A Model of Development Gambier Farming in Pakpak Bharat Regency Based on System Thinking Approach

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Abstract: Gambier farming is the main plantation business in Pakpak Bharat Regency. From a macro perspective, gambier is a national strategic commodity that is widely exported to India and Europe. At the farmer (producer) level, the problem of gambier farming is a farming itself where there are still many problems such as quality of gambier, trade chains, commodity prices, and management strategies in addition to policies. The development of gambier farming is a complex, dynamic, and stochastic problem. Therefore, a systems thinking approach that is cybernetic, holistic, and effective in character is needed in order to obtain a comprehensive and sustainable solution. The demand for gambier continues to increase and the potential of the region promises a prospect for a farming business that can provide income to the community so that welfare can be achieved. However, the low productivity of gambier farming in Pakpak Bharat Regency has not been able to keep up with demand by managing the existing potential. The gambier farming business that is carried out should aim to improve long-term welfare, so that its development efforts must towards the economy and business sustainability orientation. This research was conducted to understand the phenomenon of gambier farming developed in Pakpak Bharat Regency, which aims to build a gambier farming model with a systems thinking approach. The systems thinking approach is used as a research methodology because it can provide an understanding of the relationship between structure and behavior in a system. With this understanding, effective strategy and policy designs can be made for the development of gambier farming. The results showed that the development of gambier farming was oriented to economic aspects, social aspects, and environmental aspects. Gambier farming development system thinking is based on existing market opportunities, farmers have limitations in providing dry latex production continuously. Limited production capacity is the main constraint due to cash availability problems for farmers. Based on these things, the model developed is a generic model of gambier farming. The causal loop diagram can be seen in the existing phenomena, namely (a) gambier land and trees; (b) production capacity; (c) production; and (d) household economy. Increasing community income can be pursued through development initiatives in gambier farming, including: land conversion, technology improvements to increase production capacity, and increase in other incomes that are still based on gambier farming.

1 INTRODUCTION

Gambir is one of Indonesia's plantation commodities whose main market is exports. According to BPS (2019), Indonesia's gambier exports in 2018 reached around 18,000 tons with a value of US$ 50 million. As the most important exporting country, Indonesia controls more than 80 percent of the gambier market share in the world (Evalia et al., 2012; Sidik & Apriani, 2019). India is the main export destination in addition to Bangladesh, Japan, Malaysia, Pakistan, Singapore and several other countries.

The volume of gambier exports to India reaches 90% of the total export volume of Indonesian gambier. This condition causes a very high dependence on one market which weakens Indonesia's bargaining position in global gambier marketing and on the contrary greatly strengthens India's dominance in the world gambier trade

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(Manalu & Tri, 2019). India's strong bargaining position does not only apply to the trading of gambir derivative products in the global market, but also in purchasing and determining the price of gambir at random from the community.

In Indonesia, the main producer of gambier is West Sumatra, which supplies about 90 percent of Indonesia's total production. From the publication of BPS (2019), gambir is also cultivated in several other provinces, namely North Sumatra, Riau and South Sumatra. The gambier producing center in North Sumatra is Pakpak Bharat Regency which is spread out in Sitellu Tali Urang Jehe District, Salak District, Kingdom District and Pergetteng-getteng Sengkut District (Sebayang, 2019).

According to Ermiati (2004), although gambier farming is profitable, it does not necessarily improve the welfare of farmers' lives when viewed from the analysis of the feasibility of gambier farming. Several studies illustrate that there are several problems related to gambier farming, causing the gambir commodity business to not develop either in terms of increasing farmers or regionally. According to Asben (2008), the problems faced in the exploitation of gambier commodities are 1) the quality of gambier is low and the amount of loss in processing that requires quality improvement, 2) the long trading chain and dominated by outsiders (Singapore and India), 3) bargaining position low farmers where there is no guarantee of a stable price at a level that benefits farmers, 4) lack of international market information regarding the real price of gambier, 5) the habit of mixing gambier with other ingredients so that the selling price is lower, and 6) the role of local government limited.

The main problem of gambier today is the low productivity and quality of the product, as a result of the cultivation method and postharvest/processing processes that are not optimal and the lack of technological support (Sa'id et al., 2010). The closing of price information, the position of gambier farmers who are forced to sell gambier because they are in debt to traders, and the dominance of collector traders who are extensions of gambier exporters have resulted in the low bargaining position of farmers (Dhalimi, 2006).

Besides that, the authority of exporters in determining the domestic price of gambir, which tends to consider the demand quota of export destination countries compared to international prices of gambier (Dhalimi, 2006) also strengthens the notion that the gambier market is inefficient, especially with the variety of quality and quality of gambir products produced by farmers due to problems. in the processing of gambier, also contributes to the pricing system carried out by traders.

Evalia et al. (2012) stated that the main weakness in the development of gambier commodities is the absence of local government strategies and policies contained in regional laws and regulations to support the development of gambier agroindustry. Capital problems also have an impact on people's technological capabilities which affect the quality of their gambier products. The conditions and areas of the extraction (compression) process to produce gambier to traditional handling have caused the quality of gambier products to not be controlled properly (Atman & Misran, 2015).

The complexity of the gambir problem based on the study also occurs in the development of gambir farming in Pakpak Bharat Regency so it needs to be solved comprehensively with a systems approach not with partial or reductionism solutions with reasons or considerations that the cause of the problem is not single and not simple, but complex and complicated. because it deals with many factors that influence each other and many actors are involved in the system (Trauger, 2009; Verzijl & Dominguez, 2015). The system approach in question is an approach with regular stages starting from problem identification, problem formulation, system identification, system modeling, computer program creation, model verification, and implementation, to the evaluation stage (Avianto, 2017; Sterman, 2000; Suryani et al., 2020).

The modeling is carried out on the premise that whether or not the development of gambir farming in Pakpak Bharat Regency is closely related to community readiness factors, natural and environmental resource factors, government policy factors, marketing factors, and other factors (Andhika, 2019).

2 LITERATURE REVIEW

2.1 Gambir Commodity and Its Development in Pakpak Bharat

Gambir is one of the Indonesian people's plantation commodities that has high economic value and has commercial prospects in the future considering its various uses. The term gambier is not only used as a plant name, it is also a trading name for products produced by plants, leaf extracts, and young branches of the gambier plant. In Indonesia, gambier has lived in a golden age and has become a leading commodity.

At the beginning of the 19th century, gambier had become one of the commodities traded in Europe (Putri, 2013). After World War II, gambier is no longer an important export product traded on the international market.

Furthermore, the information on the development of gambier plantations in Indonesia is not very clear. Currently in Indonesia, West Sumatra is the center of gambier production, moreover gambier is also known as a typical plant of West Sumatra. Most of the gambier is produced by small cottage industries with traditional tools and uses more manpower. Gambier is cultivated and processed unique, so the development of gambier plants is complicated.

However, the development of gambier in Indonesia, especially in Pakpak Bharat Regency, North Sumatra in the future is still quite promising, considering its various uses and Indonesia's role as a major world producer (Atman & Misran, 2015; Banurea, 2012). Along with all these supporting factors, there are many challenges and obstacles in the development of various aspects of this commodity. Furthermore, intense participation of stakeholders; government, farmers, researchers, investors, and traders in the management of cultivation, processing, trading, and institutional techniques are needed (Sidik & Apriani, 2019). Thus, it is hoped that gambier will turn into a leading commodity in the future (Fauza, 2014).

Aswardi et al. (2010) found that the gambier agro-industry process using the traditional system through chopping before boiling resulted in a higher yield of gambier sap than without chopped but had a lower-catechin content. Traditional processing activities and lack of attention to hygiene and purity aspects make improvements and development of the gambier agro-industry very necessary so that the content of important compounds in gambier is not lost in the extraction process.

This can be done through the development of an integrated gambier refining industry so that the quality produced is uniform and a wafer block gambier is obtained that meets SNI standards or gambier products that are by the needs of the export market (Gumbira- Sa'id et al., 2010). On the other hand, the use of gambier as an industrial raw material can be seen through the utilization of all parts of gambier as an economic source. The utilization of gambier as a source of income for farmers will be more profitable if processing activities are not only limited to semi- finished gambier production or processed into other derivative products that have a higher economic value.

Gambir as one of the people's plantation commodities is the leading commodity of Pakpak Bharat Regency which supplies 80% to 90% of North Sumatra's gambier production (Sebayang, 2019). Indonesia has positioned itself as the largest supplier for dozens of export destination countries (India, Pakistan, Bangladesh, Singapore, Japan, Malaysia, Vietnam, South Korea, Nepal, Turkey, Sri Lanka, China, Saudi Arabia, Taipei, United Arab Emirates, Thailand, and America). Union). However, farmers who depend on gambier cultivation and agro-industry have not yet obtained maximum results. In gambier development activities, several problems often arise, namely those related to problems of capital, marketing, cultivation, and processing (Asben, 2008; Dhalimi, 2006; Evalia et al., 2012).

The problem of capital is related to the position of farmers who have not formed an institutionalized group and the absence of a capital institution that can guarantee gambir farmers so that farmers tend to rely on their capital. Marketing problems are related to the low bargaining position of farmers where there is no guaranteed stable price at a level that benefits farmers, the attachment of farmers to traders due to debt, and the gambir market structure which causes a long marketing chain and is dominated by outsiders (Singapore and India) and lack of information. international market regarding the real price of gambier. Cultivation problems are related to the low knowledge of farmers, the presence of superior seeds that have not been identified so that the seeds used are hereditary seeds, and the absence of maintenance and fertilization activities in gambier cultivation. Processing problems are related to traditional processing and the habit of mixing gambier with other ingredients so that the quality of gambier is low and the selling price is lower.

The low quality of gambier and the habit of mixing gambier with other ingredients are closely related to aspects of technological limitations in the development of gambier processing agroindustry. The quality of gambier which is an absolute requirement to compete in the international market requires special attention through technological improvements in the gambier production process in gambir agroindustry SMEs (Sa'id et al., 2010). The development of industrial-oriented gambier products (catechins and tannins) must be supported by institutions so that the gambir produced is by the SNI issued by the government (Nasution, 2015).

Apart from improving technology for the production process, improving the quality of gambier is also closely related to raw materials and is supported by a good evaluation and reporting system

(Sa'id et al., 2010). On the other hand, it is also hoped that the implementation of various strategies from the results of studies on gambir development, such as expanding the gambier market and increasing the added value of gambier to increase local government income and farmers' income from gambir export trading activities (Sa'id et al., 2010).

Another important aspect that needs to be improved in developing gambier as a leading commodity is the aspect of institutional development for the sake of improving marketing development (domestic and export), product development, improving the quality of human resources, and handling capital problems (Nasrul, 2017; Nasution, 2015). Institutional support is expected to be able to solve the problems of gambier farmers with good coordination and equitable distribution of information to increase the bargaining power of gambier farmers.

2.2 Basic Concepts of System Thinking

The system is a collection of several elements or components that are interrelated and organized with each other to achieve a goal in a complex environment (Suryani et al., 2020). This understanding reflects the existence of several parts and the relationship between parts and shows the complexity of the system which includes cooperation between parts that are interdependent with each other (Marimin, 2005). While the systems approach is defined as a problem-solving methodology that begins by tentatively defining or formulating goals and the result is an operating system that can effectively be used to solve problems (Bala et al., 2017). According to Sterman (2000) a systems approach will work well if the following conditions are met: 1) The purpose of the system is well defined and can be recognized if it cannot be quantified; 2) The decision-making procedure in this system is decentralized or has fairly clear boundaries; and 3) In the long term planning is possible.

Maani & Cavana (2000) mention: System Thinking (ST) is an emerging discipline for understanding complexity and change. This complexity underlies business, economic, scientific, and social systems. ST has three dimensions: paradigm, language, and methodology. So according to Muhammadi et al., (2001) the conclusion is that systems thinking is an approach to thinking that looks at the problem as a whole where the events in it interact with each other. Paradigm is a way of thinking about describing dynamic relationships that affect behavioral systems; the language used in systems thinking: as a language, systems thinking is equipped with tools to understand the complexity and dynamic decision-making, while the methodology, in this case, is a set of modeling and learning technologies used in System Thinking. Modeling will be used to understand the structure of a system, the interconnections between components, and show how changes in one area will affect the entire system and all of its constituents over time.

The system thinking methodology uses a set of modeling and learning technology modeling tools consisting of Causal Loop Diagram (CLD); computer simulation, stock & flow diagrams (S & F Diagrams), and Learning Laboratory (Lab.) The analytical methods used are CLD and computer simulation with VENSIM software, wherewith these two instruments it is possible to produce key variables, key variables behavior, relationships between variables, dynamic behavior in CLD, identification of the main cause pattern, identification of leverage points and developing intervention strategies. VENSIM model simulation software is a visual modeling tool that allows to conceptualizing, documenting, simulating, analyze, and modelling expectations of dynamic systems (Avianto, 2017).

2.3 Causal Loop Modelling

2.3.1 What is Causal Loop Diagram?

Cavana & Maani, (2000), states that: A causal loop diagram (CLD) is a tool for revealing the causal relationships among a set of variables (or factors) operating in a system. The basic elements of CLDs are variables (factors) and arrows (links). A 'variable' is a condition, situation, action, or decision which can influence, and can be influenced by other variables. A variable can be quantitative (measurable) such as profit, productivity, or absenteeism, or it can be quantitative (soft).

According to Muhammadi et al., 2001, CLD or feedback diagram is the disclosure of causal relationship events into certain picture language. The figure is arrows that intertwine, thus forming a feedback diagram (causal loop), where the head of the arrow reveals the cause and the tip of the arrow reveals the effect. Both elements of cause and effect, or one of them (only cause or effect) must refer to a measurable situation, both qualitatively for the perceived state and quantitatively for the real situation (actual). It must be remembered that logic is a process (rate) as a cause that produces a state (level) as an effect, or vice versa, information about a state

as a cause produces an influence on the process as a result.

2.3.2 CLD Basic Elements

The basic elements of a CLD consist of:

a. Variabels (factors)

A Variable is a condition, situation, action, or decision that will affect, and can be influenced by other variables. A variable can be quantitative data, such as profit, productivity, or worker absenteeism; or it can be in the form of qualitative variables, such as motivation, public trust, reputation, and so on.

Quantitative variables are variables that can be calculated and measured, while qualitative variables are variables that are generally difficult to measure directly. In more detail, Ward & Audrey grouped variables into the following three types of variables, namely: (1) hard variables; (2) soft variables, and (3) performance measure variables. Hard variables and soft variables relate to quantitative and qualitative variables, while performance measure variables relate to performance, such as average population growth, cost and performance ratios, market share, and financial and operational ratios.

b. Arrow

The arrows indicate a direct causal effect (causal relationship) between the two variables. Each causal relationship is marked with the polarity of the relationship, positive (+) or negative (-) to indicate the nature of the influence that strengthens the relationship or shows a sign of balancing between a relationship (Cavana & Maani, 2000).

2.3.3 How to Compile CLD

Sherwood (2011) states that there are 12 rules in drawing a good CLD, namely: 1) Know your boundaries: One of the benefits of systems thinking is that encourages a holistic view, taking everything of relevance into account; 2) Start somewhere interesting; 3) Ask “What does this drive?” and “what is this driven by?”; 4) Don't get cluttered, don't fall in to analysis trap of burrowing down to ever deeper levels of details; 5) Use nouns, not verbs; 6) Don't use terms such as “increse in” or “Decrease in”; 7) Don't be afraid of unusual items; 8) Do the SS and the OS as you go along; 9) Keep Going; 10) A good diagram must be recognized as real; 11) Don't fall in love with your diagrams; and 12) No diagram is ever “finished.

2.3.4 Archetype Diagrams

Archetype can be interpreted as the most important empowerment, and the potential in systemic thinking is due to a certain pattern of systemic structure that appears repeatedly in the lives of individuals and organizations. This generic archetype aims to recondition our perceptions to be better able to see the structures at play and see the levers in them. Archetypes are formed from the basic building blocks of the system, namely the strengthening process, balancing process, and delaying process. Maani & Cavana, 2000 mentions that System Archetypes are generic systems models or templates that represent a wide range of situations. Systems archetypes provide a high-level map of dynamic processes. Using the analogy of language to illustrate systems thinking, we can say that while variables are 'words' (building blocks) and pairs of variables (and the connecting arrows) are sentences, causal loop are stories, and systems archetypes are common phrases.

So it can be concluded that the basic pattern of the system is a simple model that is very effective in understanding the structures or patterns of behavior that exist in the system, making it easier to find the leverage or leverage needed.

2.4 Modelling Concept

The model is a representation of the system. In developing a model, it is necessary to have knowledge of the basic concepts of modeling which learns how to make the model as shown in Figure 1.

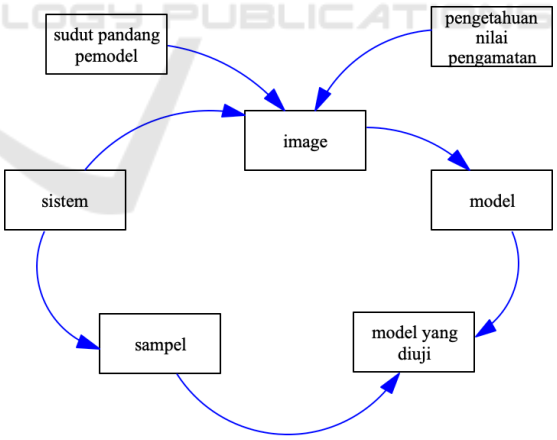

Figure 1: Model development process.

It can be seen in Figure 1 that the first thing observed in the modeling process is the system. There is a problem in the system. Then the problems that exist in the system will be observed by a model maker and will form an image. Everyone who views a system will have a different image depending on knowledge, values that will be formalized using a

very structured language, can be in the form of mathematical equations and can also be in the form of diagrams, so that a model is created. According to (Andhika, 2019; Saeed, 2014; Suryani et al., 2020), the model made by the model designer needs to be tested to see the level of model validity. The model is tested using sample data taken from the actual system.

3 RESEARCH METHODS

This study uses a descriptive method with a qualitative approach because it requires an understanding of the phenomena that occur in the development of gambir farming in Pakpak Bharat Regency, especially in Pergetteng-getteng Sengkut District in February 2022. In addition, it is necessary to understand the extent of the management of gambir farming for traders and policymakers. The scope of this research is the phenomenon that exists around gambier farmers directly.

Data collection techniques using interviews and observation. Interviews were conducted with unstructured personal interviews with gambier farmers. Observations were made on every behavior and activity of the gambir farmer business actors, seeing the daily activities carried out by the informants at a certain time during the research, listening to what was said, and inviting informants to provide information as it was. Document studies are carried out by studying literature, applicable laws and regulations, Strategic Plans, and various documents from relevant agencies such as the Department of Agriculture and the Planning, Development, Research, and Regional Development Agency.

Data analysis using causal loop diagram (CLD) by following the process as follows:

a. Problem identification is done by observing environmental factors that influence directly or indirectly in the management of gambier farming;

b. Determining the choice of the basic system pattern or Archetype, namely the Limit to Success (Growth) Archetype pattern, considering that gambir farming activities at a certain point will experience growth inhibition due to various reasons;

c. Designing CLDs. After obtaining the relationship between various variables with gambir farming, a Loop diagram was drawn up using the Vensim application program, based on the guidelines put forward by Sherwood (2011) as explained in the description of the literature review used in this study.

4 RESULTS AND DISCUSSION

Gambir (Uncaria Gambir Roxb) is one of the leading commodities specifically for North Sumatra, especially the Pakpak Bharat Regency to export markets. As an export commodity, gambier contributes to the GRDP of North Sumatra through the contribution of the plantation sub-sector. Gambir is a people's commodity and is the main source of income for farmers at the production center, namely the Pakpak Bharat Regency. To increase the income of gambier farmers, the attention and guidance of the government are mainly directed at the subsystem of production and processing of products by facilitating various production facilities. The aim is to increase production so that the value of exports increases. Gambier exports are mainly to India, Pakistan, Singapore, Bangladesh, Taiwan, Germany, Japan, and others (Dhalimi, 2006; Sa'id et al., 2010).

The prospect of developing gambier plants on a large scale and agribusiness-oriented is still very open. Several factors that support this are: (1) Indonesia is the world's main exporter of gambier and most of it comes from North Sumatra; (2) Indonesian gambier farmers have experience in cultivating gambier; (3) Return on business investment is not so long; (4) Plants are tolerant of marginal land and slopes; (5) Gambier products are not easily damaged even though they are stored for a long time; (6) This plant can be harvested sustainably and has a long life; (7) The need for gambier is always increasing, and (8) There is a tendency for people to use natural ingredients (herbs) in industrial products.

The gambier plantation business and the processing of its products are an inseparable series of activities, and are not like other smallholder plantation businesses. In general, gambier farmers carry out activities ranging from land clearing, nurseries, planting, maintenance, and harvesting, as well as acting as product processors to produce gambier products that are ready to be sold. The main problems are: (i) Low productivity and product quality; and (ii) The gambier market is dependent on exporters (Asben, 2008). This is partly due to the absence of conventional cultivation techniques and the absence of micro and small-scale processed product industries. The usefulness of gambier content is needed in the pharmaceutical, cosmetic, paint, leather, traditional food and other industries. This shows the prospect of Gambir is very good.

Gambier plant is a plant that grows well in the fields that spread in Pakpak Bharat Regency. At first, people used the gambier plant as medicine. In the last twenty years or so, the community has processed

gambier leaves into dry sap as an ingredient for mixing betel nut (betel nut is a habit of several tribes in North Sumatra, including the Karo and Pakpak tribes). The use of gambier in that era was still limited to local where most were sold to the Karo area. Gambier farming business is growing in line with the increasing demand for gambier both for domestic and foreign use. The use of gambier is increasing, such as the need for raw materials for the pharmaceutical industry, tanneries, the confectionery industry and others (Suharman, 2018). The expansion of the gambier concession area is increasing from year to year.

Gambier business in Pakpak Bharat Regency is mostly found in three sub-districts, namely Sitellu Tari Urang Jehe District, Kingdom District, and PGGS District. For some residents, gambier farming is the main source of household income (Sebayang, 2019).

Hosen (2017) mentions that the cultivation techniques carried out by farmers ranging from nurseries to the processing of gambier sap are generally simple. Seeds are used carelessly without selection from several varieties of parent trees that are not well maintained. The mother tree is in the gambier area. Some farmers have implemented nurseries for commercial purposes only to meet their own environmental needs.

In general, the managed agricultural land is own land, with average ownership of 0.5 – 1 ha per household. Generally, agriculture is multicultural where there are plants other than gambier on the same land. On average 70-80% are planted with gambier and the rest are forest plants such as durian, rubber, petai, jengkol, and others. This is because the land was originally a forest that was cultivated into agricultural land (Banurea, 2012).

Although farmers have ownership rights to gambir land, generally the land does not have a land certificate so land boundaries are often unclear between cultivated land and forest. The absence of a land certificate also causes land assets cannot to be used as a source of capital because they do not have legal force. The majority of gambier farmers in Pakpak Bharat Regency have low education and are at the age of 30 years and over. Gambier farming is managed by the nuclear family, especially the father and mother. Farmer's children help after school activities are over. Families who try to farm gambier generally pass the business on to their children.

For the farming community, the origin of gambier farming is less known. However, gambier farming was inherited and developed because of the ease of planting, maintenance, and the suitability of the topography of the soil. Gambier cultivation is still relatively traditional where there is no system of seedling, fertilization, and irrigation. The seeds used by farmers come from cuttings, namely branches of existing gambier trees, taken and then planted directly on land that has been processed. Maintenance of plants is enough to gogo or clear the land of weeds/nuisance plants, which is usually done twice a year where the use of fertilizers or compost is rarely applied.

Gambier plants which are classified as shrubs mean that these plants can grow well in steep or hilly areas. This is an advantage for farmers in Pakpak Bharat because the type of area that is steep, steep and hilly does not become an obstacle in developing gambier. Gambier plants also do not require high water content so that even though the area is hilly, plants can develop well without watering.

Gambier plant products are marketed in 3 forms, namely leaves, wet latex, and dry latex (Tinambunan, 2008). Furthermore, the results of Tinambunan's research stated that the form that has the most profitable economic value is dry latex. The decision to sell or process the leaves into sap is still very much dependent on the market situation. When there is a demand for leaves, farmers prefer to sell the leaves rather than processing them. This is because there is a long process until the leaves become sap. By selling leaves, farmers are faster to earn money. In addition to economic and market factors, farmers also have other considerations, when selling leaves, farmers have the opportunity to do other jobs. In this case, processing leaves into sap is considered a tedious and time- consuming job and the income earned is lower when compared to doing other jobs. In this context, cultural factors are one of the reasons why farmers prefer to sell leaves rather than processing them into sap.

Gambier sap is produced with the aim of being exported and a small portion (5%) is marketed domestically. Gambir marketing is quite smooth, there is no unsold gambier. Gambier exports fluctuate from year to year, this depends on the availability of production. The gambier plant is quite prospective because of its many benefits and the development of various industries such as the cosmetic, medical, and other industries that require chemical content from gambier as auxiliary materials such as leather tanning, batik dyes and others. The prospect of gambier commodity marketing is quite bright, it is necessary to strive for improvements in cultivation, processing, quality and marketing strategies. Besides that, there is still wide open research on the diversification of the use of gambier. This is very

important so that this commodity has a comparative and competitive advantage in international trade (Sa'id et al., 2010).

Gambir prices fluctuate from month to month. There are times when the price of gambier is quite profitable for farmers at a price level above Rp. 25,000/kg which usually occurs in July and August. In certain months, usually in January-March the price of gambier falls below Rp. 20,000/kg and at such a price level is not profitable for farmers. Many farmers are trapped in the 'bondage' system in gambier marketing. These farmers are tied to collecting traders in the Nagari/village to make ends meet, where farmers have borrowed money before harvesting. They were forced to sell their produce to the merchant. This makes the bargaining position of farmers weak and the price received by farmers is relatively low compared to the price it should be. Other farmers who can afford it, they can sell freely to collectors at a price and quality according to the trader's request (whether mixed 50% or 30%).

Wet sap is accommodated by farmers or local agents which is then processed into dry sap. The dry sap that the agent can accommodate is an average of 100 tons per month. The dried sap is then sold to wholesalers in Medan for export abroad. Gambier farmers in Pakpak Bharat Regency who are productive, earn income from gambier farming >Rp 20 million/year. The income is used mainly for household needs and generally has not been allocated for farming development. From observations in the field, productive gambier farmers can have a decent life and are able to compete with farmers who cultivate other crops. Some of the farmers interviewed were even able to send their three children to college with income derived from gambier farming (Banurea, 2012).

4.1 CLD Analysis

CLD modeling is done using VENSIM software as a tool to describe CLD. The process is as below:

a. Identification of CLD variabel variables

Based on environmental scrutiny described above and various literature studies, it can be concluded that several variables are very influential on the management of gambir farming. These environmental factors are transformed into value-free variables but have a certain behavior pattern, namely if the variable changes it will affect other variables according to the behavior pattern.

The selected variables in the CLD modeling of gambir farming are at least 21 variables, namely: gambier land, gambier trees, leaf production, income from selling leaves, gambir farming income, income, income from gambier land, non-gambir land, land conversion, income from sales of wet sap, production of wet sap, production of dry sap, income from sales of dry sap, plant maintenance, production capacity of wet sap, production capacity of dry sap, other income, planting of seeds, production expenses, household expenses and cash.

b. Application archetype limit success (growth)

From the variables mentioned above, one reinforcing feedback and one balancing feedback can be drawn, as can be seen in Figure 2.

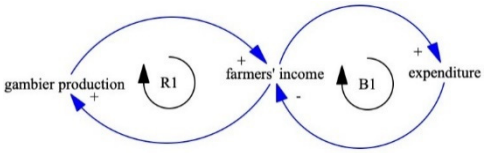

Figure 2: 3rd Archetype Pattern, limit to grow.

Figure 2 shows that the higher the income of farmers, the higher the production of gambier, where this becomes a reinforcing feedback, namely higher the income of farmers, of course, the expenditure will also be greater, but it will reduce the income of farmers so that the higher the expenditure will reduce the income of farmers, which can be caused by many things. This situation becomes a balancing feedback, namely feedback that limits the growth process. This condition will cause a behavior graph / Behavior Over Time (BOT).

4.2 CLD Modelling

The following problems were found based on aspects of cultivation, processing, and marketing of gambier farming (Banurea, 2012), namely:

1. Cultivation aspects include: a) relatively scattered cultivation locations, in the hills, transportation accessibility is relatively difficult; and b) relatively low crop productivity (rarely or even no fertilization or other maintenance).
2. Processing aspect includes processing technology that is still traditional, resulting in low quality and yield of dry extracts and high time required, especially in the processes of deposition, draining, and drying which still depend on the sun's heat.
3. Marketing aspects include: a) a relatively long marketing chain resulting in depressed selling prices at the farmer level; b) farmers sell their produce for immediate funding needs for household expenses/living needs; c) the absence of institutions at the farmer level that

accommodates farmers' products, causing the bargaining position of farmers to be low (farmers are in the position of "price takers"); and d) accessibility to price information and a low level of price certainty.

From these various problems, the main focus in the model is how to develop gambir farming properly. While market opportunities exist, farmers have limitations in providing continuous production of dry latex. Limited production capacity is the main constraint due to cash availability problems for farmers. Based on these things, the model developed is a generic model of gambir farming

Based on the above variables and the interrelationships between variables, the following is the CLD model for gambir farming in Pakpak Bharat Regency, especially in Pergetteng-getteng Sengkut District.

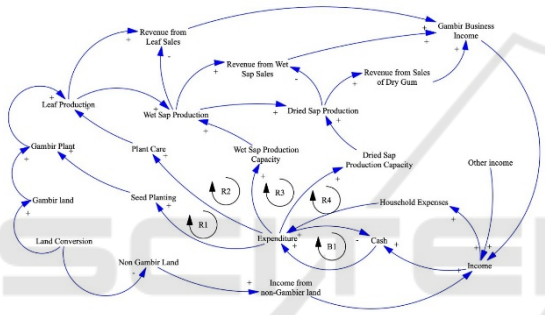

Figure 3: Modeling of Gambier Farm CLD.

The interaction of the various variables resulted in five feedback loops, of which there were 4 positive feedback and 1 negative feedback. The explanation of the five feedback loops is as follows.

Loop 1 is a positive loop and has reinforcing properties (reinforcing=R1). Loop 1 connects the land and trees sub- model, production sub-model, and economic sub-model. Land conversion in the sense of land expansion for gambier farming causes the availability of land for the addition of gambier trees. However, the addition of trees is affected by the availability of funds for seedlings. The more funds available for seedlings, the more trees may be added, resulting in land conversion. However, if seed funds are not available, land conversion is not possible. Land conversion causes expenses to increase due to funds allocated for the purchase of seeds and reduced income from other plants that were previously on the land.

Loop 2 is a positive loop that connects the production sub-model and the economic sub-model. In increasing crop productivity, maintenance in the form of fertilization, composting, and land clearing is necessary. The more sufficient maintenance, the higher the level of productivity. However, the level of maintenance is strongly influenced by the availability/allocation of funds to purchase fertilizers, composts, herbicides, pesticides and land clearing costs. The more maintenance funds are available, the productivity increases, which in turn will have an impact on increasing income. On the other hand, the greater the income, the higher the effect on expenses. Costs allocated for maintenance will add to expenses.

Loop 3 is a positive loop that connects the wet rubber production capacity sub-model with the economic sub-model. The higher the wet sap production capacity, the higher the production. Increasing the capacity of wet sap requires funds so there must be investment in its addition.

Loop 4 is a positive loop that connects the dry latex production capacity sub-model with the economic sub-model. The higher the production capacity of dry latex, the higher the production. Increasing the production capacity of dry latex requires funds so there must be an investment in its addition. The funds allocated for the addition of dry latex production capacity will increase spending.

Loop 5 is a negative loop contained in the sub-economic model. This loop connects income and expenses. In this loop, it can be seen that the greater the income obtained from the sale of gambier, the allocation for expenditure can also be greater. However, the greater the costs required for expenses, the more the income that has been obtained will be reduced. Thus, this loop has the property of balancing (balancing=B1) in achieving goals (goal-seeking).

5 CONCLUSIONS

5.1 Conclusions

The results showed that the development of gambir farming was oriented to the economic, social, and environmental aspects. Gambier farming development system thinking is based on existing market opportunities, farmers have limitations in providing dry latex production continuously. Limited production capacity is the main obstacle due to cash availability problems for farmers.

Based on these things, the model developed is a generic model of gambir farming. The feedback loop diagram (causal loop diagram) can be seen in the existing phenomena, namely (a) gambier land and trees; (b) production capacity; (c) production; and (d) household economy. Increasing community income can be pursued through development initiatives in

gambier farming, including: land conversion, technology improvements to increase production capacity, and increase in other incomes that are still based on gambier farming.

5.2 Suggestions

Some suggestions for further research are (1) the need for additional variables obtained in observing phenomena such as price fluctuations, farmers' capacity in farming, markets, farmers' finances, the economics of gambier plants, and other forms of gambier derivatives that can be traded at the farmer level. ; (2) it is hoped that further research related to the validity of the data from farmer interviews, such as production data, is assumptive; and (3) so that the resulting model can resemble the existing phenomena, the results of this system thinking need to be continued with model simulations with a system dynamics approach.

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