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Challenges in the Development of Porang Tuber Processing Industry with the Fishbone Diagram Approach

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Abstract Wonogiri Regency is one of the porang tuber-producing areas in Central Java, Indonesia, but the porang processing industry has not developed in the area. Various obstacles are the factors causing the underdeveloped porang processing industry so that the added value of processed porang is not enjoyed by the farmers. These various obstacles need to be studied more thoroughly to determine the solutions. The empirical research study was carried out in Wonogiri Regency. The research respondents were porang farmers, traders, processing industries inside and outside Wonogiri Regency, and government officials. Data were analyzed using a fishbone approach. This study has identified five challenges: market, production, technology, human resources, and government policy. The most significant obstacle is the monopsony market, which is difficult for farmers to penetrate. Limited access to market and price information makes it safer for farmers to sell porang in tuber form. The uninterrupted availability of porang tubers and limited supply from other regions have prevented the processing industry from achieving an economic production scale. Porang contains oxalic acid, which has to be removed with a particular technology. The technology for separating glucomannan contained in porang tubers has not been mastered by farmers, even though this glucomannan has a high economic value. On the other hand, porang tuber is not a strategic food priority so local government policies do not prioritize developing the porang processing industry.

Keywords Monopsony, Supply, Access to Information, Price

1. Introduction

Porang (*Amorphophallus muelleri* Blume) is an endemic plant that belongs to the family Araceae or tubers [1]. This plant is found in the tropical regions of Asia and Africa [2]. In Indonesia, porang is cultivated on Java Island and thus this plant is known as "Javanese Mukago Konyaku" in Japan [3]. The original habitat of this plant is the forest. This plant has unique characteristics, with bulbils or tubers in the branching petioles [4]. Porang can grow at an altitude of 0-700 meters above sea level and prefers shade with a cover of 50-60%. This plant produces tubers with a very high glucomannan content, a polysaccharide compound with high fiber content, which makes it used as a gelling agent. In addition to its ability to form gels, glucomannan has great swelling power and high viscosity [5]. Based on the characteristics of glucomannan, the food, textile, paper, and cosmetic industries utilize it as a raw material. The content of glucomannan in porang is quite high, which

ranges from 50-70% [6].

The high economic value of glucomannan makes it very potential for export [7]. The export volume of Indonesian porang has increased by 40.19% since 2017, with porang production reaching 11,200 tons in 2019. Countries with the highest number of importers are China, Thailand, and Malaysia [8]. Porang plants can be found in several regions of Indonesia, starting from Java, Sumatera, to Sulawesi [9]. One of the locations for the development of porang cultivation is Wonogiri Regency, Central Java Province. This commodity is developed by farmers in several sub-districts, which are the production centers both in open land and production forest areas belonging to Perhutani (Perusahaan Umum Kehutanan Negara/State Forestry Public Company) [8]. Based on the regulation of the Minister of Agriculture (Peraturan Menteri Pertanian/Permentan) No 104/2020, porang is a commodity fostered by the Ministry of Agriculture. Even though porang is widely cultivated, its processing at the farm level remains suboptimal [10]. Most of the farmers sell the commodity in the form of wet tubers. According to Santoso [11], the price of wet porang tubers is only around IDR 6,000, while the price of porang dried chips can reach IDR 40,000 per kilogram. Meanwhile, porang can only be utilized if oxalic acid is removed and converted into glucomannan. The selling price of glucomannan can reach IDR 300,000 per kilogram [10].

The porang market in Wonogiri Regency is monopsony, where most of the farmers' crops are purchased by Asia Prima Konjac in Madiun Regency, East Java [8]. Farmers receive income from the sale of porang tubers. Limited information causes farmers to sell their crops directly without further processing to increase added value. In addition, pouring processing technology at the farm level is limited. Chopper tools for producing porang chips are only owned by a small number of business actors [10]. Moreover, farmers have not been able to remove oxalic acid that causes itchy skin. In an effort to increase added value, technology plays a significant role to increase long-term economic growth [12]. The technology for processing porang tubers into glucomannan that is only owned by large companies as well as expensive processing costs and the lack of porang processing skills at the farm level are reasons for farmers not to cultivate porang tubers [8]. Furthermore, the waiting time to obtain glucomannan in porang tupeandbers is quite long, which is 20 weeks after harvest [13].

Farmers in Wonogiri Regency are enthusiastic about cultivating porang [14,8]. This is because its price is quite promising for farmers. Many farmers use part or all of the land for porang cultivation. Some of them also rend the land to expand the planting areas. If there are more farmers cultivating porang, the production will be more abundant. This condition causes the price of porang in Wonogiri Regency gradually to decrease and drop significantly. Meanwhile, the cost of cultivating porang is higher than the expenses of cultivating other commodities [15]. Farmers' dependence on the sale of wet tubers causes many farmers to experience losses when prices are quite low in the market. Farmers can only anticipate by delaying porang harvest until the price is deemed suitable because they are unable to process porang tubers into flour, which can be used as industrial raw materials. On the other hand, if not harvested immediately, porang will turn into porang seeds after being dormant [16].

About 20% of the total demand for porang exports has been met. This opens opportunities and market share to be developed [17]. However, this opportunity has not been used optimally by farmers or entrepreneurs in Wonogiri Regency. Even though Wonogiri Regency is one of the centers for porang cultivation, there has not been any processing industry in this area. Various obstacles are faced in developing porang processing industry. On the other hand, the processing industry plays an important role in increasing added value, growing the welfare of farmers, and opening up a wider market. Based on these problems, the research aims to examine the obstacles to the development of the porang processing industry in Wonogiri Regency. Identification of the obstacles encountered became the basis for analysis in formulating strategies for developing porang processing industry. The novelty of this paper is the identification of obstacles in the development of the porang processing industry. Not many researchers have studied these constraints, so the development of the porang processing industry in several countries producing porang tubers has also not been studied more comprehensively. The processing industry close to raw materials can increase operational efficiency and produce other multiplier effects.

2. Materials and Methods

The research location was determined purposively, namely in Wonogiri Regency. This location was chosen because it is one of the porang-producing centers in Central Java and there is a porang farmer association although the processing industry has not yet developed. Respondents in this study were porang farmers, porang farmer association officials, porang tuber/chip traders, porang chip entrepreneurs, porang processing companies, porang processing industries, exporters, end consumers, the Department of Agriculture and Food Security (Dinas Pertanian dan Ketahanan Pangan), and the Department of Trade, Industry, Cooperative, and SMSE (Dinas Perdagangan, Perindustrian, Koperasi, dan UMKM) of Wonogiri Regency. Respondents were collected using purposive sampling [8]. A total of 60 porang farmers in the four largest porang-producing sub-districts in Wonogiri Regency, including Karangtengah, Manyaran, Slogohimo, and Jatisrono sub-districts, were invited to be respondents. They have an area of more than 0.5 Ha. Porang/chip traders, chip entrepreneurs, processing companies, processed user industries, exporters, and end consumers were selected as

respondents by snowball sampling. Meanwhile, the respondents from the management of porang farmer associations, the Department of Agriculture and Food Security, as well as the Department of Trade, Industry, Cooperatives, and SMSE of Wonogiri Regency were taken purposively. Data collection was carried out through in-depth interviews using questionnaires, recording, and observation of the research objects [18]. Data triangulation was used to obtain valid data [15]. Data cross-checking and rechecking among respondents are very important to obtain valid data.

Data were analyzed using the fishbone diagram method, a tool for identifying some of the problems that occur in a phenomenon [19]. This method was first used and developed by a quality control statistician from Japan named Kaoru Ishikawa with the aim of investigating potential factors that cause production failure [20]. A fishbone diagram is shaped like a fishbone and used to identify each root cause of a phenomenon that is explained in each of its branches [21]. The fishbone diagram can explain every possibility that can occur from not developing the porang processing industry in Wonogiri Regency. Fishbone diagrams are used as an analysis tool compared to Pareto Chart, 5 Whys, Failure Mode and Effects Analysis (FMEA), Scatter Diagrams, Affinity Diagrams, and Fault Tree Analysis (FTA) because they are more suitable in analyzing root causes in underdeveloped industries. Determination of the root of the problem in the fishbone diagram is based on data that often arises from the respondents' answers and has gone through a triangulation process. The availability of large raw materials is not a guarantee for the development of the porang processing industry. It is necessary to identify the root of the problem. The use of a fishbone diagram can provide a comprehensive and thorough picture of the problem being investigated [22].

3. Results and Discussion

The glucomannan content in porang tubers has a high economic value, but this added value is not enjoyed by porang farmers in Wonogiri Regency. This added value is enjoyed by the processing industries or exporters [23-25]. The difference in the prices of porang, in the forms of tubers and chips, as well as flour and glucomannan, is significant [26]. The porang tuber processing industry is located outside the regency and/or province. The root causes of the undeveloped porang tuber processing industry in Wonogiri Regency need to be identified. The production of porang tubers in Wonogiri Regency is spread in almost all sub-districts. There are four sub-districts that are centers of porang cultivation production, namely Karangtengah, Manyaran, Slogohimo, and Jatisrono. The National Porang Farmers Association in Wonogiri Regency has also been established since 2019 but has not been able to leverage the development of the porang tuber processing industry.

Based on the fishbone diagram approach, the root causes of the underdeveloped porang processing industry in Wonogiri Regency are explained in each of its branches (Figure 1). Figure 1 shows five root causes, including market, production, technology, human resources, and government policies. The Triple Export Movement Policy has not been implemented because it is in conflict with several interests in the provision of staple food, especially rice. The root of problem ranking method is based on data triangulation. Data originating from porang farmers is then cross-checked with porang farmer association officials, porang tubers/chip traders, porang chip entrepreneurs, porang processing companies, porang processing industries, exporters, end consumers, the Department of Agriculture and Food, and the Department of Trade, Industry, Cooperative, and SMSE of Wonogiri Regency. Based on the results of data triangulation, it is obtained a ranking of the root causes in the development of the porang processing industry in Wonogiri Regency (Figure 1).

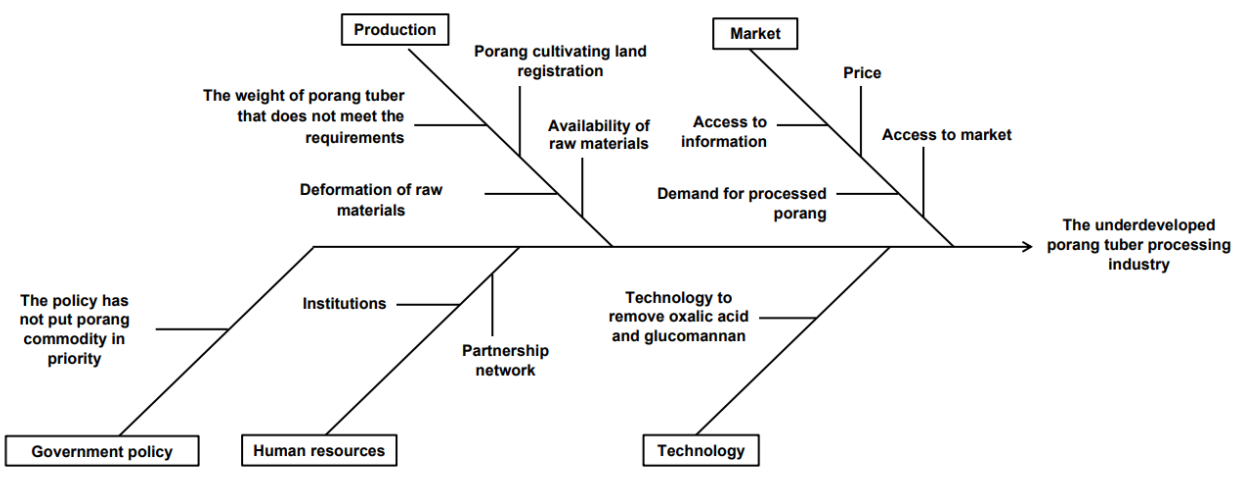

Figure 1. The root of the problems and the causes of the underdeveloped porang tuber processing industry in Wonogiri Regency

3.1. Market is the First Root of the Problems

3.1.1. Access to Market

Access to the market for porang is relatively difficult because the market is monopsony. Farmers cannot directly access the porang tuber or processed porang markets because they do not have a delivery order (DO) contract. Farmers who do not have DO contracts will sell their yield to other farmers or traders with DO with processing industries or exporters. Only farmers with DO whose products are purchased by Asia Prima Konjac in Madiun Regency, East Java, or exporters in East Java [8] and Star Indo Porang in Semarang City, Central Java. It was found that the porang production in Wonogiri Regency is only sold to these two companies, even though it goes through several marketing chains. So, a shorter marketing chain is needed for a more effective the channel [27]. Farmers or traders have DO because they are able to meet the requirements of the processing industry to supply porang tubers/chips in particular quantity and quality. The number of porang tuber processing industries in Indonesia is limited, while the porang-producing areas are almost available all over Indonesia. This is what causes the weak bargaining position of porang farmers. The number of buyers is small or there is only one market so the price of porang is determined by the buyer [28,29].

Porang processing industry centers on Java Island are Madiun Regency and Surabaya City, East Java Province [30]. The porang processing industries have contracts with exporters or importers. The exported products are chips, flour, and glucomannan. New players, either investors in the porang processing industry, traders, or exporters, find it difficult to access the export market. Importers have great trust in entrepreneurs who have existed in the market earlier than new players.

3.1.2. Demand for Processed Porang Products

The glucomannan content in porang is the main raw material for large industries, such as the cosmetic, paper, adhesive, and food industries [31]. The export trend of Indonesian porang has increased by 40.19% over the last five years. Meanwhile, in January-February 2021, the export value of porang was 1.52 million US dollars, growing 160.72% compared to the same period the previous year. In the same period, the volume of porang exports reached 965.5 tons, increasing 32.31%. The three biggest export destination countries for Indonesians are China, Thailand, and Malaysia. Even though porang exports have grown positively and significantly, currently porang does not yet have a harmonized system (HS) so it is still included in the classification of other tubers [32]. This makes porang export data not recorded properly. The market for processed porang in the country has a limited demand of only 2% of the total porang production [33]. Most of the domestic production is to meet export demand. Dependence on foreign markets becomes a boomerang for exporters if there is a market shock. This has happened during the Covid-19 pandemic until today.

Exporters have not been able to meet this demand due to limited processing industries [34]. The limitations of the porang industries have also resulted in porang tubers being temporarily suspended because farmers are unable to process them. Farmers' dependence on the porang industry ultimately harms farmers as cultivators. If the demand for processed porang is high, porang tuber production will increase at the farm level. However, because the processing industry still has limited production capacity, farmers bear the risk that their crops are not immediately marketable [35].

3.1.3. Price

Prices for porang tubers and processed products tend to be unstable [9,8]. Farmers have difficulty estimating receipts and profits from selling porang. The average price of porang tubers in 2022 was 2,500 – 3,500 IDR/kg, which was much lower than the price of the previous year in 2021, which reached 11,000 IDR/kg [17,23]. Price uncertainty causes farmers to sell when prices are favorable or delay harvesting to get a better price. On the other hand, porang tubers experience a dormant period so after the dormant period is over, the tubers will develop into seeds [1]. As a result, these tubers do not meet the requirements as raw materials for the processing industry.

3.1.4. Access to Information

Access to information regarding price standards and DO contracts in the processing industry, exporters, and importers is relatively difficult. This is consistent with the results of Santoso's research (2015) that farmers as cultivators experience limited access to information to determine porang market conditions. This condition makes it difficult for farmers to determine when to do the right harvest time to match the profitable price. Limited access to information regarding market conditions and trends in porang demand has an impact on the lack of careful planning regarding cropping patterns or whether or not land expansion is necessary. Limited access to information has an impact on farmers' strategies for meeting their daily needs [36,15]. This also has an impact on investors, making them reluctant to invest in the porang processing industry.

3.2. Technology is the Second Root of the Problems

Technology to Remove Oxalic Acid and Glucomannan

Porang tubers have a high selling value when they have been processed to produce glucomannan flour. This processing requires high technology to remove oxalic acid and produce glucomannan contained in porang tubers. Porang tubers have not been processed by farmers due to the limited mastery of technology to remove oxalic acid and convert it into glucomannan. Porang tubers cannot be eaten only by processing them by boiling or making them into flour. Oxalic acid must be removed first because it can cause an itchy throat or mouth [37]. In India and China,

removal of oxalic acid on a household scale by boiling, roasting, frying and adding certain ingredients in various ways [38]. The porang tuber processing into glucomannan requires high technology so the investment costs are significant [8]. The use of high technology and large investment costs make investors reluctant to invest in the porang processing industry.

3.3. Production is the Third Root of the Problems

3.3.1. Availability of Raw Materials

The availability of porang tubers as industrial raw materials is limited. This is because the porang harvest season is not all year round, but from May to August with optimal production at the age of three years after planting [39]. After going through a dormant period of 4-6 months [40,39], porang tubers will grow into seeds [41]. Raw materials for porang tubers are not available throughout the year in Wonogiri Regency, so the production process does not continue. Supply from other areas is limited due to the characteristics of porang tubers, which cannot be harvested all year round. This makes investors reconsider it thoroughly about making investments and compare it with other businesses with raw materials available throughout the year.

3.3.2. Raw Material Damage

One of the obstacles in porang cultivation is the possibility of raw material damage due to fungi or viruses that attack plants [42]. The same problem occurs in the porang processing industry in China. The high water content in porang tubers causes damage to the tubers in the harvest and processing processes [43]. The attack is not visible but causes the appearance of black spots on the porang, which will rot after a few days of harvesting. With this condition, the rotting porang tubers do not pass the selection to be processed in the porang processing industry. There are many domestic porang productions that do not meet the standards set by the processing industry, such as intact tubers not affected by fungi or viruses, diameters of more than 15 cm, and a minimum weight of 1-2 kg [44]. A less careful harvesting process can cause tuber deformation. This makes it easier for fungal/viral contamination to occur during transportation, storage, or handling prior to processing.

3.3.3. The Weight of Porang Tubers that does not Meet the Requirements

The weight of one porang tuber is between 2-3 kg in the second year and will increase significantly in the third year of planting. The weight of this tuber has met the minimum weight requirements set by the exporter [45]. The larger the porang tuber and the wider the diameter, the more porang weight and glucomannan content [24,25]. However, one-year porang tubers are sold to meet farmers' daily needs and therefore, the requirements of industrial raw materials are not fulfilled. This practice is experienced by most of the porang farmers in Wonogiri Regency.

3.3.4. Porang Cultivating Land Registration

The latest requirement set by the porang processing industry or exporters is that the cultivating land is registered. However, only a small number of farmers have registered their land for planting porang. The quality of porang can be easily traced with the data of registered land [8]. The registration of porang land is not simple for farmers because it is related to complicated administrative fillings, nutrient contents in the soil, and the locations of cultivated land spread over several areas. Farmers have limitations in filling in the nutrient contents in the soil because there must be proof of soil sample testing [46].

3.4. The Fourth Root of the Problem is Human Resources

3.4.1. Partnership Network

The partnership network among porang actors or enthusiasts is not yet strong for the establishment of a porang processing industry in terms of raw material, technology, and market partnerships [47]. The human resource capacity of porang business actors has not been able to establish partnerships with porang processing entrepreneurs or exporters. Experience and competence to negotiate or enter into business contracts with other stakeholders are relatively low. This is because the level of formal education for porang farmers is relatively low [8]. The results of this research are in accordance with Pratiwi et al. [48], which concluded that the higher-level education of farmers (formal and non-formal) will gain more knowledge and experience in carrying out farming activities.

Raw material partnerships are limited to porang farmers in Wonogiri Regency who join the Porang Nusantara Farmers Association (P3N). Most porang farmers do not have the ability to expand the partnership network with fellow porang farmers/traders/porang processing industries from outside the regency. Dependence on local traders/other porang farmers who act as traders is very high. Due to the weakness of the partnership network, farmers have difficulty accessing price information and markets, and selling products directly to the processing industry [49,50].

Exim Bank has not yet entered into partnerships with farmers or porang processing actors in Wonogiri Regency. One of the functions of the Exim Bank is to facilitate exports by providing assistance to entrepreneurs whose products are ready for export. Facilitation is provided in the form of assistance in arranging export permits and product improvement to meet export and financing requirements.

3.4.2. Institution

Institutions in the porang processing industry have not

yet been formed. This institution is an important aspect of an effort to expand business networks and sources of information [51,52]. However, currently, there is only the Porang Nusantara Farmers Association (P3N) established in Wonogiri Regency [8]. With porang as an export commodity, the absence of processing industry institutions limits the flow of information, either on price, market needs, cultivation, and processing techniques, which can be implemented by farmers [53].

3.5. The Fifth Root of the Problem is Government Policy

The government's policy regarding the movement of three times exports of agricultural products, especially porang, contradicts the food security policy of increasing the cropping index to 400 [54]. The movement will reduce paddy fields used for rice/corn cultivation. This causes a conflict of interest between porang production and rice and maize production in increasing food security. Some farmers who are tempted by the lucrative prospects of selling porang switch their crops from sta to porang [15]. This is contrary to the government's policy to realize food security with IP400.

The Policy of Developing the Porang Processing Industry has not been a Priority by the Wonogiri Regency Government

As a center for porang production, Wonogiri Regency has great potential to increase added value by producing processed porang. However, this potential has not been supported by policies for the development of the processing industry in the regency. Strategic plans from related institutions have not become a priority for the development of agricultural commodity-based industries. The absence of a blueprint for the development of the porang processing industry between government institutions contributes to the lack of funding allocation to build the industry. This condition hampers efforts to develop the porang processing industry [55]. Farmers as the main actors in porang cultivation are the most disadvantaged compared to other business actors.

The most basic root of the problems that hinder the porang processing industry in Wonogiri Regency is the market. Market demand, access, and information are relatively closed and limited, making it difficult for new business actors to enter the porang market. There is a barrier to entering the market built by business actors who control the porang domestic and international markets. Requirements, price, uncertain time determined by the processing industries in accepting tubers, and the number of DO become barriers to entry. Porang tubers are easier to sell than chips or flour. The requirements for porang chips or flour determined by the processing industries are relatively difficult for porang farmers to fulfill. This is what causes investors to be unwilling to invest in the processing industry.

Porang chips or flour cannot be further processed into food that is ready for consumption if the oxalic acid has not been removed. This becomes one of the reasons for the limited market in the country. The technology for removing oxalic acid is limited to large-scale industries, and it is inefficient for commercialization for household, small, and medium-scale industries. Human resource capacity to develop the processing industry is limited. The ability to negotiate and establish networking is relatively low so business partners only come from the same regency. These partners also have inadequate access to markets, technology, and finances.

The development of porang processing industry has not yet become a priority in supporting the government's policy of increasing exports threefold. Porang is not a strategic commodity, and therefore, it has not been included in the short and medium-term development plans of the government of Wonogiri Regency. The government prioritizes rice and corn commodities in meeting food availability to support food security both at the regional and household levels [56]. On the other hand, porang is an excellent export commodity and its development needs to be facilitated.

The abundant availability of raw materials during the main harvest, closed markets and prices that tend to decrease is a leverage in the establishment of the porang processing industry. Industry establishment prioritized in removing oxalic acid in porang tubers. Environmentally friendly technology in removing oxalic acid is urgently needed for this industry to be sustainable. The chips or porang flour produced do not contain oxalic acid, so they can be used as raw materials for the food industry. This can put pressure on importers who play with the price of porang tubers and the processed porang market will be more open. Collaboration with research institutes is essential in the adoption of low-cost oxalic acid removal technologies.

4. Conclusions

Being a center for porang tuber production does not guarantee faster growth of the porang processing industry. The porang processing industry in Wonogiri Regency has not yet developed due to various root causes. The main roots of the problems lie in the market and technology that have not been mastered. Investors are reluctant to invest in the porang processing industry because the market is difficult for new businesses to penetrate. This is because market access and information are not open. Dependence on import demand has caused this industry to be relatively stagnant in increasing production capacity. Porang processing technology has not been able to be mastered by farmers, particularly in terms of removing oxalic acid and turning it into glucomannan. This causes almost all farmers to sell the commodity in the form of tubers.

The development of industries that utilize processed porang products as raw materials is urgently required in

expanding the market for processed porang in the country. This can stimulate competition among porang processing entrepreneurs for more open information and market access.

Based on the identified root causes, the government can facilitate the expansion of foreign markets for tubers or processed porang. The government stipulates export trade regulations that can reduce market concentration to become a perfectly competitive market. The government can also facilitate the transfer of technology that can be adopted by the low-cost, environmentally friendly porang processing industry. Research collaboration with research institutions is very important in producing low-cost technology transfer. Good agricultural practice (GAP) is also introduced to farmers to produce porang tubers that meet the raw material requirements of the processing industry. On the other hand, the capacity of human resources, especially actors in the porang processing industry, needs to be increased through training, comparative studies, and apprenticeships. Government policies began to be directed at increasing export commodities so as to open up opportunities for larger export markets for people.

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