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Sustaining porang (*Amorphophallus muelleri* Blume) production for improving farmers' income

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Abstract. One of the main programs of Ministry of Agriculture is GRATIEKS (Three-Fold Export Movement). It aims to boost agricultural export resulting in production enhancement as well as farmers' income improvement. Porang is among the promising commodities to enhance export. This paper aims to analyze role of porang farm business as an export commodity through sustainable agriculture, i.e. (i) to analyze land management for porang farm business, (ii) to study the cost and income of porang farm business, and (iii) to evaluate porang export development measures. This research was conducted in Madiun Regency, East Java, using a survey method. Porang farm business is conducted on production forest and protection forest areas. It should be implemented carefully in accordance with sustainable land management. Porang farm business is relatively cost-effective as it applies minimal tillage, low production inputs, and profitable farm-gate price. Porang flour export demand is still promising. Porang production enhancement is possible through sustainable land management.

1. Introduction

During the Covid-19 pandemic era the agriculture sector kept growing positively amid negative economic growth especially in the second quarter 2020 [1]. It reveals that agriculture sector has potential to sustain when national economy experiences disturbance. Indonesian agriculture is promising if the programs are well planned.

Along with national income enhancement, Ministry of Agriculture launched an export enhancement program called GRATIEKS (Three-fold Export Movement) [2]. One of the potential commodities to export is Porang. In 2019 porang export value was 11,200 tons from 25 exporters [3]. Porang commodity grows fast since 2013 where farmers adjacent to the forests plant this commodity using an agroforestry approach.

Currently porang crop is found in some provinces, e.g. West Java, Central Java, East Java, Lampung, East Nusa Tenggara, and South Sulawesi. Porang is grown under the trees in the forest with 40% of shade. Based on Decree of Minister of Agriculture *(Permentan)* No. 104/2020, porang is a crop managed under Ministry of Agriculture but this crop is grown in forest areas undertaken by PHBM (Community-Based Forest Management). Together with porang in the forest areas, there are various food crops, fruit crops, cereal crops, and industrial crops [4, 5].

The study focuses on porang as one of agro-forestry commodities, i.e. the commodity grown by farmers and developed by the Ministry of Agriculture but it is grown in the production forests and/or protected forests. General objective of this paper is to analyze porang farm business as an export commodity through sustainable agriculture. Specifically, this paper aims: (i) to analyze land

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management for porang farming, (ii) to assess cost and income of porang farming, and (iii) to evaluate crop development as an export commodity.

2. Conceptual framework

It is the role of the government to enhance export based on local resources through creation of original products with geographical identity with high value added. Porang (*Amorphophallus muelleri* Blume) crop plays an important role in increasing farmers' income especially those living close to the forest areas. During the last five years this crop grows fast as an export demand is much more than domestic production. It is expected that porang development as sustainable farming practice will enhance farmers' income in order to meet export market [6].

Growing porang needs shade of 40% [7], thus it should be planted under the trees in forest areas. Collaboration among institutions is urgent, i.e. between people living near forest areas and the farmers for sustainable porang farming such as implemented by Forest Village Community Development (PMDH) Program under Ministry of Forest [8]. PT Perhutani allows the farmers to plant porang under forest trees using agroforestry approach [9], such as carried out by the farmers in Saradan Sub-District, Madiun Regency, East Java on the area of KPH Saradan based on Regional Decree *(Perda)* No. 9/2011 on Regional Plan of Madiun Regency 2009 to 2029 where Saradan Sub-District is the main porang producing area.

There are 25 porang processing companies in Indonesia with lack of supply of porang as raw material to process into chip and flour. Ministry of Agriculture (MoA) through Directorate General of Food Crops manages and develops this commodity as food which is popular in East Asia, e.g. China, Japan, and Korea. Currently in Indonesia porang has not been processed into food due to lack of technology [10]. The Strategic Planning of MoA 2020 to 2024 informs that supply of porang seed ratio is 6% per year [11].

The strategy to develop porang is collaboration between the farmers and the porang processors [12]. In general, growing porang crop is relatively the same with cultivating the land below the forest trees and backyard land shaded by the trees and it needs to plant once.

Porang investment is contributed by the government, investors, and all stakeholders including the farmers (support) resulting in improved output and labor employment (figure 1). Thus, it is necessary to conduct financial analysis and to measure effectiveness of all business actors through investment criteria. If equity owned by producers is part of green investment program [13], it will be helpful for the government to formulate the policy on project risk mitigation of green business. Porang producers are part of green economic growth taking into consideration economic, natural, and social value factors for sustainable development. The intersection areas show that two or three parties collaborate to support porang farm business.

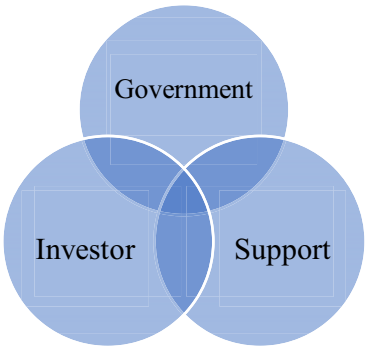


Figure 1. Stakeholders implementing porang business (adopted from *Badan Perencanaan Pembangunan Nasional* [13]).

3. Data and analysis

The study was conducted from January to August 2020. Primary data were collected from sample farmers in Klangon Village, Saradan Sub-District, Madiun Regency, East Java. Out of 30 porang farmers in the village, 15 persons of them were selected randomly as the respondents. Secondary data were collected from MoA and other Ministries and regional offices in East Java.

3.1 Farm business analysis

Farm business analysis consists of: (i) cost and income analysis, and (ii) *benefit to cost ratio* [14]. The equations are as follow:

$$Net\ income\ =\ \pi\ = TR - TC \quad (1)$$
$$Total\ revenue\ = TR\ = P.Q \quad (2)$$
$$Total\ cost\ = TC = TFC + TVC \quad (3)$$

Benefit to cost ratio analysis uses the following approach:

$$B/C\ Ratio = \frac{\pi}{TC} \quad (4)$$

If B/C ≥ 1, the business is feasible to develop, but if if B/C ≤ 1 then the business is not feasible [15].

3.2. Return on investment (ROI) analysis

ROI or called as "Return on Total Assets" is measurement of total business actors' assets available in the company [16]. The greater the ROI value, the better the business performance will be. ROI equivalent is expressed as follow:

$$\text{ROI} = (\text{Net profit after tax}) / (\text{Total assets}) * 100\% \quad (5)$$

3.3. Residual income (RI) analysis

If RI is positive, it indicates that the company creates asset. If RI is negative it reveals capital loss. In the long term, the sustaining companies are those that create assets. RI is residual profit to measure performance by estimating difference between profit before tax and capital cost of investment. Economic added value is achieved if the business actors get residual as profit before tax decreased by capital cost. RI equation is as follow [16]:

$$\begin{aligned} \text{RI} &= \text{NOPAT} - \text{Capital cost} \\ &= \text{EBIT}\ (1 - \text{T}) - (\text{WACC x Total Assets}) \end{aligned} \quad (6)$$

where,

NOPAT = Net operating profit after tax
EBIT = Profit before interest and tax
T (Taxes) = Tax
WACC = Weighted average capital cost

4. Results and discussion

4.1. Land management for porang farm business

Farmers grow porang on the soil below the trees' shade in the forest. Usually the good tree shade is around 40%. Farmers practice for porang farm business apply minimal tillage where soil of the forest floor is hoed to plant porang seed or porang tuber. This practice is carried out because the top soil is still fertile and relatively deep.

Fertilizers applied are both chemical and organic at moderate rate as the soil is still relatively fertile due to organic matters accumulated by forest trees. To some extent, porang farming is in accordance with sustainable land management. The farmers just utilize space under the trees with less dense crop

spacing. Land erosion is minimized as porang crop is first harvested two years after planting, and year later subsequently. Dispute among farmers may arise if they do not put definite border for their farmland areas. If the farmers grow porang in the production forest it will be relatively easy to control. However, growing porang in the protected forest will be critical to land management.

4.2. Cost and income analysis of porang farm business

Porang could be harvested after 3 years after planting (one cycle) started with *bulbil* planting as the seed. Average seed needed for one-hectare porang farming is 247 kg. Porang farming consists of land preparation, planting, crop management, and harvest. In the study location, land planted porang is under the tree stands in the forest. The farmers just conduct weeding and no soil cultivation. Crop spacing is 40 x 40 cm^2 or 50 x 50 cm^2.

Porang planting is conducted on early wet season from September to October. Crop management is carried out one month after planting, such as weeding using chemical or mechanical devices. Farmers need herbicide for weeding average of 8.6 L ha^{-1}. Weeding is implemented during vegetative phase. Fertilizers applied are dung manure (200 kg ha^{-1} y^{-1}) and chemical fertilizers such as Phonska and ZA each of 200 kg and ZA 160 kg ha^{-1} y^{-1} on average.

Low application of fertilizers because farmers deem that the soil is still relatively fertile. Farmers apply fertilizers twice a year, i.e. when planting the seed and early wet season, through putting them into the soil or spread around the porang stems. Pests and disease usually found are worms attacking the tuber and fungi on the leaves making them dried. Pests and diseases are controlled using pesticides. Flood on some parts of farmland areas takes place during rain due to crop planting in the basins.

Porang crop grows during wet season (5 to 6 months) and it is dormant during dry season. Farmers harvest the porang tuber during dry season and some farmers also harvest bulbil and sell it as seed. The tuber harvested is each of at least 3 kilograms. Average yield for the second and third years is 7,345 kg and 14,050 kg, respectively.

Table 1 shows cost and income of porang farming in the study location. The biggest cost shares are allocated for purchase of seed and labor wage. Transporting porang tuber from inside the forest to the closest road is conducted manually. Most farmers purchase subsidized fertilizers. Land rent paid to Forest Village Community Institution (LMDH) and PT Perhutani. Total porang production costs in first, second, and third years are Rp 39,596,000, Rp 7,421,000 and Rp 12,446,000, respectively. Total porang farming cost for three years is Rp 59,463,000.

Selling price of fresh tuber is Rp 9,000 kg^{-1} and the bulbil price is Rp 100,000 kg^{-1}. These farm-gate prices are relatively high compared to similar study [17]. B/C ratio of porang farming is 2.77 > 0 indicating that porang farming is feasible to sustain.

Some farmers process the tuber into chip, but most of them sell fresh tuber due to lack of labor for processing and facility for drying. The porang processors process porang into flour or konjac powder. The farmers sell tubers in cash to collecting traders in their settlement areas. The processors purchase porang tuber from collecting traders.

Farmers sell fresh porang tuber to village-level collecting traders who process it into chip. To some extent the village-level collecting traders sell chip to sub-district level collecting traders. Wholesalers and sub-district level collecting traders sell chip directly to the processor. Wholesalers usually pay advanced payment to collecting traders requiring minimal chip supply. Chip price to some extent is determined by wholesalers who get direct access to the processor. Porang marketing channel is depicted in figure 2.

Table 1. Income and cost analysis of porang farming in Madiun Regency, 2020.

No.	Item	Unit price	Year 1			Year 2			Year 3			Total 3 years
			Requirement		Total	Requirement		Total	Requirement		Total	Total
		(Rp)	Volume	Unit	(Rp)			(Rp)			(Rp)	(Rp)
I.	**Costs**											
1.	**Seed**											
	a. Katak/bulbil	100,000	247	kg	24,700,000	-	kg	-	-	kg	-	
2.	**Herbicide**	65,000	8.6	L	559,000	8.6	L	559,000	8.6	L	559,000	
3.	**Fertilizer**											
	a. Ponskha	2,500	200	kg	500,000	200	kg	500,000	200	kg	500,000	
	b. ZA	3,200	160	kg	512,000	160	kg	512,000	160	kg	512,000	
	c. Organic	1,000	200	kg	200,000	200	kg	200,000	200	kg	200,000	
4.	**Labor**											
	a. Land clearing	100,000	44	MAN DAYS	4,400,000	-	MAN DAYS	-	-	MAN DAYS	-	
	b. Making mounds	75,000	44	MAN DAYS	3,300,000	-	MAN DAYS	-	-	MAN DAYS	-	
	c. Planting	75,000	46	MAN DAYS	3,450,000	-	MAN DAYS	-	-	MAN DAYS	-	
	d. Replanting	75,000	3	MAN DAYS	225,000	3	MAN DAYS	225,000	-	MAN DAYS	-	
	e. Weeding 1	100,000	4	MAN DAYS	400,000	4	MAN DAYS	400,000	4	MAN DAYS	400,000	
	f. Fertilizer application	75,000	2	MAN DAYS	150,000	2	MAN DAYS	150,000	3	MAN DAYS	225,000	
	g. Weeding 2	100,000	3	MAN DAYS	300,000	3	MAN DAYS	300,000	-	MAN DAYS	-	
5.	**Harvest cost**											
	a. Tuber harvest	100,000	-	MAN DAYS	-	-	MAN DAYS	-	50	MAN DAYS	5,000,000	
	b. Bulbil/katak harvest	100,000	-	MAN DAYS	-	18	MAN DAYS	1,800,000	4	MAN DAYS	400,000	
6.	**Transport**	1,875,000	-		-	1		1,875,000	2		3,750,000	
7.	**Land rent**	900,000	-	Per year	900,000	1	Per Year	900,000	1	Per Year	900,000	
	Total cost				**39,596,000**			**7,421,000**			**12,446,000**	**59,463,000**
II.	**Income**											
1.	**Fresh tuber**											
	a. 2nd year	9,000	-	kg	-	7,435	Kg	66,915,000	-	kg	-	
	b. 3rd year	9,000	-	kg	-	-	Kg	-	14,050	kg	126,450,000	
2.	**Katak/bulbil**	100,000	-	kg	-	102	Kg	10,200,000	205	kg	20,500,000	
	Total income				-			**77,115,000**			**146,950,000**	
III.	**Profit**				**(39,596,000)**			**69,964,000**			**134,504,000**	**164,602,000**
IV.	**B/C Ratio**											**2,77**

Source: primary data

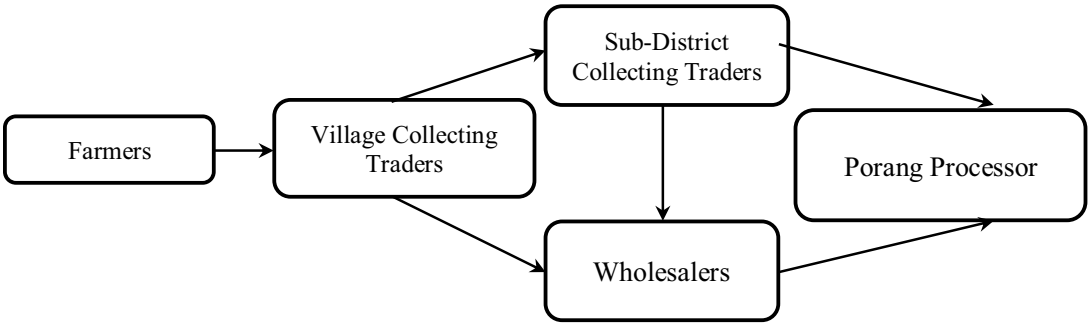


Figure 2. Porang marketing channel in Madiun Regency, 2020.

Porang processor/exporter sell porang in the forms of chip and powder. China and Japan markets prefer chip and powder, while Korea, Europe, and US market prefer flour. The processor purchase porang, either tuber or chip, from many provinces in the country. Table 2 shows porang supply by producing areas and schedule. Madiun Regency is the main supplier of 13,000 t y^{-1}. The other porang producing areas are East Nusa Tenggara, South Sulawesi, and West Nusa Tenggara.

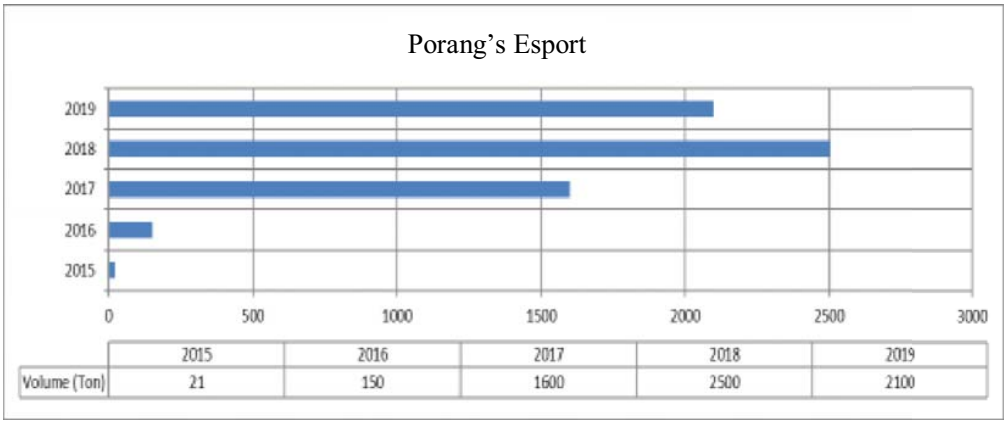
Potential capacity of the porang processor in Madiun Regency is 20,100 t y^{-1} of fresh tuber. In addition, the processor has capacity of 2,800 t y^{-1} or equal to 1,500 t y^{-1} of powder. Annual supply of fresh porang is 72,500 t y^{-1} surpassing the processor potential capacity and its potential capacity will be enhanced to 60,300 t y^{-1} of fresh porang and chip of 8,400 t y^{-1} or equal to 2,805 t y^{-1} of powder. This porang processing business is still promising indicated by profitable price at export market and high demand for this commodity.

Table 2. The processors' supply plan of porang tuber by producing areas, 2020.

No.	Producing areas	Harvest schedule	Estimated fresh tuber supply (t)
1	Banyuwangi	January – April	1,400
2	Jember	January – April	7,000
3	Probolinggo	February – May	2,900
4	Situbondo	February – April	100
5	Mojokerto	March – May	200
6	Nganjuk	April – September	3,050
7	Madiun	April – November	13,000
8	Ngawi	March – May	1,200
9	Ponorogo	April – September	6,000
10	Trenggalek	April – July	1,700
11	Pacitan	March – July	1,200
12	Kediri	March – July	900
13	Blitar	April – June	200
14	Malang	April – June	200
15	Bojonegoro	April – June	300
16	Central Java	January – May	3,700
17	West Java	January – May	1,350
18	Makasar	January – May	3,750
19	Bali	January – April	300
20	NTB	January – June	3,400
21	NTT	January – October	17,000
22	Kalimantan	January – May	3,400
23	Lampung	January – May	250
		Total	**72,500**

Source: primary data, 2020.

The processing company's performance is depicted in Figure 3 showing the positive trend for the period of 2015 – 2019. Before 2015 the company just started exporting porang powder as low as 21 t. However, in 2018 its export was 2,500 t. This company started with initial capital of Rp 20 billion registered at the Regional Investment Board.



Source: primary data, 2020.

Figure 3. Export performance of porang processors in Madiun Regency, 2020.

Table 3 shows ROI values of the porang processing company with pay-back period of investment for 5 years at 10.4% to 49.5%. Those ROI values were affected by capital cash-flow for operating business in one period. Cash-flow of the company in the early years was still relatively low and searching for porang producing areas. ROI distribution of the company is not stable each year due to the fluctuating porang price at international market resulting in unstable profits.

Table 3. Porang processors' ROI and RI estimates, 2015 to 2019.

Year	Profit after tax	Total asset	ROI	RI
	(Rp)	(Rp)	(%)	(Rp)
2015	2,901,780,000	20,421,016,358	14.2%	859,678,364
2016	20,713,500,000	41,873,470,471	49.5%	16,526,152,953
2017	220,800,000,000	1,808,273,470,471	12.2%	39,972,652,953
2018	344,775,000,000	2,497,823,470,471	13.8%	94,992,652,953
2019	289,422,000,000	2,787,245,470,471	10.4%	10,697,452,953

Source: primary data primer, 2020.

RI is a measure of the company's net income whether it surpasses the targeted profit. If residual profit is positive, the gained profit surpasses the targeted profit. If residual profit is negative, the attained profit is less than the target. If residual profit is zero, thus the profit earned is equal to the target. The company's RI is positive indicating that profit of the business financed by the investment surpasses the target.

The company deals with low quality of farmers' fresh porang because it is harvested before it is mature. It leads to smaller chip size less than 8 cm or below the international market standard. The farmers cope with lack of guidance on Good Agricultural Practice (GAP) of porang farming.

4.3. Porang export development

Porang export is promising as it is shown by its export volume of 11,170 t in 2019. The porang export was mainly shipped to China, Vietnam, and Thailand and new export markets, i.e. Pakistan, Malaysia, Cambodia, and Bangladesh [3].

Increased porang export was mainly due to improved porang price in China for the last 10 years which was twofold for fresh, chip, and powder. Booming demand for porang starting in 2017 was due to awakening of industry requiring porang as additional raw material for processed products [18]. Porang export also improved during the period of 2012 to 2017 as domestic industry's demand for this commodity increased to 42.1 t. Porang is industry's raw material for soft drink, jelly, bread, cake, cosmetic materials, and mixture material. Trend of business using porang flour is depicted in table 4.

Table 4. Trends of total business units using porang powder in Indonesia, 2010 to 2013.

No	Industry type	Total business units				Trend
		2010	2011	2012	2013	
1.	Industry of macaroni, noodle, and the like	295	292	296	269	-2.60
2.	Industry of glue	47	47	48	49	1.47
3.	Industry of meat and chicken meat processing and preserving	45	45	49	47	2.18
4.	Industry of processed food and cook	84	75	63	52	-14.90
5.	Industry of soft drink	99	97	98	100	0.40
6.	Industry of other drinks	11	21	19	25	26.65
7.	Industry of ice cream processing	17	14	17	15	-1.80
8.	Industry of bread and biscuit	671	633	639	617	-0.10
9.	Industry of cake	76	87	87	85	3.41
10.	Industry of cosmetics material and cosmetics	73	69	71	88	6.07
11.	Industry of pharmacy	20	10	13	12	-11.93
12.	Industry of pharmacy products	167	165	168	166	0.00

Source: Ministry of Industry, 2020.

Porang downstream industry prospect fluctuated according to annual economic growth. This commodity is utilized as raw material of food industry, various products (cake, bread, etc.), condensing agent, tablet filler and bond, coating and edible film, glue, water proof layer, etc. [19]. Porang is promising as food processing industry fast develops resulting in its better agribusiness.

Porang industry, however, deals with the following challenges:

- Porang seed (especially bulbil/katak) is expensive, i.e. Rp 1,000 per piece due to very high demand for fast porang farming development.
- The expensive price of Porang seed leads to costly porang farming investment as it requires around seed of 40,000 pieces per hectare. Nevertheless, demand for porang seed is still high as profit earned in three years reaches Rp 166 million ha^{-1} (table 1).
- Release of porang seed variety, i.e. Porang Madiun-1 has not been realized and it was targeted on April 2020. Government assistance for porang farming development of 15,000 ha in East Java requires certified seed.
- There is no specific HS code for porang as new emerging commodity in international market either for fresh tuber, chip, and powder.
- The porang processing companies need continuous supply of raw material. The company processes fresh porang of 100 kg into 18 kg of chip with water content of 11% [20] or equal to 5.7 kg containing 56,445 glucomannan [21].

5. Conclusions and policy implications

5.1. Conclusions

Land management for porang farming is relatively sustainable for environment as the farmers practice minimum tillage and relatively low inputs. Porang farming gives positive impact on

social change and farmers' income. Positive B/C ratio of porang farming indicates that it is financially feasible to practice in the forest areas. ROI tells higher value than interest rate and positive RI reveals that porang processing business is feasible. These indicators support downstream product of processed porang as exported commodities.

5.2. Policy implications

Collaboration among government agencies and stakeholders is urgent in order to develop porang farming and to create its high value added for farmers, traders, and processors. Porang agribusiness is feasible to be developed for green economic growth. Technology innovation and regulation facility from upstream to downstream are essential for porang agribusiness actors.

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