Red Chilli Farming on Beach Sand and Rice Land with Various Irrigation Systems in Bantul

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Abstract. Red chilli is a horticultural crop that is commonly utilized by Indonesian people. In 2019 – 2020, red chilli was the most-produced vegetable in the Special Region of Yogyakarta. The high production is caused by the variety of agroecosystems in the Special Region of Yogyakarta, such as beach sand land, which is optimal for red chilli cultivation. This study compares the costs, revenues, income, profits, feasibility, and risks of red chilli farming on beach sand land and rice fields with shower and non-shower irrigation systems in Kretek District. Sampling was conducted by simple random sampling and a population of 116 farmers. Data analysis used the analysis of costs, receipts, income, profits, feasibility analysis based on R/C, labour productivity and capital productivity, and risk analysis based on the coefficient of variation. The results showed that the non-shower irrigated beach sand land farmers had the greatest cost and highest income, while the showered-irrigated beach sand land farmers had the most profits. Red chilli farming on paddy fields and sand with shower and non-shower irrigation systems in the Kretek subdistrict is deemed feasible based on R/C analysis, labour productivity, and capital productivity. The highest production risk value is the shower-irrigated paddy fields, and the highest cost risk value is the non-shower irrigated beach sand land.

1 Introduction

Red chilli is a horticultural plant often used for consumption and medicine. The multiple uses of red chilli are reinforced by the continued increase in red chilli production in 2010-2019, with 8.56% produced on Java island and 7.14% from outside Java [1]. Red chilli is the vegetable with the most production in the Special Region of Yogyakarta in 2019-2020 [2]. The high production of red chillies in the Special Region of Yogyakarta is due to various agroecosystems, including the coastal sandy land with great potential for red chilli cultivation [3]. Currently, beach sand farmers in the Special Region of Yogyakarta have succeeded in producing various types of commodities such as red chillies and other vegetables. The

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production can even supply markets in other regions such as Cipinang, Jakarta and Sumatra [4]. Bantul and Kulon Progo regencies in the Special Region of Yogyakarta have successfully utilized beach sand land for agriculture [5].

Kretek district became the largest producer in Bantul Regency in the 2017-2020 period [6–8]. Kretek subdistrict, located on the coastal side, initiated farming activities on coastal land to utilize the beach sand. Apart from sand land, there are other types of land found in Kretek District, namely paddy fields. Thus, farmers in the Kretek district can be grouped according to the type of land used: the coastal land and paddy fields.

As the Kretek subdistrict is near the coastland, temperatures during the dry season can rise, leading horticultural crops, notably red chillies, to wilt rapidly. Beach sand land has a sand texture with a separated structure, making it difficult to bind water and has a high evaporation rate [9]. This type of land has better yields and increased productivity of red chilli [10]. The farmers in Kretek District use two irrigation systems: shower and non-shower. The shower irrigation system uses water pipes with many holes at the end of the pipe, called nozzle. At the same time, the non-shower irrigation system differs between the beach sand and paddy fields. On beach sand land, farmers are assisted by pumps to transport water and hoses without a nozzle to drain it, but the hose is partly clamped with a finger so that the water coming out from the water can reach the far away plants. However, this causes the discharge of water cannot be controlled and uneven. Farmers water the plants directly in paddy fields, either by hand or using a bucket of water that has flowed into the fields from a water source.

There are huge differences between beach sand land and paddy fields in structure and maintenance. In addition, the use of irrigation systems used by farmers on each land can bring different effects. This study aims to compare the costs, acceptance, income, profits, feasibility, and risks of red chilli farming with shower and non-shower irrigation systems on the beach sand and paddy fields.

2 Methods

2.1 Sampling technique

The Kretek district was purposively selected as the location in this study as the district was the largest chilli-producing district in the Bantul Regency in 2017-2020. The sampling method used was simple random sampling with a total of 116 farmers. Table 1 displays the respondents of this study.

Table 1. The number of red chilli farmers respondents in Kretek District, Bantul

Farmers' Name	Population	Shower Irrigation System		Non-shower Irrigation System	
		Paddy Field	Beach Sand Land	Paddy Field	Beach Sand Land
Muneng	30	3		27	
Tani Asih	37	2		28	
Tani Mulyo	40	10			
Ngadi Mulyo	45		8		23
Sederhana	40		15		
Amount	**192**	**15**	**23**	**55**	**23**

2.2 Data Analysis Techniques

The cost of farming was calculated by adding up the explicit costs ($TC_{explicit}$) and implicit costs ($TC_{implicit}$),

$$TC = TC_{explicit} + TC_{implicit} \quad (1)$$

The total revenue (TR) was calculated by multiplying the selling price (P) by the amount of production (Q),

$$TR = P\ x\ Q \quad (2)$$

The net revenue (NR) was measured by the difference between receipts (TR) and explicit costs (TCexplicit),

$$NR = TR - TC_{explicit} \quad (3)$$

To calculate profit (∏), the difference between total revenue (TR) and total cost (TC) was analysed.

$$\prod = TR - TC \quad (4)$$

To calculate the feasibility of the RC ratio, total revenue (TR) was divided by the total cost (TC).

$$R/C = \frac{TR}{TC} \quad (5)$$

Description:
R/C > 1 : Farming is feasible.
R/C = 1 : Farming is at the break-even point.
R/C < 1 : Farming is not feasible.

To calculate the feasibility of labour productivity, equation (6) can be used as below:

$$Labor\ productivity = \frac{NR\text{-}CO_{land}\text{-}CO_{seed}}{FLF} \quad (6)$$

Description:
NR : Net revenue
CO_{land} : Costs of owned land
CO_{seed} : Costs of owned seeds
FLF : Family labour force fees

Criteria:
If labour productivity > labour wages, farming can be considered worthy.
If labor productivity < labor wages, farming can be considered unworthy.

To calculate the feasibility of capital productivity, equation (7) can be used below,

$$Capital\ productivity = \frac{NR\text{-}NFLF\text{-}CO_{land}}{TC_{explicit}} \times 100 \quad (7)$$

Description:
NR : Net revenue
NFLF : non-family labour force fees
CO_{land} : costs of owned land
$TC_{explicit}$: total explicit cost

Criteria:
If capital productivity > loan interest rate, then farming is said to be eligible.
If the productivity of the capital < the interest rate of the loan, then the agricultural business is said to be ineligible.

The value of the coefficient of variation is proportional to the amount of risk that farmers will bear [11]. Therefore, the risk of farming can be calculated using the coefficient of variation. The coefficient of variation itself can be calculated after obtaining the standard deviation (Equation 8).

$$p = \sqrt{\frac{\sum(x_i - \underline{x})^2}{n-1}} \quad (8)$$

Description:
p : Standard deviation value
x_i : Production value or cost
$\underline{x}$: The average value of production or cost
n : Amount of data

In this study, a risk analysis of farm production and costs was carried out using equation (9) and 10 below,

$$CV_{cost\ risk} = \frac{\sigma}{C} \quad (9)$$

$$CV_{production\ risk} = \frac{\sigma}{Q} \quad (10)$$

Description:
CV : Coefficient of variation
σ : Standard deviation
Q : Average production (Kg)
C : Average cost (IDR)

Criteria:
If CV ≤ 0.5, the farmer is spared from risk.
If CV > 0.5, there is a possible risk for the farmer.

3 Results and Discussion

3.1 Analysis of Red Chilli Farming

3.1.1 Total cost

The total cost is derived from the sum of the explicit and implicit costs. Explicit costs are costs incurred by farmers to conduct red chilli farming activities. Meanwhile, implicit costs are not incurred by farmers but should be considered to support red chilli farming activities. The total cost of red chilli farming can be seen in Table 2.

Since beach sand farmers must add manure to the soil before preparing it for planting, beach sand farming is more expensive than farming in other fields. Manure can increase soil fertility because it carries organic matter containing nutrients, helps retain water so as to maintain water availability, increases cation exchange capacity, loosens the soil, and when it has decomposed it will strengthen the root system so that microbes can develop and then help the process of decomposing organic matter on the land [12]. Sembiring et al. [13] stated that beach sand land requires additional manure to increase soil fertility. Another method to enhance the soil's fertility is by adding lime to lower the pH of sandy land. However, no farmers in this study used lime for their crops because they were more accustomed to using manure and lacked knowledge. Another difference is the cost of labour outside the family because paddy field farmers require more energy to prepare the land to cultivate former paddy fields.

Table 2. Average Total Cost of Red Chilli Farming of Paddy Field and Beach Sand Land with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Cost	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Explicit				
Seeds	480,816	678,767	1,370,228	1,455,656
Fertilizer	1,678,443	1,744,941	3,312,217	3,435,758
Pesticide	500,396	485,828	616,412	473,440
Equipment depreciation	153,590	102,359	196,619	190,978
Other expenses	1,087,239	439,556	1,976,774	1,320,123
Non-family labour force	4,396,506	4,267,412	2,211,667	2,252,346
Land costs	377,778	1,059,079	0	0
Amount (IDR)	**8,674,768**	**8,777,941**	**9,683,915**	**9,128,302**
Implicit				
Family labour force	2,622,152	5,722,620	4,847,836	7,823,439
Cost of owned land	1,288,889	607,035	0	0
Interest in owned equity	115,374	116,747	128,796	121,406
Cost of owned seeds	1,071,000	673,501	0	0
Amount (IDR)	**5,097,415**	**7,119,902**	**4,976,632**	**7,944,845**
Total Cost (IDR)	**13,772,184**	**15,897,843**	**14,660,548**	**17,073,147**

3.1.2 Revenue

The revenue discussed in this study is the amount of yield farmers will receive from selling red chillies. The average revenue obtained by red chilli farmers is displayed in Table 3.

Table 3. Average Revenue of Red Chilli Farming Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Production (kg)	1,667	1,650	1,915	1,791
Price (IDR)	13,486	11,756	13,824	15,804
Revenue (IDR)	**22,482,600**	**19,399,164**	**26,475,283**	**28,298,761**

As displayed in Table 3, farmers in beach sand land have greater income than farmers in paddy fields. Regardless of their irrigation systems, all beach sand farmers used imperial variety seeds, which have the highest selling price compared to the red chillies of the TW and Tropong varieties that paddy field farmers use. Farmers only sell red chillies to unauthorized collectors or intermediaries so that farmers only receive prices determined by the collectors or intermediaries. On the contrary, research by Basyarahil et al. [10] in Banaran Village, Kulon Progo, reported that farmers in the area obtained the best price and even higher than the market price by selling red chillies at the auction market.

3.1.3 Income

Income is one of the benchmarks of a farming that can be said to be successful with the aim of getting maximum income, so that the amount of income can make the farm successful [14]. The average income of the red chilli farming business in the Kretek district is shown in Table 4.

Table 4. Average Income of Red Chilli Farming Business on Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Revenue (IDR)	22,482,600	19,399,164	26,475,283	28,298,761
Explicit Cost (IDR)	8,674,768	8,777,941	9,683,915	9,128,302
Income (IDR)	**13,807,832**	**10,621,222**	**16,791,367**	**19,170,459**

Beach sand farmers own the largest income with non-shower irrigation systems (IDR 19,170,459). Although they have a high average explicit cost, farmers who use non-shower irrigation systems on beach sand fields can cover those costs with the highest average income. In research conducted in coastal land of Srigading and Gadingsari Villages, Sanden District, the average income of red chilli farmers was the highest during the first planting season, which was IDR 4,193,321 [15].

3.1.4 Profit

The average profit of red chilli farming in the Kretek district is illustrated in Table 5.

Table 5. Average Profit of Red Chilli Farming in Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Revenue (IDR)	22,482,600	19,399,164	26,475,283	28,298,761
Total Cost (IDR)	13,772,184	15,897,843	14,660,548	17,073,147
Profit (IDR)	**8,710,416**	**3,501,321**	**11,814,735**	**11,225,614**

Table 5 illustrates that farmers who used beach sand land with a shower irrigation system have the highest average profit of IDR 11,814,735. Although farmers with beach sand land and non-shower irrigation systems showed the largest income (Table 4), the farmers also suffered the largest average total cost. This results in the beach sand field farmers with non-shower irrigation systems being the second largest average profit. This proves that both revenue and total costs have a very large influence on profits.

3.2 Feasibility Analysis

3.2.1 R/C

Based on Table 6, all red chilli farmers, despite the field type and irrigation systems, showed an R/C value of more than 1, indicating that all four red chilli farming businesses could be cultivated.

Table 6. R/C of Red Chilli Farming Business on Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Reception (IDR)	22,482,600	19,399,164	26,475,283	28,298,761
Total cost (IDR)	13,772,184	15,897,843	14,660,548	17,073,147
R/C	**1.63**	**1.22**	**1.81**	**1.66**

Red chilli farming with a shower irrigation system has a greater R/C value than the non-shower irrigation system, which implies that the shower irrigation system was better than the

non-shower irrigation system. A previous study conducted by Sundari et al [16] reported a higher R/C value of 2.78 due to the higher selling price of IDR 23,986.99, which leads to higher income obtained by farmer.

3.2.2 Labor Productivity

Table 7 displays red chili farmers' labour productivity with different field and irrigation systems.

Table 7. Labor Productivity of Red Chilli Farming Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	**Non-shower**	**Shower**	**Non-shower**
Income	13,807,832	10,621,222	16,791,367	19,170,459
Capital interest	115,374	116,747	128,796	121,406
Cost of owned land	1,288,889	607,035	0	0
Family labour force	30,47	66,51	54,49	91,57
Labor productivity (IDR/man-hour)	**407,094.70**	**148,805.97**	**305,806.19**	**208,03.80**

The minimum wage in Kretek district was IDR 80,000/man-hour. Compared to the value of labour productivity (Table 7), all red chilli farming was considered feasible despite the type of fields and irrigation system used, as all four farms have greater labour productivity values than IDR 80,000/man-hour.

Farmers of red chillies displayed increased labour productivity when shower irrigation systems were used regardless of their growing method, which indicated that red chilli farming with a shower irrigation system is better than a non-shower irrigation system in terms of labour productivity. Previous research conducted in Sukamantri Village, Ciamis, reported that labour productivity was IDR 277,779/man-hour for independent farmers and IDR 443,882/man-hour for group farmers. The farmers in farmer groups were higher because the income of independent farmers was lower [17].

3.2.3 Capital Productivity

In Table 8, the capital productivity of red chilli farmers is depicted.

Table 8. Productivity of Red Chilli Farming Business Capital of Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	**Non-shower**	**Shower**	**Non-shower**
Income	13,807,832	10,621,222	16,791,367	19,170,459
Family workforce	2,622,152	5,722,620	4,847,836	7,823,439
Lease of owned land	1,288,889	607,035	0	0
Explicit cost	8,674,768	8,777,941	9,683,915	9,128,302
Capital Productivity (%)	**114.09**	**48.89**	**123.33**	**124.31**

The interest rate for savings in the Kretek District is 4%. In red chilli farming in paddy fields and beach sand, shower and non-shower irrigation systems showed higher capital productivity value than the prevailing interest rate. Thus, it can be claimed that all four farming businesses are feasible. Higher capital productivity than interest rates can be useful supporting data to obtain capital for red chilli farmers, as the data demonstrates that the chilli farming system is feasible.

Red chilli farming on beach sand land has a higher capital productivity value than paddy fields. Most chilli farming in paddy fields has an intercropping system with shallots; thus,

the earned income is not optimal. Nevertheless, all four farming businesses are still feasible to run.

3.3 Farming Business Risk Analysis

3.3.1 Production Risk

Production risks faced by red chilli farmers on beach sand land come from pest attacks, climate change, and flooding [10]. Climate change can cause extreme weather and increase the frequency of pest and disease attacks on plants so that production risks in agriculture tend to increase [18]. Natural factors or things the farmers cannot prevent can affect the plants, leading to crop failure and decreased yields [19]. The production risks of red chilli farming in the Kretek district are displayed in Table 9.

Table 9. Production Risk of Red Chilli Farming in Paddy Field and Beach Sand Irrigation with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Standard deviation	533.66	365.71	215.76	418.07
Production average	1,667.15	1,650.19	1,915.21	1,790.58
Production Risk	**0.32**	**0.22**	**0.11**	**0.23**

All four farm businesses in this study are protected from the production risk of farming because the coefficient of variation is less than 0.5. Even so, the value of the coefficient of variation owned by chilli farming in paddy fields with shower irrigation systems was the highest. The main cause of production risk in red chilli farming in this study is Patek disease or anthracnose and erratic weather. This is in line with the research of Karyani et al. [20], which stated that red chillies are very susceptible to anthracnose disease, which can be made worse by spraying water on them since it helps the fungus spread.

3.3.2 Cost Risk

Table 10 illustrates the cost risks of the red chilli farming business in the Kretek district.

Table 10. Cost Risk of Red Chilli Farming Business in Paddy Field and Beach Sand with Shower and Non-Shower Irrigation in Kretek District per 2000 m^2

Description	Paddy Field		Beach Sand	
	Shower	***Non-shower***	***Shower***	***Non-shower***
Standard deviation	2,471,667.75	4,730,146.94	3,962,673.58	5,880,992.87
Cost average	13,772,183.50	15,897,843.08	16,327,214.21	18,739,813.60
Cost Risk	**0.18**	**0.30**	**0.24**	**0.31**

Chilli farming in the Kretek Sub-District can avoid the risk of costs despite the different field types and irrigation systems, as all farms have a coefficient of variation of less than 0.5. Cost risks include the large production costs incurred by farmers [20]. The causes that can trigger the occurrence of cost risks in this study are the costs of fertilizer procurement. The subsidized fertilizers by the government did not reach the farmers easily, making it difficult for farmers to get fertilizer. Moreover, it is also difficult for the farmers to purchase fertilizer as the prices differ between farm shops. The large price differences were also seen between buying the fertilizers by the kilo and per sack.

4 Conclusions and Recommendations

4.1 Conclusion

1) The red chilli farming on beach sand land and paddy fields with shower and non-shower irrigation systems in the Kretek district was compared. The chilli farmers using beach sand with non-shower irrigation systems showed the highest costs, income, and revenue. The chilli farming business with the most profit is the farmers of beach sand land with shower irrigation system shower.
2) Red chilli farming on paddy fields and beach sand with shower and non-shower irrigation systems in the Kretek district can be feasible based on R/C analysis, labour productivity, and capital productivity.
3) Production and financial hazards are avoided in red chilli farming. While beach sand farmers with non-shower irrigation systems had the largest coefficient of variation for cost risks, rice farmers with shower irrigation systems had the highest coefficient of variation for the production risk of red chilli farming.

4.2 Suggestion

1) Shower irrigation systems have a higher R/C value and labour productivity than non-shower irrigation systems. Thus, it is necessary for red chilli farmers, both in paddy fields and beach sand, to consider switching to the shower irrigation system.
2) Beach sand land farming has a higher capital productivity value than paddy fields. Thus, it is necessary to consider planting chillies with a monoculture cropping pattern for farmers with paddy fields to maximize capital.
3) To reduce costs and production risks, government action is required to stabilize production inputs' prices and offer advice on red chilli farming, including pest control, particularly for now incurable Patek disease.

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