to buy it at a high price. Roasting determines coffee taste (Seninde et al., 2020). Accuracy in the coffee roasting process, starting from light roast, medium roast, and dark roast, will create a taste and aroma of coffee that suits consumers.

Good quality processed coffee will increase the price. According to Idsan et al. (2020), a production activity's added value and profits will be higher downstream. Marketing activities also play an essential role in agro-industrial activities (Adisetya et al., 2022). Rising prices and increasing consumers will encourage increased processing capacity. Consumers of processed coffee produced in Lampung Province are currently spread across the country and abroad (Europe, America, Asia, and others). Increasing processing capacity will increase the need for raw materials for coffee beans at the farmer level. Therefore, raw material providers and processing places must collaborate (Supratman et al., 2020). The coffee agro-industry development requires consistent production and quality from the upstream side (raw material provider/farmer sub-model and intermediary/collector sub-model) and increased processing capacity on the downstream side (processor sub-model). This condition will increase the coffee agro-industry absorption capacity in Lampung Province. Agro-industry absorptive capacity is the industry's ability to optimize the use of raw materials (coffee beans) in its processing in order to meet market demand (Rosiana et al., 2019). The agro-industry's absorption capacity will be higher if more raw materials (coffee beans) are needed for processing. This condition will increase the coffee processing industry's ability to expand the market to increase coffee agro-industry added value. Lampung robusta coffee has been included in the Geographical Indication (GI) list so that this product adds strength to the agro-industry development in this region. The processing sub-model can be seen in Figure 5.

**Figure 5. Processor Sub-model**

Information:
- Causal relationships are Reinforcing (R)
- Causal relationships are non-Reinforcing (R)

**CONCLUSIONS**

The coffee agro-industry development model in Lampung Province is structured based on three sub-models: the raw material provider or farmer sub-model, the intermediary trader sub-model, and the
processor sub-model. Quality is a connecting variable in each formed sub-system. The coffee beans quality produced by the farmers is obtained from superior seeds, cultivation activities, post-harvest handling, and farmers' skills in managing risk. This condition encourages increased profits so that farmers are motivated to cultivate coffee. At the collecting trader level, the risk faced is price risk, which is influenced by the quality of coffee beans purchased from farmers. Intermediary traders also face the risk of market uncertainty. Skills in managing coffee beans and risk management will determine the market and thus influence the profits of intermediary traders. At the processing level, quality raw materials will improve the quality of processed coffee and increase prices and profits. Processing capacity is an essential factor in agro-industry development in this sub-system. The volume of processed coffee production will be greater if the processing capacity is more significant, so the coffee agro-industry absorption capacity in Lampung Province will also increase. Therefore, improving the quality and continuity of raw materials, increasing processing capacity, and increasing the skills of involved actors (farmers, intermediary traders, processors) must be the focus in developing the coffee agro-industry in Lampung Province.

References


Coffee Agro-industry Conceptual Model …


