Change on Production and Income of Red Chili Farmers

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Abstract. Climate change in the farming of red chili can cause a significant decrease in production as a result of high pest and drought attacks. The study wanted to find out the impact of climate change on the production and income of red chili which was carried out starting from planting to harvest in Garut Regency, West Java Province. Qualitative analysis is used to analyze the use of production inputs in red chili farming. Farmer income is done by analyzing agricultural income, while the factors that influence red Chilean production are analyzed using logistic regression. This finding concludes that the effects of climate change affect production efficiency and red chili income. This can be seen from the large value of the R / C ratio in red chili farming both in the dry season and in the rainy season is still greater than one. This means that the cultivation of red chilli is still feasible to be developed. Besides, increased production of red chili farming has the opportunity to be increased by increasing the use of production inputs such as land area, fertilizer and labor use.

1. Introduction

The phenomenon of climate change has become a serious concern for the world and has a direct impact on primary sectors, one of them is agriculture [1]. Climate change in the agricultural sector has a negative impact, especially on the level of products produced [2]. The shift in the rainy season and fluctuating rainfall causes a shift in cropping and harvesting patterns. As a result, the production and supply of agricultural products will be disrupted and has the potential to create wider socio-economic problems [3]. Climate change can also threaten the national food supply, with the increasing population, of course, must be followed by additional food supplies to meet the increasing needs of the community [4].

According to Food and Agriculture Organization, Indonesian chilli includes as the top ten chilli producing countries in the world. In the last few years, the production of horticultural crops, especially red chili, has experienced quite a fluctuating development. This is caused by an increase in land productivity due to the use of production technology that is getting better. However, the increase in red chili production has not been able to meet the need for consumption of community red chili which is also increasing due to population growth. Based on data from [5], the average consumption of Indonesian people's red chili is 1.752kg /capita/yr. Indonesian chili consumption is relatively fluctuating but tends to increase from year to year. Three types of chili are consumed by households in Indonesia, but the most dominant consumption is red chili followed by cayenne pepper and green chili.
To meet the consumption needs, the import of red chili is needed.

Table 1. Development of Production, Consumption and Import of Indonesian Red Chili

| Years | Production (Ton) | Consumption | Import |
|-------|-----------------|-------------|--------|
| 2013  | 1 012 879       | 354 193     | 23 194 |
| 2014  | 1 074 602       | 368 067     | 27 228 |
| 2015  | 1 087 573       | 426 621     | 29 036 |
| 2016  | 1 020 569       | 432 037     | 25 327 |
| 2017  | 1 283 000       | 463 545     | 42 128 |
| 2018  | 1 296 529       | 536 126     | -      |

Source: [9]

Data in Table 1 showed that the development of production, consumption, and import of red chili fluctuates. At certain times (the month of Ramadan, the feast of Eid al-Fitr / Eid al-Adha, Christmas), the demand for red chili will increase sharply, while at other times the demand for red chili is constant and continuous every day. This certainly will affect the fluctuations in the price of red chili because the production of red chili is still seasonal [6]. In addition, the production of red chili is also influenced by the conditions of the season (rainy season), high production costs, the length of marketing channels, as well as the disparity in chili price between regions that occurs because the production center is concentrated in Java while the road infrastructure is also inadequate [7].

On the other hand, the production system of red chili farming, in general, is still traditional, even though a small portion has been carried out with the principles of modern business using modern production. The supply of red chili in Indonesia was still dominated by domestic production, but there was also an abundance of imports and exports [8]. Red chili characters were extremely sensitive to the seasons, so it will have an impact on the instability of the supply amount of red chili and will affect the price of red chili [9].

The red chili commodity is receiving attention because the price instability that occurs in this commodity can have a direct impact on the national economy. The frequent fluctuations in the price of red chilies are generally caused by the availability of an uneven supply of red chilies throughout the year. As a result, chili prices will usually rise when the market supply is low, on the contrary, the price of these commodities will immediately fall when supply from production centers increases in the market. The imbalance in the production side (cost-push inflation) and consumption (demand-pull inflation) of red chili, can be one source of inflation. Nationally inflation is still dominated by supply-side pressure (cost-push inflation) due to negative supply shock caused by natural / climate disasters or distribution disruptions as well as inflation caused by chili due to lack of supply and seasonal factors [10].

One factor that causes the amount of chili available is not following the number of community needs is due to the weak knowledge of farmers about climate change. Consequently, will certainly affect the planting and harvest schedule, as well as the handling of red chili plants against the influence of pests and diseases. On the other hand, red chili is a vegetable commodity that is very familiar with people's lives in Indonesia, because red chili is used every day by almost all people in every dish served. Yet as a strategic commodity, the price of chili will usually affect the price of vegetables and other food commodities [11].

The study is focused to investigate and analyze the income of red chili farmers in the dry season and the rainy season and to find out the factors that affect the production of red chili associated with climate change.

2. Research Methods
2.1. Types and Data Sources

This research was conducted in Garut Regency, West Java Province one of the largest red chili
production centers in West Java. West Java Province was chosen purposively because it is one of the biggest red chili producing provinces in Indonesia. Garut Regency is one of 7 centers producing red chili in West Java with a production contribution of 1 million tons [12].

This study uses cross-section data taken by conducting direct interviews with 100 farmers who plant red chilies. The respondent's farmers selected in this study were spread across 2 sub-districts and 10 villages in the Garut Regency. The respondents interviewed were respondent farmers who planted chili almost all year round (both in the dry season and the rainy season).

Sampling was carried out using a simple random sampling method in the population of farmers who planted red chilies. Data collected in the form of data on characteristics of farmers such as age, education, farming experience, arable land area, use of production inputs, output and input prices and output prices obtained by farmers. In addition to primary data collection, this research was also supported by secondary data obtained from the Department of Agriculture, Central Statistics Agency (BPS), scientific journals and documents or publications from related agencies.

2.2. Data Analysis Method

This study uses several analyzes, where data analysis is adjusted to the purpose of the study. The first objective of this study was conducted by analyzing the income of red chili farming in the dry and rainy seasons. This income analysis is useful to measure the magnitude of the success rate of red chili farming activities which can be seen from the efficiency of the farming. Effectiveness is one indicator of success in horticultural ventures. One way to calculate efficient farming with a return cost ratio or R/C approach was the value of revenue obtained for each rupiah's costs incurred. To measure the level of cost efficiency seen based on the cost structure or costs of each horticultural commodity. Components forming the structure of horticultural production costs are seeds, fertilizers, pesticides, labor, and other expenses.

Greater profits reflect better farmers' success. The greater the value of R/C, the greater the farm receipts will be obtained for each rupiah's costs incurred. Farming activities are said to be efficient if the R/C value > 1, which means that any additional costs to be incurred will result in additional revenues greater than those obtained.

The second objective analysis is to analyze the factors that influence the production of red chili in the dry and rainy seasons. Factors affecting the production of red chili farming were analyzed using multiple linear regression in the form of logarithms. To find out the relationship between production and production factors that influence it can be used as a statistical test of the econometric model, the Cobb-Douglas function with the following model:

\[
\ln Y = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + u_i
\]

where: \(Y\) = Production (kg); \(X_1\) = Land area (ha); \(X_2\) = Pesticide (lt); \(X_3\) = manure (kg); \(X_4\) = chemical fertilizer (kg); \(X_5\) = labor (HOK); \(\beta_0\) = intercept; \(\beta_i\) = estimated parameter (i = 1, 2, … 5); \(u_i\) = error term.

3. Result and Discussion

3.1. Farm Characteristic

The characteristics of farmers are important to explain because they aim to describe or describe the socio-economic conditions of farmers and the performance of the red chili farming (Table 1). The characteristics of farmers are important to explain because they aim to describe or describe the socio-economic conditions of farmers and the performance of red chili farming (Table 1). Farmers have the freedom to interact with the surrounding environment, learn new things, and follow any existing developments. This, of course, will shape the characteristics of farmers related to their level of competence in farming. The characteristics of these farmers will reflect behaviors that describe motivation, characteristics, self-concept, knowledge or expertise that perform superior in farming.

In general, farmers plant red chili with intercropping systems with other vegetable crops such as cabbage (cabbage), potatoes, leeks, mustard spoon (pokcoy), mustard greens, tomatoes, and others.
This is done as a form of agricultural land efficiency, and to obtain income from other crops while waiting for the harvest season for red chilies.

Table 2. Farmer's Socio-Economic Characteristics

| No | Description                                      | Average | Std  | Max | Min |
|----|--------------------------------------------------|---------|------|-----|-----|
| 1  | Age (years)                                      | 45,43   | 13,14| 75  | 21  |
| 2  | Education (years)                                | 8,80    | 3,54 | 18  | 5   |
| 3  | Experiences (years)                              | 14,17   | 11,27| 49  | 1   |
| 4  | Number of family (people)                        | 3,79    | 2    | 7   | 1,27|
| 5  | Number of family members involved in farming (people) | 1,98   | 1    | 5   | 1,13|
| 6  | Land Area (Ha)                                   | 0,59    | 0,52 | 2,13| 0,03|

Data in Table 2 reveals that the majority of farmers are in the 45-year age group. Farmers who conduct red chili farming in the research location can still be said to be the group of farmers who are still productive to carry out farming activities. This is also the case with the education level of farmers, who are generally still at the same level as elementary school. The level of education is very influential in the implementation of farming activities, both on how to manage to farm technically, management and absorption of new technology.

Farming experience can affect the ability of success in managing to farm, with long farming experience, farmers have a better understanding of farming activities carried out. In general, the respondent farmers had quite a long experience of farming, namely an average of around 14 years.

Labor is an important factor in family farms, especially farmworkers with family members. Farming households are generally very limited in terms of capital, the role of family labor is crucial. If it can still be completed by the family's own workforce then there is no need to hire outside workers, which means saving costs. This can be seen in the results of the study where the average number of farm household members ranged from 1 to 5, with only 1-2 working in red chili farming.

Red chili farming in Garut district was mostly managed by farmers with 45 years of age. The level of education of the majority of selected red chili farmers educated until graduating from elementary school with a fairly long experience of farming around 14 years. The average number of farm household members ranges from 1 to 5, with only 1-2 working in the red chili farm. When viewed from the average area of arable land by farmers in general approximately 0.59 ha which means there are still many farmers who are included in the group of small farms with an average production of only around 7000 kg.

3.2. Cost and Revenue Analysis

The success of the red chili production business is largely determined by the technical aspects of cultivation in the field. Some things must be considered well in the technical implementation of red chili cultivation including the selection of good and quality seeds. The success of red chili production is strongly influenced by and determined by the quality of the seeds used. The superior nature is reflected in high production. Resistance to pests and diseases and a high level of adaptation to climate change [2].

The high demand for red chili requires farmers to be able to increase their productivity, beginning with the selection of good quality chili seed varieties. Of course, the selection of good chili seed varieties is expected to increase farmers' incomes. Farmers will usually choose varieties of red chili seeds that are following market demand (taste, color, appearance, and size). The results of red chili production obtained between one variety and another are not the same as shown in Table 3.
Table 3. The Productivity of Various Red Chili Seed Varieties

| No | Varieties | Age of Harvesting (day) | Potential Yield (ton/ha) | Superiority |
|----|-----------|-------------------------|--------------------------|-------------|
| 1  | Lembang 1 | 90-95                   | 9.3                      | Adapt well in the lowlands to high |
| 2  | Tanjung 1 | 58                      | 18                       | Tolerant to leaf-sucking pests |
| 3  | Tanjung 2 | 58                      | 19.9                     | Somewhat tolerant of anthracnose disease |
| 4  | Lingga    | 88-95                   | 16.1                     | Adapts well to the plains of the dry wet season medium |
| 5  | Ciko      | 81-84                   | 20.5                     | Adapt well to medium plains |
| 6  | Kencana   | 95-98                   | 18.4                     | Adapt well in plain medium |
| 7  | TM 999    | 99-110                  | 20                       | Tolerant to Antarocsa and wilt disease |

Based on observations in the field, not all respondent farmers planted red chili at the same time. The decision to plant red chili is greatly influenced by the availability of capital, natural factors (climate and weather), the price of seeds and the price of medicines. This is also the case with the use of inputs used in the farming of red chili, the difference of which is quite significant between the growing seasons. The difference in the use of these inputs occurs due to the influence of environmental conditions (climate and weather). This will affect the productivity generated and the income that will be received by farmers.

The analysis of profits and R/C values in the red chili farming (Table 3) showed that the red chili farming both in the dry season and in the rainy season is still quite profitable. However, the large income and R/C ratio of cash costs and total costs in the farming of red chili in the dry season and the rainy season show significant differences. Farming success is measured by the amount of farm income, which is the difference between revenue or production value and costs incurred.

Red chili production takes place throughout the year in Indonesia. There are four red chili planting done by farmers, namely the first planting time in September-February, the second planting time in April-October, the third planting time in December-June and the fourth planting time in September-February. On the other hand [13] divides the two main production seasons of red chili. The first began planting in mid-February; then, after 3 months from the end of April to the beginning of June is harvest time.

The average income received by farmers from red chili farming is highly dependent on climatic and weather conditions. The fourth level of productivity planting is different and is strongly influenced by climate and weather conditions. Usually, the highest production of red chili can be obtained by farmers in the dry season with a period from December to June. In that period according to the conditions of chili planting. While between September and February, planting chilies in the rainy season lowers chili production due to pests and diseases [14, 15].

The cost of producing red chili in the rainy season was much higher than in the dry season because of the additional costs, especially on the cost for controlling the diseases and pest, in the rainy season pest and disease attacks on red chilies such as bacterial wilt, fruit and leaf spots, and fruit rot and leaf rot, making the intensity of spraying (use of drugs) more frequent. The supply of chili is usually reduced during the rainy season because most of the chilies planted in paddy fields compete with rice.
Table 4. Production Costs and Income of Red Chili Farming in One Planting Season

| Description | Dry Season | Rainy Season |
|-------------|------------|--------------|
|             | Unit Value (Rp) Percentage Unit Value (Rp) Percentage |             |
| A. Production (kg) | 8.700 56,000,000 56.000.000 | 6.600 59,400,000 59.400.000 |
| B. Farming Cost | | |
| a. Cash Fee | | |
| - Seed (pack)* | 20 27,500 550,000 2.86 | 20 27,500 550,000 2.49 |
| - Fertilizer: | | |
| Manure (kg) | 2500 500 1,250,000 6.49 | 3000 500 1,500,000 6.79 |
| NPK (kg) | 200 2500 500,000 2.60 | 300 2500 750,000 3.39 |
| KCL (kg) | 150 7400 1,110,000 5.76 | 170 7400 1,258,000 5.69 |
| SP36 (kg) | 130 2400 312,000 1.62 | 150 2400 360,000 1.63 |
| ZA (kg) | 100 1400 140,000 0.73 | 125 1400 175,000 0.79 |
| Urea (kg) | 65 1800 117,000 0.61 | 95 1800 171,000 0.77 |
| - Pesticide: | | |
| Solid Pesticide (kg) | 10.6 34.500 365.700 1.90 | 25 34.500 862.500 3.90 |
| Liquid pesticide (lt) | 5.1 97.000 494.700 2.57 | 10.4 97.000 1,008.800 4.57 |
| - Outside family labor (HOK) | 100.75 15.000 1,511.250 7.85 | 150.54 15.000 2,258.100 10.22 |
| Total Cash Cost | 6,350,650 | 8,893,400 |
| b. Cost Calculated | | |
| Land rent (Ha/th) | 1 12,000,000 12,000,000 62.32 | 1 12,000,000 12,000,000 54.31 |
| Inside family labor (HOK) | 60.32 904,800 4,70 | 80.25 1,203,750 5.45 |
| Total Cost Calculated | 12,904,800 | 13,203,750 |
| Total Cost | 19,255,450 | 22,097,150 |
| Income on cash (Rp) | 49,649,350 | 50,506,600 |
| Income on total cost (Rp) | 36,744,550 | 37,302,850 |
| R/C on cash | 7.82 | 5.68 |
| R/C on total cost | 1.91 | 1.69 |

Note:*) 1 pack = 100 gram, 1 HOK = 7 hours of works

Data in Table 4 showed that based on the results of direct interviews with respondents, chili plants are harvested every 7 days after the age of the plant is 100 days. The average quantity of red chili production in the dry season is 8,700 kg, with an average price of Rp 7,000 / kg while in the rainy
season the average production of red chili is 6,600 with an average price of Rp 9,000 / kg. Thus, the average acceptance of chili farming in the area of land per one planting season is Rp 56 million in the dry season and Rp 59.4 million in the rainy season.

The success rate of farming is also determined by the value of R/C ratio, which is the ratio between total revenue to total production costs. Based on the research, it can be seen from the average R/C in the red chili farming in the dry season at 1.91 and in the rainy season at 1.69. This means that at each expense of Rp 1.00 then the red chili farmer will receive income of Rp 1.91 in the dry season and Rp 1.69 in the rainy season. This means that red chili farming is still profitable to be cultivated. This is in accordance with the opinion of [16] who said that farmers will remain motivated to improve the quality of their red chili production as long as the product price is above the production cost.

Farmers in Garut Regency also use more factors of production with cash costs, not non-cash costs. This is indicated by the difference in the value of R / C over cash costs and R / C over total costs that are not much different. The difference can also indicate that the red chili farming carried out by farmers is managed commercially.

3.3. Factors Affecting the Production of Red Chili

The results of the estimation of the production function in Table 5 show that the Cobb-Douglass production function formed is quite good and has described the behavior of farmers in the production process. The coefficient of determination (R²) of the average production function obtained is worth 0.715 for the dry season and 0.652 in the rainy season. That is, the inputs used in the estimation model of the production function of red chili farming both in the dry season and in the rainy season can explain 71.5 percent in the dry season and 65.2 percent in the rainy season from the variation of curly red chili production in the study area. While the rest (28.5 percent and 34.8 percent) are influenced by other variables not included in the model.

| Variable          | Dry season | Rainy season | t-Value | t-Value |
|-------------------|------------|--------------|---------|---------|
| Constanta         | 2.054      | 2.038        | 2.85    | 5.13    |
| Land area         | 0.644      | 0.175        | 8.13    | 1.59    |
| Seed              | 0.065      | 0.508        | 1.50    | 4.13    |
| Manure            | 0.035      | 0.120        | 0.97    | 1.84    |
| Chemical Fertilizer | 0.056    | 0.005        | 1.06    | 0.01    |
| Pesticide         | 0.025      | 0.146        | 0.63    | 1.71    |
| Labor             | 0.068      | 0.056        | 1.30    | 1.39    |
| R-Square          | 0.715      | 0.652        |         |         |
| Adj.R²            | 0.820      | 0.701        |         |         |

The results of the analysis show the effect of each red chili production factor in the dry season or the rainy season is influenced by several variables. In the dry season, variable land area, seeds, manure, pesticides, and labor affect the production of red chili produced. This is also the case with the rainy season where it is seen in Table 5 that all parameter signs on the production function for the rainy season are positive as expected. Variable land area, seeds, manure, pesticides, and labor have a significant effect on the production of red chili. Variable of chemical fertilizer had no significant effect on red chili production.

4. Conclusion and Recommendations

Weather and climate factors reduce production efficiency and farm income for red chili. The average income of red chili farming in the dry season is lower than the rainy season. This is because, in the dry season, farmers reduce the harvested area because of limited water resources. In addition, the low price
of chili in the dry season is also the cause of the smaller R/C ratio received by farmers. Likewise, the condition of red chili farming in the rainy season, pests and diseases that attack red chili increase production costs to buy pesticides. However, the chili price which is quite high is able to cover the production costs that have been incurred so that the R/C ratio value is still greater than one.

This research shows the importance of increasing the ability of farmers to deal with climate change. Improving the ability of farmers can be facilitated through increasing knowledge about the planting system of red chili that is appropriate to climate conditions, regulating cropping patterns, using varieties that are resistant to drought and disease pests. This is useful for maintaining the average production capacity needed by consumers. In addition, there is also a need for ease of information focused on climate change in the form of short messages available through farmers' cellphones.

References
[1] Ananda R, Rima and W Tri. 2019. A General Assessment of Climate Change - Loss of Agricultural Productivity in Indonesia. Munich Personal RePEc Archive [MPRA] Paper No. 91316, posted 09 Jan 2019. https://mpra.ub.uni-muenchen.de/91316/
[2] Chen Y, Z Zhang, F Tao. 2018. Impacts of Climate Change and Climate Extremes on Major Crops Productivity in China at a Global Warming of 1.5 and 2.0 °C. Published by Copernicus Publications on Behalf of the European Geosciences Union.
[3] Hartono R and HB Astuti. 2015. Farming Feasibility of Local Varieties of Red Chili in the Plateau of Mojorejo, Rejang Lebong, Bengkulu. International Seminar on Promoting Local Resources for Food and Health, 12-13 October, 2015, Bengkulu, Indonesia.
[4] Mariyono J and Sumarno S. 2015. Chilli Production and Adoption of Chilli-Based Agribusiness in Indonesia. Journal of Agribusiness in Developing and Emerging Economies. Vol. 5 No. 1, pp. 57-75. https://doi.org/10.1108/JADEE-01-2014-0002.
[5] BPS Statistics Indonesia. 2018. Consumption Expenditure of Population of Indonesia, March 2018. Sub-directorate of Household Statistics. BPS-Statistics Indonesia.
[6] Kusdiyartini V, I Supriyanto, BY Wibowo, Al Rahutami. 2017. Chili Supply Chain and Pricing Management In Sumowono Central Java. International Journal of Business, Economics and Accounting, Vol. 13, Issue 2, August 2017.
[7] Webb AJ, FG Kartikasari, and IA Kosasih. 2012. Do Chili Traders Make Price Volatility Worse? A Qualitative Analysis of East Java Trading Practices. Accessed 15 July 2013. <http://ssrn.com/abstract=2176153> or <http://dx.doi.org/10.2139/ssrn.2176153>
[8] Mussema R. 2006. Analysis of Red Pepper Marketing: The Case of Alaba And Siltie in Snnprs of Ethiopia. Haramaya University [Thesis]
[9] Lee SG, Kim SK, Lee HJ, Lee HS, Lee JH. 2017. Impact of Moderate and Extreme Climate Change Scenarios on Growth, Morphological Features, Photosynthesis, and Fruit Production of Hot Pepper. Journal Ecology and Evolution. 2018;8:197–206
[10] Shin JW and SC Yun. 2010. Elevated CO2 and Temperature Effects on the Incidence of Four Major Chili Pepper Diseases. The Plant Pathology Journal 26(2) : 178-184 (2010).
[11] BPS Garut Regency Central Statistics Agency. 2018. Garut Regency in Figures 2018 (ID): Statistics Indonesia, Garut Regency, West Java.
[12] BPS Garut Regency Central Statistics Agency. 2018. Garut Regency in Figures 2018 (ID): Statistics Indonesia, Garut Regency, West Java.
[13] Masipa TS. 2017. The impact of Climate Change on Food Security in South Africa: Current Realities and Challenges Ahead, Jàmbá: Journal of Disaster Risk Studies 9(1), a411. https://doi.org/10.4102/jamba.v9i1.411.
[14] Ueda A and Samdup T. 2009. Chilli Transactions In Bhutan: An Economic, Social And Cultural Perspective. Bulletin of Tibetology.
[15] Ichwan B, RA Suwignyo , R Hayati and Susilawati. 2017. Response of Red Chilli Varieties Under Drought Stress. RJOAS, 6(66), June 2017. https://doi.org/10.18551/rjoas.2017-06.43
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