

PROFIT OPTIMIZATION OF KURING TOFU PRODUCTION IN SEMARANG USING THE SIMPLEX METHOD

Miftahur Rohmah^{1*}, Annisa Fitriani², Muhamad Gani Rohman³

^{1*,2,3} Universitas Islam Negeri Salatiga, Salatiga, Indonesia

* Corresponding author. Jl. Lingkar Salatiga, Km. 2, Pulutan, Kec. Sidorejo, Kota Salatiga, Jawa Tengah

E-mail: mitarohmah544@gmail.com^{1*}
af008740@gmail.com²
muhamadganirohman@gmail.com³

Received 13 April 2026; Received in revised form 25 May 2026; Accepted 27 June 2026

ABSTRACT

The tofu industry continues to grow as part of the food business sector in Indonesia. However, tofu producers often make production decisions under limited raw materials, production capacity, and processing time, while production costs may change over time. Therefore, an optimization model is needed to help determine a production plan that can generate maximum profit. This study aims to determine the optimal production volume and maximum profit for white tofu and yellow tofu at Kuring Tofu Factory, Tengeran, Semarang Regency. This study applies linear programming using the simplex method, supported by POM-QM for Windows. Data were collected through interviews and direct observations related to raw material use, production capacity, production time, and profit from each product. The results show that the optimal solution is achieved by producing 20 batches of white tofu ($X_1 = 20$) and no yellow tofu ($X_2 = 0$), with a maximum profit of Rp10,566,000 per day. Compared with the factory's current profit of approximately Rp10,000,000 per day, this model provides an additional profit of Rp566,000 per day, or 5.66%. The manual calculation produced the same result as POM-QM for Windows, indicating that the simplex method is consistent in determining the optimal production plan. These findings show that the simplex method can support production planning and resource allocation in tofu production businesses.

Keywords: linear programming; maximum profit; simplex method.

ABSTRAK

Industri tahu terus berkembang sebagai bagian dari sektor usaha makanan di Indonesia. Namun, produsen tahu sering kali mengambil keputusan produksi dengan keterbatasan bahan baku, kapasitas produksi, dan waktu pengolahan, sementara biaya produksi dapat berubah dari waktu ke waktu. Oleh karena itu, diperlukan model optimasi untuk membantu menentukan rencana produksi yang dapat menghasilkan keuntungan maksimum. Penelitian ini bertujuan untuk menentukan volume produksi optimal dan keuntungan maksimum pada produksi tahu putih dan tahu kuning di Pabrik Tahu Kuring, Tengeran, Kabupaten Semarang. Penelitian ini menerapkan pemrograman linear menggunakan metode simpleks dengan bantuan POM-QM for Windows. Data dikumpulkan melalui wawancara dan observasi langsung terkait penggunaan bahan baku, kapasitas produksi, waktu produksi, dan keuntungan dari setiap produk. Hasil penelitian menunjukkan bahwa solusi optimal dicapai dengan memproduksi tahu putih sebanyak 20 kali produksi ($X_1 = 20$) dan tidak memproduksi tahu kuning ($X_2 = 0$), dengan keuntungan maksimum sebesar Rp10.566.000 per hari. Dibandingkan dengan keuntungan pabrik saat ini yang sekitar Rp10.000.000 per hari, model ini memberikan tambahan keuntungan sebesar Rp566.000 per hari atau 5,66%. Perhitungan manual menghasilkan hasil yang sama dengan POM-QM for Windows, yang menunjukkan bahwa metode simpleks konsisten dalam menentukan rencana produksi optimal. Temuan ini menunjukkan bahwa metode simpleks dapat mendukung perencanaan produksi dan alokasi sumber daya pada usaha produksi tahu.

Kata kunci: keuntungan maksimum; metode simpleks; pemrograman linier.



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Introduction

Industry in Indonesia has continued to grow along with technological development and innovation. In general, industry refers to economic activities that process raw materials or semi-finished goods into products with higher value (Ariska, 2024; Wirayuda et al., 2025). One of the food industries that continues to develop is tofu production. In Semarang Regency, particularly in Tengaran, Kuring Tofu Factory is one of the factories that produces silken tofu. Established in 2015 by Iwan Muliawan, Budi Setiawan, and H. Nizar, this factory produces two main products, namely white silken tofu and yellow silken tofu.

Since the Covid-19 outbreak, soybean prices as the main raw material for tofu production have increased significantly (Hamanay et al., 2021; Wakiden et al., 2024). This condition has created challenges for tofu producers, especially in maintaining production efficiency and profit. Several tofu factories in the Salatiga-Semarang area have experienced financial difficulties because they were unable to adjust to the increase in raw material prices. On the other hand, consumer demand for tofu remains relatively high, so producers need to manage production costs carefully without causing a significant increase in selling prices. For this reason, production planning needs to be supported by an optimization approach that can help determine the most profitable production combination under limited resources.

Previous studies have shown that linear programming, particularly the simplex method, can be used to solve production optimization problems. Linear programming is a mathematical method used to allocate limited resources to achieve certain objectives, such as minimizing costs or maximizing profits (Abidah et al., 2022; Rumetna et al., 2019; Sitohang & Idayani, 2024). The simplex method is often applied in decision-making because it provides a systematic way to obtain the optimal solution in resource allocation problems (Sari et al., 2020; Sundari et al., 2022; Suvriadi Panggabean et al., 2023). In practice, the use of software such as POM-QM can also help simplify the calculation process and make the results easier to verify (Akhmad Mukhlis et al., 2025; Hidayat et al., 2025; Mardillah et al., 2025; Wahyudien et al., 2022)

Susanti (2021) applied the simplex method to optimize the production of white tofu and takwa tofu, while (Clacier et al., 2023) used the simplex method assisted by POM-QM to optimize white tofu and yellow tofu production. Although these studies have shown the usefulness of the simplex method in tofu production, research that specifically examines production optimization at Kuring Tofu Factory is still limited. In addition, previous studies have not focused on comparing the optimal solution with the factory's actual production condition to estimate the potential increase in daily profit.

Therefore, this study offers a practical contribution by applying the simplex method to the production system of Kuring Tofu Factory and comparing the optimization result with the actual production pattern. This study aims to determine

the optimal production volume and maximum profit in the production of white tofu and yellow tofu at Kuring Tofu Factory, Tengaran, Semarang Regency. Using the simplex method assisted by POM-QM for Windows, this study models production quantity as the decision variable and profit as the objective function, while considering production capacity, production time, and raw material availability as constraints.

Research Methods

Research Design

This study employed a descriptive quantitative approach using linear programming with the simplex method to determine the optimal production combination and maximum profit at the Kuring Tofu Factory in Tengaran, Semarang Regency. The simplex calculations were carried out manually and verified using POM-QM for Windows software.

Research Location

The research was conducted at the Tahu Kuring Factory located on Jl. Tanjungsari, Kadipurwo, Bener, Tengaran District, Semarang Regency. This research was conducted in December 2025.

Research Object

The object of study in this research is the amount of production and profits generated in the process of making white tofu and yellow tofu.

Research Variables

The variables used in this study consisted of:

- a. Decision Variables
 X_1 : the number of white tofu productions
 X_2 : the number of yellow tofu productions
- b. Objective Function
The objective function was to maximize production profit
- c. Constraint Variables
The constraints in this study included the availability of soybeans, garlic, butter, salt, turmeric, firewood, production capacity, and production time.

Research methods

1. Data collection

The most important research activity is data collection (Ardiansyah et al., 2023). In this study, data was collected with the aim of identifying and obtaining information that is closely related to the subject being studied. Data collection techniques were carried out through interviews with the manager of the Kuring Tofu Factory regarding the tofu production process and observations of processing at the factory site. The data required in this study include raw material data for silken tofu production, product data, production quantity data, material capacity data, and tofu product profit data per production. The interview data can be presented in the Table 1.

Table 1. Data on tofu production ingredients

Ingredients for Making Tofu	White Tofu	Yellow Tofu	Capacity
Soya bean	29 kg	14.5 kg	2.5 tons
Garlic	400 g	200 g	20 kg
Butter	500 g	250 g	225 kg
Salt	1500 g	750 g	1 ton
Turmeric	0	1.7 kg	2 quintals
Firewood	37.5 kg	37.5 kg	1500 kg
Production capacity	1452	726	29040
Time	30 minutes	30 minutes	20 hours
Profit	528300	257350	

Based on Table 1. the simplex method will be used to maximize production volume and profit. Given the limitations of raw materials, time, and production capacity, this method helps maximize profits and helps make production decisions more efficient and accurate.

2. Data Processing and Analysis Technique

The data obtained from interviews and direct observations were first processed by organizing and classifying the data based on raw material usage, production capacity, production time, product output, and profit generated from each type of tofu production. The processed data were then transformed into a linear programming mathematical model consisting of decision variables, objective functions, and constraint function to determine the optimal production combination.

The data analysis technique used in this study was the simplex method assisted by POM-QM for Windows software. The simplex method was selected because it is effective in solving optimization problems involving limited resources and maximizing profits Luh & Pivin (2017). The simplex method works iteratively until the optimal solution is obtained (Abidah et al., 2022; Antonio Alberth Pratama et al., 2024; Saputra et al., 2024). Simplex method calculations can be done in two ways, namely manually or through an application or software program (Firdaus et al., 2024). The stages of data processing and analysis using the simplex method are as follows (Nurmayanti & Sudrajat, 2021; Reynoldtan et al., 2024):

- a. Determine and convert the decision variables to be used into a mathematical model.
- b. Determine the objective function and convert it into a mathematical equation.

- c. Determine the existing constraint function and then change it into a mathematical equation.
- d. Arrange all forms of mathematical equations into a simplex table and determine the pivot column and pivot row as in Table 2.

Table 2. Initial table of simplex method

Basic variables	x_1	x_2	...	x_n	S_1	S_2	...	S_n	NK
S_1	a_{m1}	a_{m1}	...	...	...	...	...	1	b_m
S_2	a_{11}	a_{12}	...	a_{2n}	1	0	0	0	b_1
\vdots	a_{21}	a_{22}	...	a_{2n}	0	1	0	0	b_2
S_n	...	...	...	...	...	...	...	...	...
Z	$-c_1$	$-c_2$	...	$-c_n$	0	0	0	0	0

Based on Table 2 description:

- The basic variable is the variable whose value is the same as the right side of the equation.
 - NK is the right-hand value (key value) of the equation, that is, the value behind the equal sign or the value of the available limiting resource.
 - $x_1 \dots x_n$ is a constraint function
 - $S_1 \dots S_n$ is a slack variable, namely a variable that is added to the mathematical model of the constraint function to convert an inequality into an equation.
 - Z is the objective function
- e. Determines the intersection between the pivot column and the pivot row, namely the pivot element.
 - f. Perform the iteration stage by updating the decision variables and dividing the value in the pivot row by the pivot element.
 - g. Change the values outside the pivot row until there are no negative values.
 - h. If there is still a negative Z value, the iteration continues until optimal results are obtained (Novia et al., 2025).

The simplex method solves problems through repeated calculations until an optimal solution is found. Therefore, using an application to simplify and speed up the calculation process is essential, one example being the QM for Windows application (Putri et al., 2026).

Results and Discussion

The data obtained in this study were taken from interviews with the management of the Tahu Kuring Factory, which are presented in Table 1. Based on the interviews conducted, it was discovered that the Tahu Kuring Factory produces two types of tofu: white tofu and yellow tofu. The Tahu Kuring Factory can produce up to 40 tofu batches per day. The stages for producing tofu are as follows:

1. Soybeans are soaked for 4 hours to soften the soybeans and peel off the soybean skin.

2. Then the soybeans are washed until clean and the soybeans are ground until smooth using a grinding machine.
3. After the soybeans are smooth, then the soybeans are boiled until cooked and boiled 3 times, each time producing 30 minutes.
4. Next, the tofu extract is printed on each mold provided and left for 10 minutes.
5. The tofu that has been printed goes into the slicing process, namely each board gets 121 pieces of tofu.
6. The next process is to season the tofu by boiling it again using salt, while for yellow tofu, 1.7 kg of turmeric juice is added for each production.
7. The final step is packaging the tofu, each package contains 10 pieces of tofu.

The raw materials, products, and capacity of Kuring Tofu are detailed in Table 3.

Table 3. Raw materials, products, and capacity of kuring tofu

	White Tofu	Yellow tofu	Capacity
Soya bean	29	14.5	2500
Garlic	0.4	0.2	20
Butter	0.5	0.25	225
Salt	1.5	0.75	1000
Turmeric	0	1.7	200
Firewood	37.5	37.5	1500
Production capacity	1452	726	29040
Time	0.5	0.5	20
Profit	528300	257350	

*in kilograms

Based on Table 3, the optimization problem was formulated into a linear programming mathematical model using the simplex method. The identification of the mathematical model using the simplex method is:

1. Decision variables

X_1 = The amount of white tofu that must be produced

X_2 = The amount of yellow tofu that must be produced

2. Objective function

The objective function aims to maximize the total production profit obtained from white tofu and yellow tofu production. The mathematical model of the objective function is formulated as follows :

$$Z = 528300X_1 + 257350X_2$$

3. Constraint function

The production constraints are based on availability of raw materials, production capacity, and production time. The constraints are formulated as follows:

$$\begin{aligned}
 \text{Soya bean} & : 29X_1 + 14,5X_2 \leq 2500 \\
 \text{Garlic} & : 0,4X_1 + 0,2X_2 \leq 20 \\
 \text{Butter} & : 0,5X_1 + 0,25X_2 \leq 225 \\
 \text{Salt} & : 1,5X_1 + 0,75X_2 \leq 1000 \\
 \text{Turmeric} & : 1,7X_2 \leq 200 \\
 \text{Firewood} & : 37,5X_1 + 37,5X_2 \leq 1500 \\
 \text{Production capacity} & : 1452X_1 + 726X_2 \leq 29040 \\
 \text{Time} & : 0,5X_1 + 0,5X_2 \leq 20 \\
 & X_1, X_2 \geq 0
 \end{aligned}$$

After being made into a mathematical formulation, it is then entered into the simplex method, namely in the form of iterations.

1. Initial simplex method table

Once the mathematical model is formulated, the data is processed using the simplex method. The initial iteration of this process is presented in Table 4.

Table 4. The first iteration of simplex method

Basic variables	X1	X2	S1	S2	S3	S4	S5	S6	S7	S8	NK	R
S1	29.5	14.5	1	0	0	0	0	0	0	0	2500	84.75
S2	0.4	0.2	0	1	0	0	0	0	0	0	20	50
S3	0.5	0.25	0	0	1	0	0	0	0	0	225	450
S4	1.5	0.75	0	0	0	1	0	0	0	0	1000	666.67
S5	0	1.7	0	0	0	0	1	0	0	0	200	0
S6	37.5	37.5	0	0	0	0	0	1	0	0	1500	40
S7	1452	726	0	0	0	0	0	0	1	0	29040	20
S8	0.5	0.5	0	0	0	0	0	0	0	1	20	40
z_j	0	0	0	0	0	0	0	0	0	0	0	
$c_j - z_j$	528,300	257,350	0	0	0	0	0	0	0	0	0	

- Step 1: Determine the pivot column
 In the initial table, the values $c_j - z_j$ for $X_1 = 528.300$ and for $X_2 = 257.350$. Since X_1 they are the largest values, the pivot column is X_1
- Step 2: Determine the pivot row
 The smallest ratio obtained is 20 in row S_7 , so the pivot row is row S_7 . Thus, the variable S_7 is removed from the row and replaced by X_1 .
- Step 3: Determine the pivot element
 The pivot element is the value at the intersection of the pivot column and pivot row. The resulting element is 1452. This element is used to perform row operations, resulting in the pivot value being 1 .
- Step 4: change the pivot row
 The pivot row is divided by the pivot element value to get the value 1 in the key column.

$$\text{New Row} = \frac{\text{Row } S_7}{1452}$$

The result produces a new row with the base variable $X1$, so that in the next iteration table $X1$ it replaces it $S7$ as the base variable.

- Step 5 : change another line

Once the pivot row is obtained, the next step is to change all other rows so that the value in the key column becomes 0.

2. The complete results of the second iteration are presented in Table 5.

Table 5. The second iteration of the two-phase simplex method

Basic variables	$X1$	$X2$	$S1$	$S2$	$S3$	$S4$	$S5$	$S6$	$S7$	$S8$	NK
$S1$	0	0	1	0	0	0	0	0	-0.02	0	1920
$S2$	0	0	0	1	0	0	0	0	-0.0003	0	12.0
$S3$	0	0	0	0	1	0	0	0	-0.0003	0	215
$S4$	0	0	0	0	0	1	0	0	-0.001	0	970
$S5$	0	1.7	0	0	0	0	1	0	0	0	200
$S6$	0	18.75	0	0	0	0	0	1	-0.0258	0	750
$X1$	1	0.5	0	0	0	0	0	0	0.0007	0	20
$S8$	0	0.25	0	0	0	0	0	0	-0.0003	1	10
z_j	528300	264150	0	0	0	0	0	0	363.84	0	10,566,000
$c_j - z_j$	0	-6800	0	0	0	0	0	0	-	0	
									363,843		

Based on Table 5, it was found that all values $c_j - z_j$ were no longer positive, so the iteration process was stopped. Thus, the optimal solution was achieved when $X1 = 20$ and $X2 = 0$ with the maximum value of the objective function of 10.566.000. These optimal calculation results are supported by the POM-QM for Windows program output presented in Figure 1.

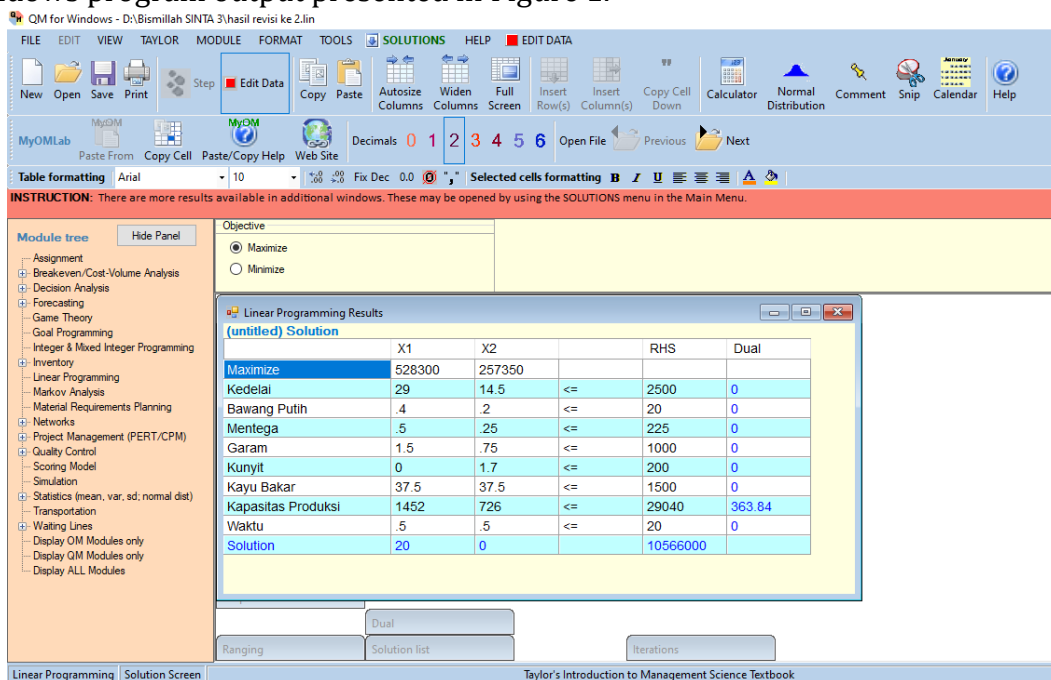


Figure 1. Results from POM-QM For Windows

Based on Figure 1, the results of manual calculations and calculations using POM-QM for Windows were the same. This indicates that the obtained solution has reached maximum optimal conditions.

White Tofu (X_1) = 20 units

Yellow Tofu (X_2) = 0 units

Maximum profit = Rp. 10,566,000

Based on the results of interviews with the management, the Kuring Tofu Factory currently produces 40 times per day with a ratio of white tofu to yellow tofu of 2:1, which is approximately 27 times the production of white tofu and 13 times the production of yellow tofu. With this composition, the profit obtained by the factory is approximately Rp10,000,000 per day. Meanwhile, the results of calculations using the simplex method show that the optimal production combination is to produce white tofu 20 times ($X_1 = 20$) and not produce yellow tofu ($X_2 = 0$), with a maximum profit of Rp10,566,000 per day.

The comparison between current production conditions and the optimization results can be seen in the following description. Under optimal conditions, the factory produces white tofu 20 times and yellow tofu 0 times with a profit of Rp10,566,000 per day. The profit difference between optimal conditions and current production conditions is Rp566,000 per day. If calculated as a percentage, the profit increase that can be obtained is $(Rp566,000 / Rp10,000,000) \times 100\% = 5.66\%$. This shows that by applying the simplex method calculation results, the factory has the potential to increase daily profits by 5.66% compared to the current production pattern.

Compared with Susanti (2021), which optimized white tofu and takwa tofu production, and (Clacier et al., 2023), which optimized white and yellow tofu production using the simplex method and POM-QM, this study offers a different contribution by applying the optimization model specifically to Kuring Tofu Factory and comparing the result with the factory's actual production condition. The advantage of this study is that it not only determines the optimal production combination of 20 white tofu batches and 0 yellow tofu batches with a maximum profit of Rp10,566,000 per day but also identifies a potential profit increase of Rp566,000, or 5.66%, compared to the current production pattern. However, this study is limited because market demand has not been included as a formal constraint in the mathematical model, so the recommendation to stop yellow tofu production should be implemented carefully. Therefore, the novelty of this study lies in its practical application of the simplex method by combining profit optimization, comparison with actual production, and managerial implications for Kuring Tofu Factory.

Conclusion and Suggestion

Based on the results of research conducted at the Tofu's Kuring Factory, Tengeran, Semarang Regency, it can be concluded that the application of the simplex method with the help of POM-QM for Windows is able to determine the optimal production amount to maximize profit. The calculation results show that the maximum profit of Rp10,566,000 per day is achieved by producing white tofu 20 times ($X_1 = 20$) and not producing yellow tofu ($X_2 = 0$). Compared to the actual production condition, which generates approximately Rp10,000,000 per day, the

optimization result shows a potential profit increase of Rp566,000 per day or 5.66%. The main limiting factors that influence the achievement of maximum profit are production capacity and production time, while other raw materials remain within sufficient limits.

Future research is suggested to include market demand as one of the constraints in the mathematical model so that the optimization result can better reflect actual consumer needs. Further studies may also conduct sensitivity analysis on soybean price fluctuations, selling prices, and production costs to obtain more flexible and realistic optimization results. In addition, future researchers can compare the simplex method with other optimization methods to determine the most suitable approach for production planning in tofu industries.

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