

Production Decision on Two Competitive Products: Black Pepper versus White Pepper

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ABSTRACT

Black and white peppers are two competitive products that increase in quantity of one reduces quantity of the other. Farmers decide whether to produce black or white pepper, or both. Black pepper is the cheapest and fastest to produce; and its post-harvest yield is the highest. White pepper's price is the highest. Output of this research is policy that allows decision-making strategy between black and white peppers that could be static or dynamic. Efficiency-driven farmers should focus on black pepper. Profitability-driven farmers should focus on white pepper. Flexibility-driven farmers keep option open until harvested and threshed pepper is ready for post-harvest process – postponed decision depends on latest price and cost, and other justifiable reasons. Policy recommends cultivars (plant varieties produced in cultivation by selective breeding) for each group of farmers as post-harvest yield varies by pepper product and cultivar. This decision-making strategy is inclusive in the sense it considers ex-farm selling price, post-harvest cost and the choice of pepper cultivar.



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KEY LESSONS

1. High-priced white pepper is mostly more profitable than black pepper.
2. Low-cost and high-yield black pepper production is the most efficient.
3. Select pepper cultivars strategically – it influences post-harvest yield.
4. Post-harvest yield and cost, and ex-farm selling price influence efficiency and profitability of black and white peppers.
5. Multi-product strategy isn't most efficient and profitable – better do single-product production.

produced 432 kmt black pepper and 91 kmt white pepper in 2017. Worldwide, 493400 ha of land are cultivated with pepper.

The **main sources** of black and white peppers are Vietnam, Brazil, India, Indonesia, China, Malaysia and Sri Lanka. Collectively, these countries produce 93% of world's black pepper production and 100% of world's white pepper production. From product perspective, they produce 80% black and 20% white pepper.

Black and white peppers are two primary products of *Piper nigrum* L. plant that black and white peppers contributed to 85% of global pepper export in 2004. They are a pair of competitive products that increase in quantity of one will reduce

INTRODUCTION

Pepper is a USD 4 billion industry. A million pepper farmers from 25 countries

quantity of the other. Each has advantage over the other. Black pepper is the cheapest (least post-harvest labor input) and fastest (least post-harvest process time) to produce; and its post-harvest yield is the highest. On the other hand, white pepper's ex-farm selling price is the highest. Pepper farmers decide which pepper product to produce, if not both. Some pepper farmers specializing on production of either black or white pepper. Other pepper farmers keep their option open until harvested and threshed pepper ready for post-harvest process – they may produce significant amount of both peppers.

Some of pepper producing countries are focusing on either black or white pepper. Brazil, India and Sri Lanka produce more than 95% black pepper and less than 5% white pepper, and China produces 100% white pepper for its domestic market. Vietnam produces 90% black pepper and 10% white pepper, Malaysia produces 70% black pepper and 30% white pepper, and Indonesia produces 60% black pepper and 40% white pepper.

Research questions. Question 1: Under what condition does white pepper production more efficient than black pepper production? Question 2: Under what condition does white pepper production give incremental efficiency better than black pepper production's efficiency ratio? Question 3: Under what condition does white pepper is the profit-maximizing product? Question 4: In the case of multi-product production, what is the profit maximizing product mix?

EXTANT KNOWLEDGE

Chen et al. (2018) did phenetic analysis on ten pepper cultivars found in Sarawak, Malaysia. (A phenetic analysis aims to classify cultivars based on similarities

between them without regard to their evolutionary relationships.) Their work is the first concurrent study on black and white peppers' post-harvest yield (also known as conversion rate and dry recovery). This enables comparison between black and white peppers in term of efficiency and profitability.

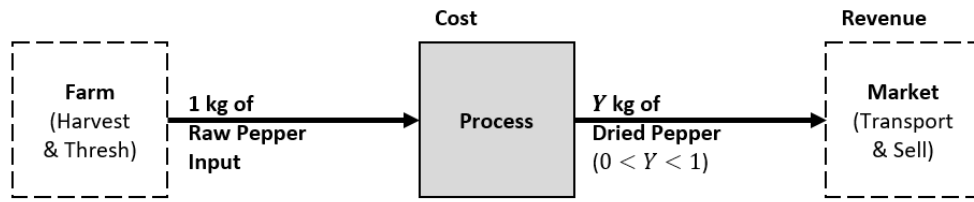
Babu et al. (1999) find that it takes 1.5 mandays of labor input to process 1 ton of raw pepper input into black pepper, and 8 mandays of labor input to process 1 ton of raw pepper input into white pepper.

From price perspective, white pepper is more expensive than black pepper due to cumbersome production, i.e., most number of steps, longest process time, and requires the most labor input (Kiong, Rahim, & Shamsudin, 2010).

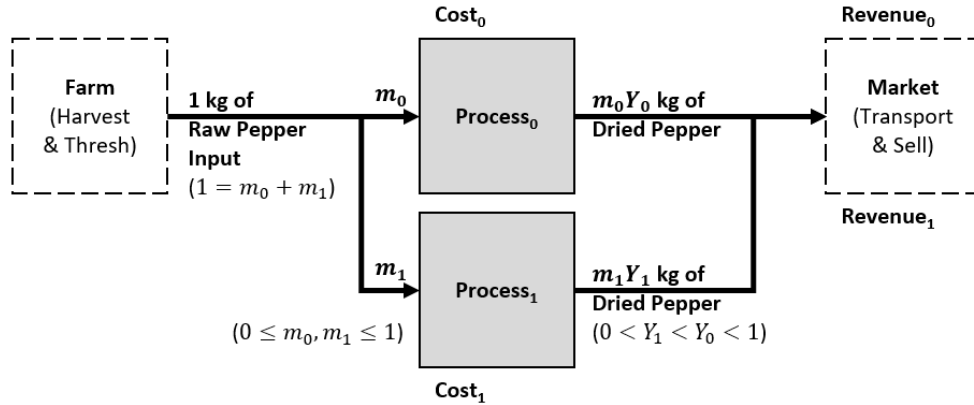
MODEL

We build upon initial intuition with single-product profit generation model (Figure 1(a)). In addition to extant knowledge mentioned earlier, we use publicly available black and white peppers' average daily prices for nine pepper production districts in Sarawak, Malaysia; and labor wage rate (W) in Sarawak, Malaysia. We observed influence of post-harvest cost ($C = WL$) and yield (Y), and ex-farm selling price (P) to profit ($R - C$) and efficiency ratio (C/R). We compare black and white peppers' efficiency and profit.

Next, we compare variables in profit generation models of black and white peppers (Figure 1(b)**Error! Reference source not found.****Error! Reference source not found.**). We introduced ratios and increments of yield, cost, labor input (L), price, revenue ($R = PY$), efficiency ratio and profit to help us to study black versus white pepper.



(a) Single-Product Profit Generation Model



(b) Multi-Product Profit Generation Model

Figure 1: Single-Product and Multi-Product Profit Generation Model

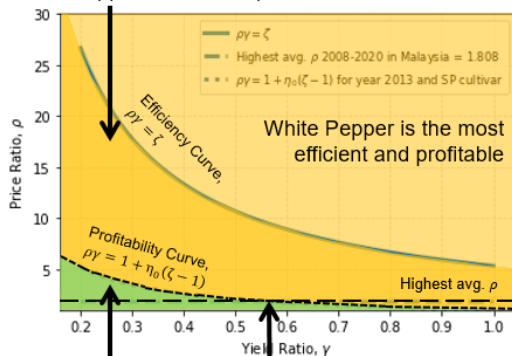
RESULTS

When price (P) and post-harvest yield (Y) are high, revenue ($R = PY$) is high. When revenue is high and post-harvest cost (C) is low, the efficiency ratio (C/R) is low and profit ($R - C$) is high.

We observed that black pepper’s efficiency ratio is lower than white pepper’s.

We observed that white pepper is mostly more profitable than black pepper – however pepper cultivar, labor wage rate (W) and pepper prices can influence adversely.

Black Pepper is the most efficient.
White Pepper is the most profitable.



Black Pepper is the most efficient and profitable
White Pepper is not always the most profitable product. Importance of pepper cultivar, which influences yield & profitability-driven decision.

Figure 2: Profitability and efficiency curves

		Efficiency: Most Efficient Product	
		Black Pepper	White Pepper
Profitability: Most Profitable Product	Black Pepper	Black pepper is the most efficient and profitable	White pepper is the most efficient. Black pepper is the most profitable.
	White Pepper	Black pepper is the most efficient. White pepper is the most profitable.	White pepper is the most efficient and profitable.

Figure 3: Profitability-Efficiency matrix

We defined and observed the relationship between efficiency ratio, yield ratio (Y_1/Y_0), price ratio (P_1/P_0) and cost ratio (C_1/C_0) influence white pepper’s

efficiency ratio and profitability relative to black pepper's.

At the initial stage of farm planning, farmers need to decide whether to focus on single product, either black pepper (efficiency-driven) or white pepper (profitability-driven); or to delay the product decision until harvested and threshed pepper ready for post-harvest process (flexibility-driven).

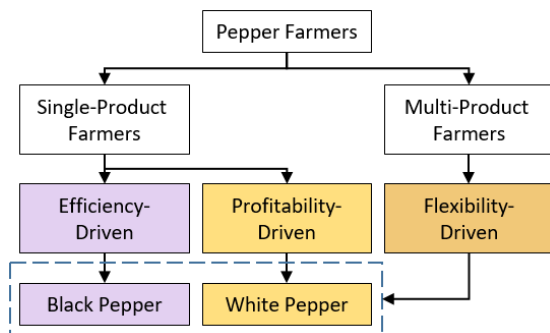


Figure 4: Types of Pepper Farmers

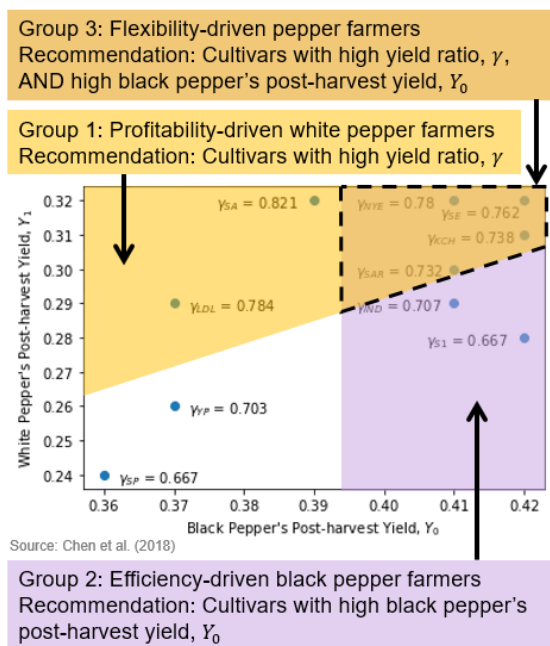


Figure 5: Scatterplot of black versus white pepper's yield

Certain pepper cultivars have advantage over the other as their black pepper's post-harvest yield (Y_0) and/or their yield ratio (Y_1/Y_0) are high. Important for farmers to

decide pepper cultivars according to their selected production strategy.

For farmers who are *efficiency-driven*, we recommend pepper cultivars with high black pepper's post-harvest yield, e.g., SE, KCH, S1, NYE, SAR and IND. High post-harvest yield means higher dried black pepper mass produced from 1 kg raw pepper input (harvested and threshed), which ultimately means higher revenue.

Farmers can pursue *profitability-driven* strategy by specializing in white pepper. They need to plant pepper cultivars with higher yield ratio, e.g., SA, LDL, NYE, SE, KCH and SAR.

For farmers who want to maximize based on existing prices and relevant costs, a flexible approach that allows to keep the option to choose between black or white pepper is key. These multi-product farmers need to prioritize pepper cultivars that have high black pepper's post-harvest yield and high yield ratio, e.g., SE, KCH, NYE and SAR. These cultivars have the high median black pepper's post-harvest yield for black pepper (≥ 0.41) and high yield ratio (≥ 0.732).

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