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FINANCIAL FEASIBILITY OF KONJAC (*Amorphophallus muelleri* Blume) PRODUCTION IN MALAYSIA USING SEED AND MOTHER CORMS OF DIFFERENT SIZES

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ABSTRACT

Konjac (*Amorphophallus muelleri* Blume) is a high-value industrial crop with growing global demand. Although it has become an export-oriented crop in the region, Malaysian production remains limited; thus, evidence on financial feasibility under local conditions is needed. The financial performance of three konjac production systems (seed-based, small, and big mother corm) was assessed using enterprise budgeting, sensitivity analysis, and partial budgeting. Pre-commercial, single-production-cycle field trials at Universiti Putra Malaysia provided yield and cost data. Enterprise budgets were prepared on a per-hectare, per-cycle basis, and a sensitivity analysis was used to assess robustness to 10%–30% reductions in farm-gate prices and increases in operating costs. Partial budgeting was applied to estimate the change in net profit when planting material was upgraded from small to big. Big mother corm achieved the highest yield and revenue (RM172,985/ha/cycle), while seed-based production recorded the lowest yield and revenue (RM75,183/ha/cycle). Profitability Index (PI) was highest for big mother corms (PI = 2.87), followed by small mother corms (PI = 2.80), and was lowest for seed (PI = 1.26). The seed-based enterprise showed the greatest vulnerability to market stress, with a 30% price reduction reducing PI to 0.89 (loss), whereas the big-corm enterprise remained profitable. Upgrading from small to big mother corms increased profit by RM24,580/ha/cycle. Corm-based production offered higher profitability and greater resilience than seed-based production, with large mother corms providing the best balance of yield, cost efficiency, and net returns for konjac cultivation.

Introduction

Konjac (*Amorphophallus muelleri* Blume) is a tuberous crop native to Southeast Asia that has gained increasing attention as a high-value industrial raw material. Its underground corms are rich in glucomannan, a water-soluble dietary fibre widely used in food formulations, pharmaceutical applications, and as a functional ingredient due to its physicochemical and health-related properties (Nurlela *et al.*, 2022; Sholichah *et al.*, 2023). Rising demand for konjac-based products has been reflected in commercial market projections. The global konjac market was valued at USD948.2 million in 2021 and is projected to reach USD1.5 billion by 2028 (KBV Research, 2022), consistent with the expanding applications of konjac glucomannan and the broader demand for fibre-based functional products.

Across regional countries, *Amorphophallus muelleri* (*A. muelleri*) has become an export-oriented industrial crop in Indonesia over the past decade (Riptanti *et al.*, 2023), while cultivation and production research have also been documented in Thailand (Sungkajanttranon *et al.*, 2013; Wongpinta *et al.*, 2024). In contrast, despite expanding regional markets and rising global demand, published documentation of commercial *A. muelleri* production in Malaysia remains limited, including limited evidence on enterprise-level profitability under local conditions. This limitation is important because current food security initiatives have emphasised the need to diversify supply sources and identify potential alternative foods (Universiti Putra Malaysia, 2025). Therefore, assessing the financial feasibility of *A. muelleri* under Malaysian conditions would provide timely evidence on its potential contribution to crop diversification and commercial production.

Before large-scale commercial production is promoted or adopted locally, the financial feasibility of *A. muelleri* under Malaysian conditions must be established. Financial evaluation is essential for assessing feasibility and scalability because input intensity, labour requirements, biological variability, and output price uncertainty shape profitability. Evidence from regional producing areas further indicates that farm-gate corm prices can fluctuate widely, implying that financial outcomes may shift substantially across different price scenarios (Wongpinta *et al.*, 2024). Financial feasibility is an important component of sustainable agricultural development because the adoption of alternative crops depends not only on agronomic performance but also on economic viability under local production conditions. In this context, evaluating the financial feasibility of *A. muelleri* production can support resource-use decisions, crop diversification, and production planning in Malaysia.

Enterprise budgets provide the foundational accounting framework for integrating variable and fixed costs with expected revenue to produce indicators such as gross margin, net return, and the Profitability Index (PI) (Wei *et al.*, 2020). Enterprise budgets are typically constructed under base-case assumptions; therefore, sensitivity analysis is required to assess the robustness of profitability outcomes to changes in key variables, such as selling price, yield, and operational costs. Sensitivity analysis quantifies downside risk by subjecting the enterprise budget to economic stress scenarios, particularly reductions in farm-gate selling price and increases in operating costs to evaluate how profitability indicators respond under adverse conditions (Chen *et al.*, 2017). Partial budgeting complements enterprise budgeting when the decision involves a marginal adjustment rather than a whole-enterprise comparison, by isolating only the cost and return components that change between alternatives, namely added costs, reduced costs, added returns, and reduced returns to estimate the net change in profit attributable to the adjustment (Kay *et al.*, 2020).

Previous field experiments under Malaysian conditions at UPM identified 70% shade and 150 kg/ha K as the optimum management combination for seed-derived corm production. Further evaluation under the same 70% shade environment showed that using larger mother corms significantly increased yield compared with smaller mother corms, while 150 kg/ha K remained the optimum rate. However, big mother corms require higher upfront expenditure on planting materials, raising the practical question of whether the yield gains justify the added investment. In addition, seed-based planting material generally produces lower yield than corm-based planting material. However, the extent to which this yield difference translates into reduced economic returns and narrower profit margins remains unclear. This information is needed to support producer decisions on planting material selection to maximise profitability and improve returns on investment. Accordingly, this study aimed (i) to quantify and compare the profitability of *A. muelleri* corm production under three different planting materials (seed, small mother corms, and big mother corms) using enterprise budgeting indicators, (ii) to evaluate the financial robustness of each planting material to possible changes in selling price and operating costs using sensitivity analysis, and (iii) to assess whether upgrading from small to big mother corms is economically justified using partial budgeting.

Materials and Methods

Data Collection

This study used both primary and secondary data. Secondary data were obtained from statistical reports, peer-reviewed journals, books, and relevant websites. Primary data on costs and yield were generated from a series of field trials conducted at Field 15, Faculty of Agriculture, Universiti Putra Malaysia (UPM), Selangor, Malaysia (2°59'N, 101°44'E). The yield values used in the financial analysis were based on the mean of four replications obtained from these field trials. The seed-based production trial was conducted in 2023 on an approximate area of 400 m², while the mother-corm size trial was conducted in 2024 on an approximate area of 300 m². These data were used to evaluate the economic viability of konjac production at the pre-commercial stage, as the crop was grown in research plots rather than under commercial farm conditions. For economic analysis, input use and production costs recorded at the plot level were extrapolated to a per-hectare basis to generate enterprise budgets. Therefore, the estimated costs and returns should be interpreted as indicative pre-commercial projections rather than actual commercial-scale values.

Planting Density and Mother Corm Size Category

In the seed-derived production scenario, plants were established at a density of 166,600 plants/ha, with three rows per bed spaced 30 cm apart and 15 cm between plants within each row. In the corm-derived production scenario, two mother-corm size categories were used, namely small mother corms (20 g to 70 g fresh weight) and big mother corms (100 g to 150 g fresh weight). Corm-derived plants were established at a density of 55,533 plants/ha, with plants arranged in two rows per bed at 60 cm between rows and 30 cm between plants within each row.

Enterprise Budgeting

Enterprise budgeting was used to estimate the costs, returns, and profitability of konjac production based on the study data (Table 1). Enterprise budgets were developed on a per-hectare, per-cycle basis for three production scenarios differentiated by planting material: Seed, small mother corms, and big mother corms. A uniform farm-gate price of RM2.50/kg was used as the baseline in the enterprise budget because it falls within the mid-range of the farm-gate prices reported for *A. muelleri* in Thailand, namely RM1.55/kg to RM3.62/kg (Wongpinta *et al.*, 2024). This source provided the most recent price information and was therefore used as a practical reference in the absence of local Malaysian commercial price data.

Total production cost was separated into fixed and variable components (operating costs). Fixed costs comprised establishment and capital items required to set up production, including the shading structure, irrigation system, and machinery or equipment used in operations. These fixed-cost items were allocated to each production cycle using a 10% annual depreciation rate based on their expected useful life. The irrigation system and structural components were assumed to last 10 years, while netting, weed mat, and silvershine were assumed to last three years. Operating costs consisted of recurrent inputs that vary with production scale, including planting materials, fertilisers, fungicides, herbicides, and labour (wages). Labour costs were estimated using Malaysia's statutory minimum wage of RM1,700 per month, as provided under

Table 1: Production cost analysis

Analysis	Formula
Total revenue	Yield × farm price
Total production cost	Operating costs + fixed costs
Net profit	Total revenue – total production costs
Gross profit	Total revenue – operating costs

the Minimum Wages Order 2024 [P.U.(A) 376/2024] (Malaysia, 2024). Labour input was assumed to be equivalent to two full-time labourers throughout the production cycle and total labour cost was derived by multiplying the monthly wage rate by the cycle duration. For each scenario, the enterprise budget summarised total revenue, total production cost, gross profit, and net profit derived from the observed yield and cost data collected during the study.

From the enterprise budgets, the profitability index (PI), breakeven price, and partial breakeven yield were calculated. The Profitability Index (PI) measures cost efficiency as the ratio of total revenue to total production cost, where PI > 1 indicates that revenue exceeds total production cost. The breakeven price represents the minimum selling price required to cover total production cost and therefore reflects full-cost viability (Dillon, 1993; Kay *et al*., 2020; Nisar *et al*., 2021). The partial breakeven yield, on the other hand, represents the minimum yield required to cover operating costs at a given selling price and is therefore an indicator of short-run operational feasibility. The indicators were calculated as follows:

Profitability index, PI:

$$PI = \frac{TR}{TC}$$

Breakeven price, P_{BE} (RM/kg):

$$P_{BE} = \frac{TC - OI}{Y}$$

Partial breakeven price, $P_{BE(OC)}$ (RM/kg):

$$P_{BE(OC)} = \frac{OC - OI}{Y}$$

where:

TR = Total revenue (RM/ha/cycle)
TC = Total production cost (RM/ha/cycle)
OI = Other income (RM/ha/cycle)
Y = Corm yield (kg/ha/cycle)
OC = Operating cost (RM/ha/cycle)

Sensitivity Analysis

For each enterprise (seed, small mother corm, and big mother corm), a sensitivity analysis was conducted to evaluate the robustness of profitability outcomes to decreases in selling price, increases in operating cost, decreases in yield, and combinations of these scenarios. The profitability index was recalculated under three downside price and yield scenarios (10%, 20%, and 30% reductions in selling price and yield) and three cost-inflation scenarios (10%, 20%, and 30% increases in operating costs). A combined adverse scenario (simultaneous selling-price decrease, yield decrease, and operating-cost increase) was also evaluated to represent a compounded risk condition and to identify scenarios most vulnerable to economic uncertainty (Sgroi *et al.*, 2015).

Partial Budgeting Analysis

A partial budget was conducted to directly compare the two corm-based enterprises (small mother corm vs big mother corm). Partial budgeting evaluates the financial effect of a change in practice by considering only differences in costs and returns attributable to that change (Sims & Heney, 2017). In this study, the partial budget was structured to isolate the incremental economic effects of switching from small to big mother corms by classifying changes into four components—added returns, reduced returns, added costs, and reduced costs. These components were organised to clearly separate positive and negative impacts, allowing the net change in profit to be calculated from the differences between the two enterprises (Table 2).

Results and Discussion

Enterprise Budgeting

Enterprise budgets were constructed to quantify and compare the costs and returns associated with konjac production using seed, small mother corms, and big mother corms as initial planting material. Budgets were prepared on a per-hectare-per-cycle basis to enable direct comparison among scenarios.

Yield and Revenue

Konjac yield differed markedly across planting material types, with the big mother corm enterprise producing the highest yield (69.19 t/ha/cycle) followed by the small mother corm enterprise (54.92 t/ha/cycle). In comparison, the seed-based enterprise recorded the lowest yield (30.07 t/ha/cycle) [Figure 1 (A)]. Using a uniform farm-gate price of RM2.50/kg, total revenue was highest for the big mother corm enterprise (RM172,985/ha/cycle), followed by the small mother corm enterprise (RM137,300/ha/cycle), and the seed-based enterprise (RM75,183/ha/cycle) [Figure 1 (B)]. On this basis, revenue from the big mother corm enterprise was 26.00% higher than the small mother corm enterprise and 130.13% higher than the seed-based enterprise, indicating that the higher yield achieved with large planting corms translated directly into substantially improved gross returns.

Operating and Production Cost

The three production scenarios also showed distinct cost profiles. Figure 2 (A) compares the operating costs per hectare per cycle. Relative to the small mother corm enterprise (RM39,848/ha/cycle), the seed enterprise's operating cost (RM47,858/ha/cycle) was 20.10% higher, while

Table 2: The concept of partial budgeting approach

Benefits	Value	Costs	Value
Return increase	RMXX	Return decrease	RMXX
Increased income due to change		Reduced income due to change	
Cost decrease	RMXX	Cost increase	RMXX
Reduced costs due to change		Increased costs due to change	
Total benefits	RMXX (A)	Total cost	RMXX (B)
Net income [(A) – (B)] = - (value) / + (value)			

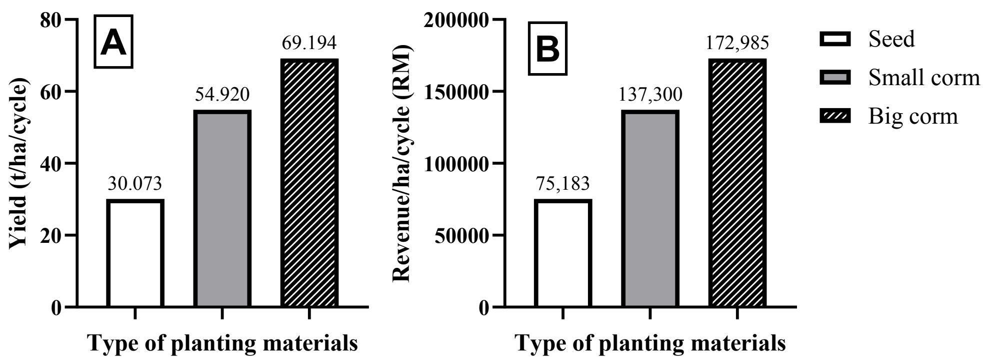

Figure 1: Yield (A) and revenue (B) for three different enterprises using different types of planting materials

the big mother corm enterprise (RM50,953/ha/cycle) was 27.87% higher. The big mother corm enterprise's operating costs also exceeded those of the seed enterprise by 6.47%.

The higher operating cost observed in the big mother corm enterprise was primarily attributable to substantially greater expenditure on planting materials. In contrast, the relatively high operating cost in the seed-based enterprise was mainly driven by higher labour requirements associated with a longer and more labour-intensive production cycle (8.5 months for seed propagation compared with 6.8 months for corm-based production). This longer cycle also increases the fixed-cost burden allocated per production cycle. Consequently, although operating cost was lowest for the small mother corm enterprise and highest for the big mother corm enterprise [Figure 2 (A)], the inclusion of fixed costs altered the ranking of total production cost [Figure 2 (B)], and reflecting differences in fixed-cost allocation across enterprises driven by cycle duration.

Operating Costs Breakdown

To further examine operating costs, a detailed component-wise breakdown is presented in Table 3. Across all three enterprises, wages constituted the largest share of total operating costs. This share was highest in the seed-based enterprise (60.39%), followed by the small mother corm enterprise (58.02%), and the big mother corm enterprise (45.38%). The lower proportion of wages in the big mother corm enterprise is a consequence of the larger share allocated to planting material costs. As shown in Table 3, planting materials accounted for 34.06% of operating costs in the big mother corm enterprise, compared with only 17.61% and 15.68% in the seed-based and small mother corm enterprises, respectively.

This contrast indicates that acquiring large corms is more costly than using small mother corms or seeds, and it is the principal factor increasing operating costs under the big mother corm enterprise. By contrast, other input costs were relatively similar across the three enterprises. For instance, fertiliser expenditure was the same in absolute terms (RM7,948/ha/cycle) across all scenarios. However, its share of total operating costs ranged from about 19.9% in the small mother corm enterprise to 15.6% in the big mother corm enterprise (reflecting differences in total operating costs). Minor cost components, such as contract services for machinery, pest and disease control, and utilities, each contributed only a few per cent or less to the operating budget in every scenario (Table 3).

These results indicate that variation in operating costs among enterprises was mainly attributable to differences in labour and planting material expenditure. In contrast, other cost components, such as fertiliser, contract service of machinery, pest and disease control, and utilities, remained comparable across scenarios.

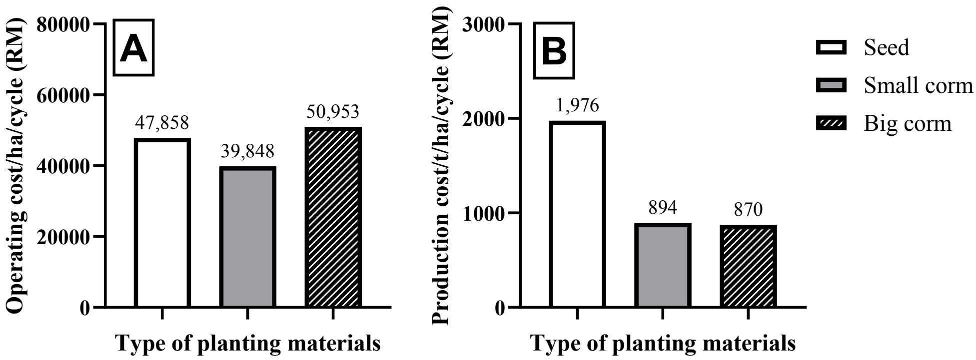

Figure 2: Operating cost (A) and production cost (B) of three different enterprises using different types of planting materials

Table 3: Breakdown of operating costs between three different enterprises using different types of planting materials

Operating Input	Seed		Small Mother Corm		Big Mother Corm	
	Cost (RM)	**Percentage (%)**	**Cost (RM)**	**Percentage (%)**	**Cost (RM)**	**Percentage (%)**
Wage	28,900	60.39	23,120	58.02	23,120	45.38
Planting materials	8,430	17.61	6,250	15.68	17,355	34.06
Fertiliser	7,948	16.61	7,948	19.94	7,948	15.60
Machineries	1,175	2.46	1,175	2.95	1,175	2.31
Pest and disease control	1,151	2.41	1,151	2.89	1,151	2.26
Utilities	255	0.53	204	0.51	204	0.40
Total	**47,858**	**100**	**39,848**	**100**	**50,953**	**100**

Breaking of Fertiliser Costs

A further breakdown of the fertiliser costs (RM7,948/ha/cycle) by fertiliser type is presented in Table 4. This fertiliser cost structure was identical across all enterprises because they used the same fertiliser types and rates. The majority of fertiliser expense (84.30%) was contributed by chicken dung manure, which was applied at 5 t/ha as an organic amendment for konjac during land preparation. In contrast, inorganic fertilisers accounted for only a small fraction of the cost, while Muriate of Potash (MOP) contributed about 6.04%, lime about 5.03%, Christmas Island Rock Phosphate (CIRP) about 3.52%, and ammonium sulphate roughly 1.10% (Table 4).

Although chicken dung was applied during land preparation, it functions as more than a physical soil amendment. Chicken manure contributes organic matter and supplies a range of plant nutrients, including N, P, and K, as well as additional micronutrients (Fallah *et al.*, 2025). The high-cost share attributed to chicken manure in this study is largely a scale effect. Organic manures used for soil amendment are typically applied at ton-scale rates (t/ha), whereas mineral fertilisers are nutrient-dense and therefore applied at much lower rates (kg/ha). As a result, total expenditure on manure can be higher even when mineral fertilisers have higher unit prices (Fangueiro, 2021).

Profit

Despite the higher costs incurred by the big mother corm enterprise, its higher yield translated into much higher profits than those of the other enterprises. Figure 3 (A) presents gross profit, GP (total revenue minus operating cost) while Figure 3 (B) presents net profit, NP (total revenue minus total production cost) for each scenario. In terms of gross profit, the big

Table 4: Breakdown of fertiliser cost

Type of Fertiliser	Cost (RM)	Percentage (%)
Chicken dung	6,700	84.30
MOP (K)	480	6.04
Lime	400	5.03
CIRP (P)	280	3.52
Ammonium sulphate (N)	88	1.10
Total	**7,948**	**100.00**

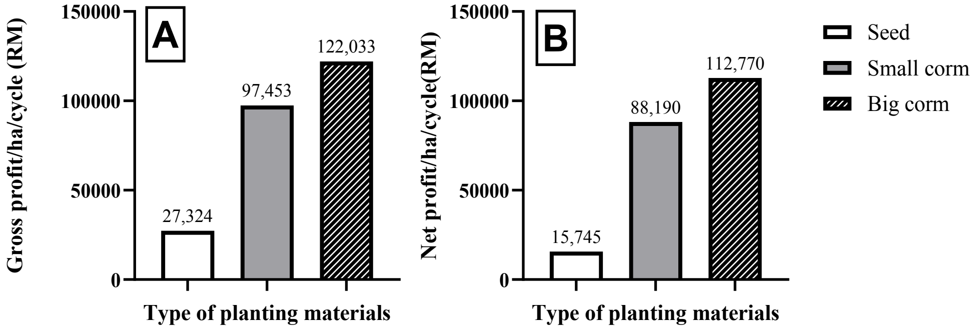

Figure 3: Gross profit (A) and net profit (B) for different enterprises using different types of planting materials

mother corm enterprise achieved approximately 25.22% higher GP than the small mother corm enterprise and 346.61% higher GP than the seed enterprise [Figure 3 (A)].

After accounting for fixed costs, the NP of the seed-based enterprise reduced to RM15,745/ha/cycle, whereas the corm-based enterprises retained very robust net profits relative to the seed-based enterprise, with 460.11% (RM88,190/ha/cycle) and 616.23% (RM112,770/ha/cycle) higher NP in the small and big mother corm enterprises, respectively. The big mother corm enterprise also recorded an NP that was 27.87% higher than that of the small mother corm enterprise [Figure 3 (B)]. Overall, the profit ranking across scenarios was primarily driven by differences in corm yield associated with planting material and establishment performance, based on the assumed yields, prices, and cost structure used in this enterprise budget.

The PI metric, plotted in Figure 4, further illustrates these differences in relative terms. The PI was highest in the big mother corm enterprise (2.87), followed by the small mother corm enterprise (2.80), and lowest in the seed enterprise (1.26) (Figure 4). In practical terms, each RM1.00 of total production cost generates approximately RM1.26 in gross revenue in the seed-based enterprise, compared with RM2.80 and RM2.87 in the small and big mother corm enterprises, respectively.

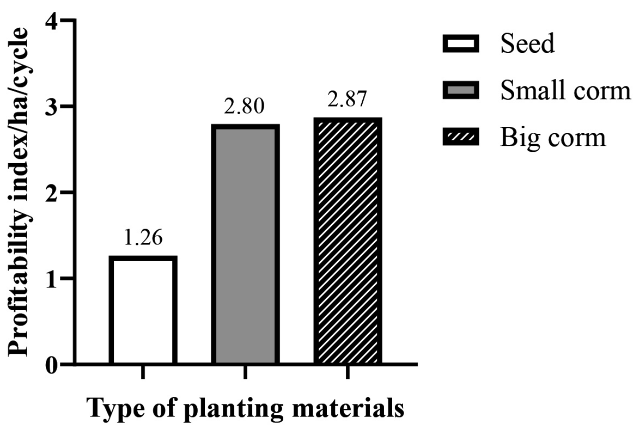

Figure 4: Profitability index for different enterprises using different types of planting materials

When profitability is evaluated relative to total production cost (PI = TR/TC), the interpretation shifts from absolute profit to cost efficiency, because PI expresses the revenue generated per unit of cost invested (Pannell *et al.*, 2024). Ratio-based indicators are particularly useful for ranking options when growers face budget or capital constraints, since they emphasise the return per unit of constrained expenditure rather than total profit alone (Pannell *et al.*, 2024). Conversely, the relatively low PI and net return observed for the seed-based enterprise indicate a thin margin, implying weaker capacity to absorb adverse yield or price fluctuations and a higher likelihood of near-breakeven outcomes under unfavourable conditions (Kahan, 2013). In this study, although all three scenarios remain profitable (PI > 1.0) under the assumed yields and prices, profitability is greater in the corm-based enterprises, indicating that the yield advantage outweighs the associated increase in total production cost under the assumed yields, prices, and cost structure used in this enterprise budget.

The PI values in this present study fall within the range of R/C ratios reported for konjac enterprises in Indonesia. Because PI in this study is defined as TR/TC, it is mathematically equivalent to the revenue-cost (R/C) ratio commonly reported in Indonesian farm feasibility studies (Khaer *et al.*, 2025). However, published enterprise budgets are mostly based on vegetative planting materials, and comparable profitability metrics for seed-based konjac enterprises are lacking; thus, evidence for benchmarking seed-based PI across countries remains limited.

Nevertheless, reported R/C ratios from Indonesian konjac farms provide a useful reference range for overall profitability. For example, a financial feasibility study in East Lombok reported an R/C ratio of 2.10, indicating strong returns relative to costs under local conditions (Prasetyowati *et al.*, 2023). In South Sulawesi, substantially higher profitability has been reported, with an R/C ratio of 5.10, showing that returns can be very high under favourable cost structures and marketing conditions (Khaer *et al.*, 2025). Khaer *et al.* (2025) clearly report the mixed use of corm and bulbils as planting materials, whereas Prasetyowati *et al.* (2023) present a feasibility budget without specifying the planting material category. Therefore, comparisons should focus on the magnitudes of ratios rather than on the assumption of identical production systems. One plausible explanation for higher PI reported in some Indonesian settings is differences in input prices, particularly labour. Because labour is the largest (45% to 60%) cost component in the present study (Table 3), lower labour prices would reduce total production cost and thereby increase the PI (TR/TC).

Breakeven

The differences in cost-effectiveness are also reflected in the breakeven metrics (Figure 5). The breakeven price represents the minimum selling price required to cover total production cost. Based on Figure 5 (A), the seed enterprise required a breakeven price of RM1,591/t (RM1.59/kg) to cover total production costs. In contrast, the corm-based enterprises required breakeven prices that were about 54.4% lower for small mother corms (RM726/t; RM0.73/kg) and 53.7% lower for big mother corms (RM736/t; RM0.74/kg). Reported konjac farm-gate prices vary widely in the region. Prices range from RM2.21/kg to RM3.19/kg in Indonesia (Dermoredjo *et al.*, 2021) and RM1.55/kg to RM3.62/kg in Thailand (Wongpinta *et al.*, 2024). Within this reported price window, the corm-based enterprises retain a wide buffer, as their breakeven prices are about 52.3% to 52.9% below the lowest published farm-gate price (RM1.55/kg). In contrast, the seed-based enterprise's breakeven price (RM1.59/kg) is within only 2.6% of the lower bound, indicating greater vulnerability when prices fall toward the low end of the reported range.

The partial breakeven results [Figure 5 (B)] are expressed as yield thresholds. At a selling price of RM2.50/kg, the seed enterprise required a partial breakeven yield of 19.14 t/ha/cycle to cover operating costs, compared with 15.94 t/ha/cycle for the small mother corm enterprise and 20.38 t/ha/cycle for the big mother corm enterprise. The lower partial breakeven yield for the small mother corm enterprise indicates a lower operating cost burden at the same selling price, meaning it requires less output to cover variable expenses. By contrast, the higher threshold for the big mother corm enterprise implies higher operating costs, which is associated with the higher cost of planting material (Table 5). The seed-based enterprise also shows a relatively high partial breakeven yield, consistent with higher operating costs per hectare due to the extended cycle duration (8.5 months for seed compared with 6.8 months for corm-based production), which increases the yield required to cover operating costs at the same selling price.

Sensitivity Analysis

Sensitivity analysis results, showing the profitability index (PI) of each enterprise under simulated decreases in price and yield, increases in cost, and combined shocks, are summarised in Table 5. At a selling price of RM2.50/kg, the simulated price reductions of 10%, 20%, and 30% correspond to RM2.25/kg, RM2.00/kg, and RM1.75/kg, respectively. The seed-based enterprise is clearly the most vulnerable to economic stress. A 20% reduction in selling price causes the seed enterprise's PI to fall to nearly 1.01 (breakeven), and at a 30% price reduction its PI drops below 1 (0.89), indicating loss (Table 5). An identical trend was observed under the simulated yield-reduction scenario, with PI values remaining the same as those obtained under the corresponding selling-price reduction levels. This was because an equivalent percentage reduction in either the selling price or the yield resulted in the same proportional decline in total revenue. In contrast, total cost was assumed to remain constant (Table 5). A 20% to 30% increase in operating costs reduces the seed enterprise's PI to about 1.02 to 1.09, leaving only a minimal buffer above breakeven. Under simultaneous reductions in selling price and yield, combined with an increase in operating costs, the seed scenario becomes unprofitable even more quickly. A simultaneous 10% price decrease, 10% yield decrease, and 10% cost increase lowers its PI to around 0.95 (total loss), and a further 30% combined shock reduces it to 0.70 (Table 5).

In contrast, the corm-based enterprises demonstrate much greater resilience. Even with a severe 30% decline in either price or yield, their PIs remain around 1.96-2.01, indicating they would still be profitable (Table 5). They also tolerate substantial operating cost inflation; a 30% increase in operating costs yields PIs of approximately 2.25 for small mother corm and 2.29 for big mother corm (Table 5). Under the worst-case combined scenario (30% lower price, 30% lower yield and 30% higher costs), both corm enterprises remain above breakeven,

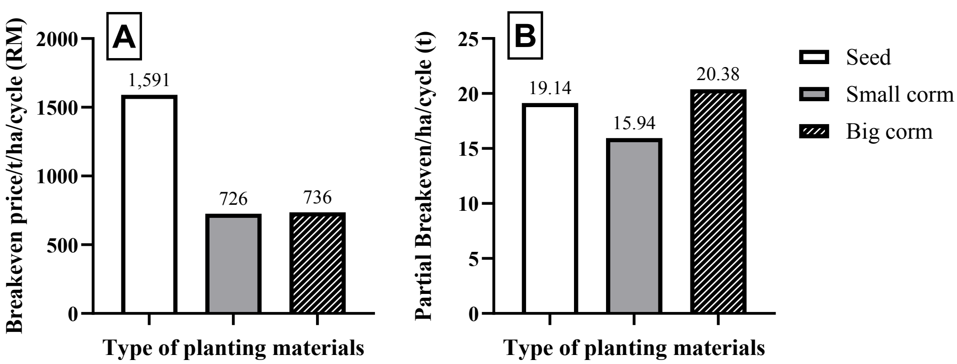

Figure 5: Breakeven price (A) and partial breakeven yield (B) for different enterprises using different types of planting materials

Table 5: Sensitivity analysis for different enterprises using different types of planting materials

	Profitability Index		
	Seed	**Small Mother Corm**	**Big Mother Corm**
Price decrease (%)			
0	1.26	2.80	2.87
10	1.14	2.52	2.59
20	1.01	2.24	2.30
30	0.89	1.96	2.01
Yield decrease (%)			
0	1.26	2.80	2.87
10	1.14	2.52	2.59
20	1.01	2.24	2.30
30	0.89	1.96	2.01
Operating cost increase (%)			
0	1.26	2.80	2.87
10	1.17	2.59	2.65
20	1.09	2.41	2.46
30	1.02	2.25	2.29
Price and yield decrease with operating cost increase (%)			
0	1.26	2.80	2.87
10	0.95	2.09	2.15
20	0.70	1.54	1.57
30	0.50	1.10	1.12

with PI values of approximately 1.10 for small mother corm and 1.12 for big mother corm (Table 5). This robustness reflects their higher initial profit margins, which can absorb adverse changes while maintaining cost coverage. These simulated outcomes are also consistent with the magnitude of price variability reported in konjac markets, where farm-gate prices have been documented to fluctuate substantially (Riptanti *et al.*, 2023). Although both corm-based enterprises were consistently resilient, differences between the small and big mother corm scenarios were modest across all sensitivity tests (Table 5). The big mother corm enterprise showed a slight but consistent advantage in PI across scenarios, suggesting marginally stronger cost efficiency or revenue generation. However, the magnitude of the difference was small.

This sensitivity analysis indicates that corm-based production not only generates higher profits under baseline conditions, but also maintains a larger buffer against adverse price or cost movements. In contrast, the seed-based enterprise exhibits limited tolerance to negative shocks. Since the small and big mother corm enterprises show relatively similar financial resilience under market and cost variability, the choice between them is more likely to depend on practical considerations such as planting material availability, cash flow constraints, and agronomic performance. Accordingly, the comparison is best framed in terms of the incremental costs and incremental returns associated with switching corm size.

Partial Budgeting Analysis

Partial budgeting was used to evaluate the incremental economic benefit of adopting big mother corms instead of small mother corms. Although sensitivity analysis showed broadly similar resilience between the two corm-based enterprises, partial budgeting isolates the differences by focusing only on the added costs and added returns associated with switching corm size. This approach provides a clearer basis for adoption decisions when overall profitability indicators differ only marginally (Kay *et al.*, 2020).

The analysis indicates that the primary benefit of upgrading to big mother corms comes from increased yield. Using big mother corms instead of small produced an additional yield of 14,274 kg/ha. At the prevailing farm-gate price of RM2.50/kg, this yield gain translates into an additional revenue of RM35,685/ha (Table 6). There were no "reduced returns" in this switch, since product prices and other outputs remained unchanged; thus, this figure represents a pure gain in income from higher production.

On the cost side, the major change is the higher cost of planting material for big mother corms. Adopting big mother corms incurs an additional cost of RM11,105/ha for planting material compared to using small mother corms (Table 6). There were no offsetting cost savings identified since other input costs such as labour, fertiliser, and pest control were assumed to remain constant between the two scenarios. Thus, the cost increase is solely attributable to the greater expense of procuring the big mother corms.

Overall, the partial budget shows a very favourable net outcome for the big mother corm strategy. The total added benefit (extra revenue) of RM35,685/ha greatly outweighs the added cost of RM11,105/ha, resulting in a net profit increase of approximately RM24,580/ha from switching to large corms (Table 6). In other words, the additional profit from using big mother corms is RM24,580/ha, after accounting for the higher planting material cost. This positive net profit change clearly demonstrates that the higher yield from big

Table 6: Partial budgeting analysis for upgrading from small to big mother corms in konjac production

Benefit (Additional returns and cost savings)		**Implication (Additional costs and reduced returns)**	
Item	**Value**	**Item**	**Value**
Yield increase, Y_{Δ} (kg/ha)	14,274.00		
Konjac price (RM/kg)	2.50		
Additional return (RM/ha)	35,685.00	Reduced returns (RM/ha)	0
Cost savings		Additional cost	
		Big mother corm planting materials (RM/ha)	11,105.00
Total cost saving (RM/ha)	0	Total additional cost (RM/ha)	11,105.00
Total benefits (RM/ha)	**35,685.00**	**Total implications (RM/ha)**	**11,105.00**
Net change in profit, Δπ		**RM 24,580.00 RM/ha**	

Note: Yield increase, Y_{Δ} represents $Y_B - Y_S$, where Y_B is yield for big mother corm (kg/ha), and Y_S is yield for small mother corm (kg/ha). The additional return is calculated as Y_{Δ} x P, where P is the konjac price (RM/kg). No cost savings or reduced returns were observed when upgrading from small to big mother corms. All values are standardised per hectare for one production cycle.

Source: Primary data (2025)

mother corms compensates for their higher cost. The partial budgeting results thus confirm the earlier findings from enterprise budgeting that upgrading from small to big mother corm planting material significantly improves the financial performance of konjac production. In practical terms, this recommendation is constrained by the availability of planting material, since large corms may be scarce and must be produced from smaller planting material before large-scale use becomes feasible. Nevertheless, based on the enterprise budgeting assumptions derived from this pre-commercial-scale plot study, the use of big mother corms as planting material appears to offer a strong economic incentive, as this strategy was estimated to improve per-hectare profitability substantially.

Conclusions

Corm-based planting material should be prioritised for *A. muelleri* production because, based on the pre-commercial plot data and enterprise budgeting assumptions used in this study, it was estimated to provide higher returns and stronger financial resilience than seed-based planting material. Within the corm-based options, big mother corms were estimated to be economically preferable to small mother corms. Nevertheless, this recommendation is subject to the availability of planting material. Accordingly, big mother corms may be considered the preferred option for commercial production where supply is sufficient, while small corms remain important for multiplication and expansion of planting stock.

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Author Contributions Statement

Muhammad Najib Othman Ghani carried out the research, wrote and revised the article. Nor Amna A'liah Mohammad Nor analysed the data, Martini Mohammad Yusoff conceptualised the central research idea and provided the theoretical framework. Muhammad Najib Othman Ghani, Martini Mohammad Yusoff, Arina Shairah Abdul Sukor, Juju Nakasha Jaafar, and Azizah Misran designed the research and supervised research progress; Nor Amna A'liah Mohammad Nor and Mark Buda anchored the review, revisions and approved the article submission.

Conflict of Interest Statement

The authors agree that this research was conducted without any self-benefit, commercial, or financial conflicts.

Ethical Conduct

All information communicated in this article does not need ethical approval for research or informed consent because human or animal subjects were not involved.

Declaration of AI-usage

During the preparation of this work, the authors used AI tools for grammatical improvements and clarity. In using the AI-tools, the authors reviewed and edited the content as needed and bear full responsibility for the content of this manuscript.

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