

# The impact of climate change on tobacco farming income in Temanggung Regency, Central Java, Indonesia

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**Abstract.** Tobacco is produced extensively in Indonesia, with the most excellent yields discovered in Temanggung Regency, located in Central Java. Climate change and increasing tobacco excise affect farmers' income. The study aims to determine the cost, profit, and feasibility of chopped tobacco farming after climate change and rising excise tax. This study involved 74 respondents, selected using simple random sampling, and utilized both primary and secondary data. The feasibility analysis employed the Revenue Cost Ratio (R/C) and Break Even Point (BEP) criteria. The results unveiled that chopped tobacco production was 773 kg/5,625 m<sup>2</sup> or 1,374 kg/hectare and climate change had no effect on production. Chopped tobacco farming per growing season for five months required a total cost of IDR 37,013,965. a revenue of IDR 38,551,056, and a profit of IDR 1,537,091. Climate change and rising excise tax on chopped tobacco farming could reduce profits. However, following the R/C and BEP criteria, chopped tobacco farming was feasible.

## 1 Introduction

Tobacco (*Nicotiana tabacum* L.) is a major annual plantation crop in Indonesia. Tobacco leaves are commonly employed for industrial purposes, especially as a raw material for making cigarettes. This commodity is crucial for farmers' livelihoods and the country's economy [1]. *Nicotiana tabacum* and *Nicotiana rustica* are Indonesia's two most common tobacco species [2]. From 2017 to 2021, Indonesia's tobacco production increased by 44.09%, from 181,142 tonnes in 2017 to 261,011 in 2021. The largest tobacco-producing province in Indonesia is East Java, with a total production of 140,283 tonnes, followed by Central Java, with 55,667 tonnes in 2021 [3].

Temanggung Regency is the center of tobacco production in Indonesia. Farmers sell chopped tobacco to Indonesia's well-known cigarette companies, such as PT Gudang Garam Tbk, PT Bentoel Prima, and PT Djarum. Temanggung's local tobacco has a unique flavor, texture, and scent, giving it a competitive and comparative advantage in some years. Tobacco can be a source of income for farmers during the peak harvest season [4].

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Production, personal, policy, pest, disease, and financial risks threaten tobacco farming [1]. Like other agricultural commodities, tobacco market prices fluctuate with various internal and external factors [5]. Tobacco quality is an internal factor that significantly affects farmers' selling prices. Climate change causes unpredictable rainy and dry seasons as well as attacks by pests and diseases, increasingly threatening the income of tobacco farmers [6]. Tobacco productivity in Temanggung dropped by half when precipitation levels were above average [7]. The government's new tobacco product excise policy, as outlined in Minister of Finance Regulation No. 156/PMK.010/2018 and has been in force since January 1, 2019, has only worsened the problem [8]. Changes in tobacco product excise accounted for a rise of 8.5% to 12.5% in 2012 and 23% in 2020 [9]. Therefore, it is clear that climate change affects chopped tobacco farming. A question emerged in response to such a condition, is tobacco worth producing?

Research related to income and feasibility of tobacco farming has been conducted by other researchers, namely by [10] in Situbondo, [11] in Jember, [12] and [13] in Limapuluh Kota Regency, West Sumatra [14] in Kendal Regency and [15] in Ngadirejo District, Temanggung Regency. Previous research has not linked climate change to the income and feasibility of tobacco farming.

Based on the above problems, this study aims to analyze the costs, profits and feasibility of chopped tobacco farming due to climate change in Temanggung Regency, Central Java.

## 2 Research method

Temanggung Regency has generated the greatest tobacco production in Central Java Province, making it one of the tobacco centers in Indonesia. Hence, this study took place in this regency. There has been a suitable tobacco farming area in all districts in Temanggung Regency. Bulu District has the largest area of tobacco growing compared to other sub-districts in Temanggung Regency. The area of tobacco land in Bulu district in 2020 was 2,385.79 hectares with a total of 1,457 farmers [16]. A total of 74 tobacco farmers as the research respondents, representing 5% of the population, gathered through simple random sampling. This study employed both primary and secondary data. A descriptive quantitative analysis was run to accomplish the research objectives. The following equations were applied to determine the cost, profit, Revenue Cost Ratio (R/C), and Break Even Point (BEP) of chopped tobacco farming [17].

$$TC = FC + VC \quad (1)$$

$$\text{Profit} = TR - TC \quad (2)$$

$$R/C = TR/TC \quad (3)$$

$$\text{Production BEP} = FC/1 - (VC/TR) \quad (4)$$

$$\text{Price BEP} = TR/Q \quad (5)$$

Description:

TC = Total Cost

FC = Fixed Cost

VC = Variable Cost

TR = Total Revenue

Q = Quantity of Product

BEP = Break Even Point

R/C = Revenue Cost Ratio

Farming is profitable and feasible if R/C is higher than 1, chopped tobacco production is greater than production BEP, and chopped tobacco price exceeds price BEP.

### 3 Results and discussion

The age of tobacco farmers in Temanggung ranged from 22 to 57, with more than 50% being 42 to 51. These tobacco farmers were of productive age and physically capable of tending their fields [18]. Tobacco farmers in Temanggung Regency were relatively younger than those in Limapuluh Kota Regency, West Sumatra [12]. Most tobacco farmers in this regency only had an Elementary or Junior High School education. Despite the low level of education, they reported no difficulties in managing their tobacco farming. They could network with one another and obtain advice from agricultural extension workers in farmer groups. Farmer groups serve as a means of learning, production unit, and cooperation [19]. On top of that, farmers in Temanggung Regency have been running tobacco farming for over 20 years on average. This long experience has given them a high level of expertise in the field. Experienced farmers produce better crops since they understand what they do [20].

Temanggung Regency is a mountainous area over 700 m height above sea level. Tobacco was farmed on dry land managed by the farmers, with plot sizes averaging 5,625 m<sup>2</sup>, ranging from 2,000 to 21,500 m<sup>2</sup>, belonging to the small and medium categories. Since most farmers possessed more than two family members, they typically employed family labor to run their farming successfully. Meanwhile, non-family labor was widely utilized in post-harvest activities, encompassing chopping and drying tobacco. Table 1. displays that the cost of family labor was greater than that of non-family labor. Tobacco farming in Kenya and Zambia also experienced a similar situation [21]. Tobacco farmers incurred the largest cost proportion on labor. It aligns with previous research [15] in Ngadirejo District, Temanggung regency and [14] in Kendal regency.

**Table 1.** Total Cost of Chopped Tobacco Farming in Temanggung Regency, 2022.

No	Description	Amount (IDR)	Percentage (%)
	Fixed Cost		
1	Land tax	83,727	0.23
2	Depreciation costs	602,168	1.63
3	Own land rent	4,687,500	12.66
	Variable cost		
4	Manure	8,564,231	23.14
5	Chemical fertilizer	4,933,446	13.33
6	Pesticide	649,625	1.76
7	Non-family labor	5,001,351	13.51
8	Transportation	204,820	0.55
9	Basket	1,545,811	4.18
10	Fuel	52,558	0.14
11	Rafination sugar	223,284	0.60
12	Family labor	9,918,919	26.80
13	Own capital interest	546,526	1.48
	Total Cost	37,013,965	100

Source: Primary data analysis

Based on Tabel 1. most costs farmers incurred on production facilities went toward purchasing manure. At the beginning of the growing season, manure was utilized as basic fertilizer, administered simultaneously with land preparation. Adding manure could boost the soil's organic C content, benefiting the growth of tobacco plants [22] and [23].

Tobacco farmers in Bulu District, Temanggung, employed various types of chemical fertilizers: Urea and ZA to meet N element needs, white KNO<sub>3</sub> fertilizer to meet K and N element needs, and Fertila fertilizer containing N, P, and K elements with a ratio of 8:15:19. Fertila fertilizer was widely selected for containing complete macronutrients and was a

directive from PT Gudang Garam Tbk, adjusted to the Regulation of the Ministry of Health to reduce cigarette nicotine levels. Fertila fertilizer produced tobacco with a light brown color, less sharp aroma, light suction, and lower nicotine content than tobacco with urea fertilizer. The manufacturer offered a higher price for tobacco with such qualifications.

The total cost of chopped tobacco farming in Temanggung Regency was IDR 37,013,965 per 5,625 m<sup>2</sup> of land area or 65,802,604 per hectare. It was much higher than the total cost incurred by tobacco farmers in Ngadirejo District, Temanggung [15] and Bondowoso Regency [10]. The rising price of production facilities led to quite a large difference in cost.

Profit is the difference between total revenue and total costs. The feasibility of chopping tobacco farming was analyzed using Revenue Cost Ratio (R/C) and Break Even Point (BEP). Profit, R/C and BEP can be seen in table 2.

**Table 2.** Profit, R/C and BEP of Chopped Tobacco Farming in Temanggung Regency, 2022.

No	Description	Value
1	Fixed cost (IDR)	5,373,396
2	Variable cost (IDR)	31,640,570
3	Revenue (IDR)	38,551,056
4	Profit (IDR)	1,537,091
5	R/C	1.04
6	Production BEP (kg)	601.06
7	Price BEP (IDR/kg)	47,884

Source: Primary data analysis

Table 2 lists that the revenue of chopped tobacco farming in Temanggung Regency was IDR 38,551,056, with a price of IDR 49,872/kg and an average production of 773 kg. Chopped tobacco productivity in Temanggung in 2022 is 1,374 kg/hectare higher than in 2019 which was 648.37 kg/hectare and in 2020 which was 750.97 kg/hectare [24], higher than in Jember Regency was 960 kg/hectare [11] and Limapuluh Kota Regency, West Sumatra Province was 907 kg/hectare [13].

There were rainy days in Temanggung Regency in 2022, with an average of 17 rainy days per month and an average rainfall of 359 mm for the entire year [24]. Since the average month in 2021 had 15 rainy days with 389 mm of heavy rainfall [16]. The existence of high rainfall in 2022, has been anticipated by farmers, by managing agricultural land sustainably. Farmers use more manure and regulate irrigation water according to the needs of tobacco plants [6], resulting in less impact of climate change on tobacco production. It was a common practice for farmers to harvest early to minimize losses [7].

The profit of chopped tobacco farming in Temanggung Regency reached IDR 1,537,091 per 5,625 m<sup>2</sup> or IDR 2,732,606 per hectare. It was lower than that received by tobacco farmers in Panrang District, Jember Regency was IDR 22,546,992 per hectare [11] and Limapuluh Kota Regency, West Sumatra Province was IDR 6,832,913 per hectare [13]. Based on information from farmers, the price of chopped tobacco in Temanggung in 2022 is close to IDR 50,000 per kg, which is lower than IDR 75,000 in 2017. The decline in tobacco prices was influenced by the quality of tobacco due to climate and weather factors. Farmers in Temanggung Regency usually prepare for planting in April, plant in May and harvest in late July to early August. However, the weather is not supportive with a short dry season, which causes the drying of the tobacco is not optimal and the quality of the tobacco is not good. This situation is exacerbated by the existence of government regulation No. 109 of 2012 concerning Control of Materials Containing Tobacco Addictive Substances for Health and Minister of Finance Regulation No. 156/PMK.010/2018 concerning Changes in Excise Tax on Tobacco Products [8].

An R/C of 1.04 implies that chopped tobacco farming was feasible because, for every IDR 1 incurred, the revenue was 1.04. However, it was lower than simporis tobacco farming in Situbondo Regency, reaching 3.28 [10], Jember Regency, acquiring 2.4 [11], Limapuluh Kota Regency, West Sumatra Province obtaining 2.5 [13] and 1.09 [12].

BEP could be employed for future planning to determine the minimum price or production to make tobacco farming profitable. Following the BEP analysis, farmers must produce chopped tobacco higher than the production BEP of 601.06 kg with a selling price greater than the price BEP of IDR. 47,884 to gain profit and make farming feasible. The average tobacco production in Temanggung was 773 kg, with an average price of IDR 49,872. In other words, chopped tobacco farming was profitable because production was higher than the production BEP, and the price was greater than the price BEP. These findings resembled what happened in Patrang District, Jember Regency with a price BEP value of IDR 3,664,- and a production BEP of 1,056 kg [11].

## 4 Conclusion

Production costs of chopped tobacco farming in Temanggung Regency per land area 5,625 m<sup>2</sup> amounted to IDR 37,013,965 and the profit obtained was IDR 1,537,091. Climate change affects the quality of tobacco which in turn affects prices and profits. Tobacco farmers encountered a declining profit due to the government's policies regarding the protection of addictive tobacco substances and changes in tobacco excise. Based on the R/C and BEP criteria, tobacco farming in Temanggung Regency was still profitable and feasible.

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