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VALUE CHAIN ANALYSIS OF ECO-FRIENDLY AND BIO-DEGRADABLE ARECANUT LEAF SHEATH PLATE AND BOWLS BUSINESS IN KARNATAKA

Chaitra G B

Central University of Punjab, Bathinda-151 001, India

ABSTRACT

In Karnataka's arecanut-growing regions, small and medium-scale enterprises have started manufacturing arecanut leaf plates and bowls, leveraging the plentiful availability of areca leaf sheaths and growing awareness of eco-friendly products. This research, conducted in 2023 in Davanagere district, Karnataka, India, involved data collection from 10 areca leaf plate and bowl producers, 30 arecanut farmers, 30 wholesalers, and 30 retailers. The study revealed that farmers received net returns of ₹11,400 per acre from areca leaf sheaths, valued at ₹1.90 per sheath. The manufacturing of areca leaf plates and bowls generated an employment potential of 1,825 man-days annually. Larger arecanut leaf plates had higher marketing margins and costs, which led to higher retail prices, while smaller sizes incurred lower marketing expenses and margins, making them more affordable for consumers. The producer's share was highest for the 10-inch plate at 73.68%, followed by the 12-inch plate at 72.73%, with both the 8-inch plate and 5.5-inch bowl each at 66.67%. Price spreads were greater for the 12-inch and 10-inch plates (₹1.50 and ₹1.25, respectively) compared to the 8-inch plate (₹1.00) and the 5.5-inch bowl (₹0.75). Marketing efficiency was highest for the 10-inch plates at 2.80, followed by the 12-inch plates at 2.67, while the 8-inch plate and 5.5-inch bowl each had an efficiency of 2.00. Entrepreneurs in the arecanut leaf plate and bowl sector faced several challenges, including power outages during the day, shortages of leaf sheaths, low-quality supplies, and restricted access to export markets.

Keywords: Entrepreneurs, Employment, Eco-friendly, Price spread, Marketing efficiency

Arecanut (*Areca catechu* L.) is a significant commercial plantation crop in India. Its principal product, known as *supari* or betelnut, is commonly used in *pan masala* and widely consumed. Additionally, arecanut holds cultural and religious significance in various ceremonies. The western coast of India is the primary region for arecanut cultivation, contributing to over half of the country's total production (Bhat *et al.*, 2023). India leads the world in arecanut production, accounting for 43% of the global cultivated area and 50% of the total output. Global production and cultivation of arecanut have been on the rise (Bhat *et al.*, 2023). In 2020, global arecanut production reached 1.79 million tonnes from an area of 1.22 million hectares, with an average yield of 1.46 tonnes per hectare. For the 2021-22 period, arecanut was grown on 770,000 hectares, producing 1.4 million tonnes with an average yield of 1.8 tonnes per hectare. Karnataka is the leading producer of arecanut in India, contributing 78.84% of the total national output of 1,445.86 thousand tonnes, followed by Kerala and Assam (APEDA, 2023).

Arecanut offers several medicinal benefits and supports digestion (Jaganathan *et al.*, 2011). The arecanut industry is a significant source of employment, providing both direct and indirect support to hundreds of thousands of farmers, especially those with small and marginal farms. Approximately three million farmers depend on arecanut for their livelihoods, either directly or indirectly. This sector is crucial for generating substantial income and employment for many individuals (Prakash, 2012). Arecanut begins to yield economically viable quantities about five years after being transplanted into the field. The primary product of the areca palm is the arecanut (betel nut), while by-products include the leaf sheath and arecanut husk. Although the arecanut itself is highly marketable, the by-products can often go to waste if not utilized effectively for other purposes.

Leaf sheaths are traditionally used as mulch or organic matter in arecanut plantations. However, recent technological advancements have improved the ability to utilize these sheaths for manufacturing leaf plates, bowls, and spoons. These products are both biodegradable and eco-friendly. As many states impose bans on plastic goods, arecanut-based products are gaining popularity and making a notable impact in the consumer market.

In July 2022, the Ministry of Environment, Forests and Climate Change enacted a nationwide ban on single-use plastics. Notably, Karnataka had preemptively implemented a similar ban as early as 2016, which facilitated a smoother transition for the

*Corresponding author: chaitragb519@gmail.com
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state (Indian Express, 2022). With these plastic bans firmly established, products made from arecanut leaves have gained considerable popularity. The abundance of raw materials and the growing consumer demand have catalyzed the emergence of numerous enterprises specializing in arecanut leaf plates and bowls within cultivation regions. These enterprises, characterized by their labor-intensive nature, have significantly bolstered local employment opportunities (Chinnappa *et al.*, 2020). As environmental consciousness increases and regulatory measures tighten, industries are increasingly motivated to embrace more sustainable materials (Sunny and Rajan, 2022).

Arecanut leaf sheath has recently gained recognition as a sustainable resource due to its high cellulose content, abundant availability, large surface area, low cost, non-toxicity, thermal stability, robust mechanical properties, and biodegradability (Loganathan, 2020). It is especially suitable for single-use, disposable packaging applications, including food packaging, small clothing items, and other lightweight products (Dissanayake *et al.*, 2018). In Karnataka's arecanut-growing regions, numerous small and medium-scale enterprises have started producing arecanut leaf plates and bowls. This trend has fostered the emergence of a new generation of entrepreneurs and significantly increased job opportunities for local residents, requiring substantial capital and labor investment. Recognizing the economic, social, and environmental importance of this burgeoning rural industry, the current study aims to conduct a comprehensive analysis of the value chain associated with arecanut leaf plate and bowl manufacturing.

MATERIALS AND METHODS

The study was conducted in the Davanagere district of Karnataka, India. It involved selecting 10 manufacturing units that produce arecanut leaf plates and bowls. Data were collected through structured personal interviews with the entrepreneurs of these units, focusing on aspects such as production processes and challenges faced. Income data from areca leaf sheaths was gathered through surveys of 30 farmers, while information on product marketing was obtained from 30 wholesalers and 30 retailers using a combination of surveys, interviews, and observations. The collected data was analyzed using descriptive statistics. Analytical tools were employed to calculate key metrics including marketing costs, marketing margins, price spreads, marketing efficiency, and producer's share, which were used to draw meaningful conclusions.

Analytical Tools

Marketable surplus: To estimate the marketable surplus of produce, the total quantity used for different purposes is deducted from the total production of the crop.

Marketable surplus = Total Production – Total Consumption

Marketing efficiency: Marketing efficiency is the degree of performance of the market. It was estimated by using the following formula.

$$ME = \frac{FP}{(MC + MM)}$$

where,

ME = Index of marketing efficiency

FP = Price received by the farmer

MC = Total marketing cost

MM = Net marketing margins

Producers' share: It was calculated using the following formula

$$Ps = \frac{Pf}{Pr} \times 100$$

where P_s = Producers' share in the consumer rupee

P_f= Producers price

P_r = Retail price

Price Spread: The difference between the producer's net price (PNP) and the retailer's selling price (RP).

PS = RP – PNPww

where,

PS = Price Spread

RP = Retailer Selling Price

PNP = Producer Net Price

RESULTS AND DISCUSSION

Table 1 illustrates the income generated by arecanut farmers from selling areca leaf sheaths, a by-product of arecanut cultivation. In a one-acre arecanut plantation with 600 trees, farmers can collect approximately 6,000 leaf sheaths. The cost of collecting these sheaths is Rs.

Table 1. Income accrued to areca farmers from the sale of areca leaf sheath (by-product)

Particulars	Value
Number of arecanut trees per acre	600
Number of leaf sheaths per acre	6000
Expenditure towards the collection of leaf sheaths per acre (Rs.)	600
Price per leaf sheath (Rs.)	2
Gross returns per acre (Rs.)	12000
Net returns per acre (Rs.)	11400
Net returns per leaf sheath (Rs.)	1.9

600 per acre. With each leaf sheath priced at Rs. 2, the gross returns per acre amount to Rs. 12,000. After deducting the collection expenses, the net returns per acre are Rs. 11,400, equating to a net return of Rs. 1.90 per leaf sheath. Additionally, organic waste generated in an arecanut plantation, including leaves, husks, and leaf sheaths, totals 10–12 tons per hectare annually (Sadasivuni *et al.*, 2015). This demonstrates the profitability and resource efficiency of arecanut farming, highlighting its economic sustainability.

Utilizing organic waste from arecanut farming, particularly areca leaf sheaths, for commercial purposes offers substantial environmental and economic benefits. Each hectare of arecanut farming generates 10–12 tons of organic waste annually, which can be transformed into biodegradable products like plates and bowls. This shift reduces dependence on plastics and helps combat deforestation (Sadasivuni *et al.*, 2015). By repurposing this waste, farmers also cut down on the carbon footprint and prevent methane emissions associated with decomposing organic material. Economically, the practice is advantageous for farmers, who can achieve net returns of Rs. 11,400 per acre from selling areca leaf sheaths, thereby promoting sustainable agriculture and resource efficiency (Table 1). Environmentally, this approach enhances soil health through composting residual matter, improves water conservation, and reduces energy consumption through localized production. Integrating these practices fosters a more sustainable farming ecosystem, aligning financial incentives with ecological stewardship.

The analysis of employment potential in areca leaf plate and bowl manufacturing units (Table 2) indicates that the industry predominantly depends on a workforce with basic to intermediate skill levels. Tasks such as drying leaf sheaths, washing, preparing materials for plate and bowl production, and packing require relatively simple skills that can be learned through on-the-job training. This accessibility allows the industry to engage a broad labour pool, including individuals with limited formal education. Furthermore, the straightforward nature of these tasks facilitates the rapid scaling of the workforce as demand grows, with minimal barriers related to skill acquisition.

Drying and storing leaf sheaths is a year-round activity that involves basic handling skills. Workers in this role are tasked with ensuring that the leaf sheaths are properly dried and stored to preserve their quality. This process demands 365 man-days of labour annually, representing a stable job opportunity for workers. They may gain expertise in efficient drying methods and optimal storage techniques over time. Given the fundamental nature of this task, it is well-suited for entry-level workers, with opportunities for skill development in process optimization and supervisory roles as they gain experience.

Washing and preparing leaf sheaths, carried out throughout the year, require attention to hygiene and preparation standards. This task, while needing basic skills, is crucial for ensuring that the leaf sheaths are properly prepared for the subsequent pressing process. Workers in this role can acquire valuable experience in quality control and hygiene practices, setting the stage for potential career advancement within the industry. The meticulous nature of this work highlights its importance in maintaining product quality and offers a solid foundation for workers to build upon as they develop their careers.

Pressing leaf sheaths into plates and bowls is a more skilled task that demands knowledge of machine operation and safety protocols. With 730 man-days allocated annually across two shifts, this activity requires intermediate skills, including mechanical aptitude and operational efficiency. Workers in this role have the opportunity to develop technical expertise and become familiar with industrial machinery, potentially

Table 2. Employment potential of areca leaf plate and bowl manufacturing units per year

Activity	Man-days	Number of Hours	Number of Shifts	Required Skill Levels/Qualifications
Drying of leaf sheaths and storing them in the godown	365	8	1	**Basic Skill Level:** No formal qualifications needed. Basic training on handling and storing leaf sheaths.
Washing and preparing leaf sheaths for plate/bowl-making	365	8	1	**Basic Skill Level:** Basic training on cleaning techniques. Attention to hygiene and detail.
Pressing leaf sheaths into plates and bowls	730	8	2	**Intermediate Skill Level:** Training on operating pressing machines. Understanding of safety protocols and machine maintenance.
Packing plates and bowls (bundling, packing, and stitching)	365	8	1	**Basic Skill Level:** Basic training on packing and handling. Attention to detail and efficiency.
Total	1825			

Table 3. Marketing costs, margins, and price spread in arecanut leaf plate and bowl marketing

Particulars	Plates			Bowls
	12 inch	10 inch	8 inch	5 inch
Manufacturer's selling price to wholesaler (Rs.)	4	3.5	2	1.5
Wholesaler's cost (Rs.)	0.25	0.18	0.11	0.1
Wholesaler's margin (Rs.)	0.35	0.3	0.25	0.18
Retailer's Cost (Rs.)	0.2	0.17	0.14	0.12
Retailer's margin (Rs.)	0.7	0.6	0.5	0.35
Consumer price/Retail Price (Rs,)	5.5	4.75	3	2.25
Total marketing cost (Rs,)	0.45	0.35	0.25	0.22
Total marketing margin (Rs.)	1.05	0.9	0.75	0.53

leading to career advancement into supervisory or maintenance positions. The dual-shift schedule not only facilitates higher production volumes but also highlights the industry's need for a reliable and skilled workforce.

The packing of plates and bowls, which includes bundling, packing, and stitching, requires 365 man-days per year. Although this task involves basic skills, it demands a high level of attention to detail and efficiency. Workers can develop expertise in inventory management and logistics, enhancing the overall production process. The consistent nature of this role provides steady employment opportunities and a foundation for workers to improve their skills in packing techniques and quality assurance. Together, these activities reflect the diverse job opportunities within the areca leaf plate and bowl manufacturing industry, demonstrating accessibility for entry-level workers as well as potential for skill development and career growth.

Marketing channels

Areca leaf plate and bowl entrepreneurs primarily distribute their products through wholesalers and retailers, capitalizing on their extensive networks and convenience. They typically engage in direct marketing to consumers only for bulk orders. Several factors influence the choice of marketing channel. Firstly, the proximity of the production facility to consumers affects the decision, with direct engagement being more favourable when the production site is nearby. Additionally, consumers often aim to reduce transportation costs for bulk purchases by dealing directly with the entrepreneurs. The reliability and availability of transportation also play a crucial role, with consumers preferring direct interaction to ensure timely delivery. In summary, while wholesalers and retailers are essential marketing channels, the preference for direct engagement with entrepreneurs for bulk orders is driven by considerations of distance, transportation costs, and the availability of transportation facilities.

Table 3 provides an analysis of marketing costs, margins, and price spreads for arecanut leaf plates and bowls of different sizes. The data shows that the manufacturer's selling price to wholesalers decreases progressively with the size of the product. Larger plates have higher manufacturer prices, with 12-inch plates priced at Rs. 4 and 5.5-inch bowls at Rs. 1.5. This trend reflects the varying costs associated with producing different sizes. Marketing costs also exhibit a similar pattern, decreasing as the product size decreases. For instance, the total marketing cost is Rs. 0.45 for 12-inch plates, Rs. 0.35 for 10-inch plates, Rs. 0.25 for 8-inch plates, and Rs. 0.22 for 5.5-inch bowls. These costs encompass expenses incurred by both wholesalers and retailers. This data shows how production and marketing costs are influenced by the size of the product, affecting the overall pricing structure.

The marketing margins highlight the profitability for both wholesalers and retailers. Wholesalers achieve higher margins for larger plates, with Rs. 0.35 for 12-inch plates compared to Rs. 0.18 for 5.5-inch bowls. Retailers also experience higher margins with larger products, such as Rs. 0.70 for 12-inch plates compared to Rs. 0.35 for 5.5-inch bowls. This trend reflects the profitability potential associated with larger items. Consumer choice plays a crucial role in the market, influenced by factors such as retail price, which often shows a significant disparity between the manufacturer's costs and the final price paid by consumers (Chaitra and Kerur, 2018a,b). Larger sizes exhibit higher price spreads, attributable to the increased marketing and margin costs associated with these products. Overall, the data indicates that larger arecanut leaf plates offer higher marketing margins and costs, resulting in elevated retail prices. In contrast, smaller sizes incur lower marketing expenses and margins, leading to more affordable consumer prices. Expanding the arecanut market can be achieved by enhancing the value of arecanut and its by-products, thus reinforcing market presence and profitability.

Table 4. Price spread, marketing efficiency, and producer's share in marketing of arecanut leaf plates and bowls

Particulars	Plates			Bowls
	12 inch	10 inch	8 inch	5 inch
Price spread (Rs.)	1.50	1.25	1.00	0.75
Marketing efficiency	2.67	2.80	2.00	2.00
Producers share (%)	72.73	73.68	66.67	66.67

Table 4 illustrates the price spread, marketing efficiency, and producer's share for arecanut leaf plates and bowls across various sizes. The price spread, defined as the difference between the retail price and the manufacturer's selling price, varies with product size. Larger plates, such as the 12-inch and 10-inch sizes, show higher price spreads—Rs. 1.50 and Rs. 1.25, respectively—compared to smaller sizes like the 8-inch plate (Rs. 1.00) and the 5.5-inch bowl (Rs. 0.75). This trend indicates that as the size of the product decreases, the price spread also tends to decrease.

Marketing efficiency assesses the effectiveness of the marketing process by evaluating the cost-benefit ratio. The data reveals that 10-inch plates achieve the highest marketing efficiency, with a ratio of 2.80, followed by 12-inch plates at 2.67. In contrast, both 8-inch plates and 5.5-inch bowls have a lower, but equal, marketing efficiency of 2.00. This indicates that the marketing process is more efficient for larger plates compared to the smaller plates and bowls.

Producers' share, expressed as a percentage, reflects the portion of the consumer price received by the producer. The 10-inch plate offers the highest producer's share at 73.68%, followed closely by the 12-inch plate at 72.73%. In comparison, the 8-inch plate and 5.5-inch bowl each provide a lower producer's share of 66.67%. This data indicates that producers receive a greater share of the consumer price for larger plates compared to smaller plates and bowls.

Table 5 offers a detailed comparison of the prices for disposable plates and bowls made from areca leaf sheaths versus plastic. For 8-inch plates, areca leaf sheath plates are priced at Rs. 3.00 each, which is approximately 3.75 times more expensive than plastic plates costing Rs. 0.80 each. The 10-inch areca leaf sheath plates are priced at Rs. 4.75 each, nearly 4 times the price of plastic plates at Rs. 1.20 each. For 12-inch plates, areca leaf sheath plates are available at Rs. 5.50 each, making them 5.5 times more expensive than plastic plates priced at Rs. 1.00 each. Additionally, 5.5-inch areca leaf sheath bowls cost Rs. 2.25 each, which is 3 times the price of plastic bowls, which are Rs. 0.75 each. This comparison highlights the substantial price difference between environmentally friendly areca leaf sheath products and their plastic counterparts.

The higher prices of areca leaf sheath products reflect their environmental benefits. Areca leaf sheath plates and bowls are biodegradable, helping to reduce waste and pollution. Their production is generally more sustainable, and they decompose naturally, offering an eco-friendly alternative to plastic. In contrast, plastic disposable products, while considerably cheaper, present significant environmental challenges. Despite their lower cost and convenience, the long-term environmental impact of plastic waste is a growing concern.

Government initiatives to ban plastic usage, combined with increased consumer awareness of the negative impacts of plastic on health and the environment, have significantly shifted consumer preferences. Consequently, there has been a notable trend towards using areca leaf plates and bowls instead of plastic alternatives. This shift is evident not only in urban areas but also in rural regions. In villages, where traditional customs hold substantial cultural significance, using areca leaf sheath products has become a symbol of prestige, especially during important communal events such as weddings and festivals. This cultural transformation reflects a broader societal movement towards sustainability and environmental consciousness. By choosing areca leaf sheath products, consumers are not only making an environmentally responsible decision but also embracing age-old traditions that emphasize harmony with nature.

Table 5. Price Comparison of disposable plates and bowls made from areca leaf sheath and plastic material (Rs.)

Type of Material	Plates			Bowls (5 inch)
	8 inch	10 inch	12 inch	
Areca Leaf Sheath	3.00	4.75	5.50	2.25
Plastic	0.80	1.20	1.00	0.75

Environmental impact of manufacturing areca leaf plates and bowls

The manufacturing process of areca leaf plates and bowls, while environmentally friendly in many aspects, does have notable impacts on resource usage. Entrepreneurs in this industry have recognized areas of significant resource consumption and have adopted practices to mitigate their environmental impact.

1. **Water Usage**: The production of areca leaf plates and bowls requires substantial amounts of water, primarily for wetting and cleaning the areca leaf sheaths. Entrepreneurs have reported daily water consumption of approximately 800 to 1,000 liters, totaling around 24,000 to 30,000 liters per month. To address this issue, they have implemented a system to repurpose this water for irrigation. This approach not only conserves water but also benefits their agricultural activities, fostering a more sustainable and resource-efficient operation.
2. **Electricity Consumption**: The production of areca leaf products involves considerable electricity usage, with monthly expenditures ranging from Rs. 15,000 to Rs. 18,000. This energy is crucial for operating the machinery and equipment required for cutting, pressing, and drying the areca leaves. The substantial electricity consumption highlights the need for sustainable energy practices. Integrating renewable energy sources could significantly reduce the carbon footprint of the manufacturing process and contribute to a more eco-friendly operation.
3. **Waste Management**: Effective waste management is a critical aspect of the production process for areca leaf products. Instead of discarding leftover broken areca leaf sheaths, these remnants are put to environmentally beneficial use. The broken sheaths are spread across arecanut plantations, where they decompose naturally. This process enriches the soil by adding organic matter and nutrients, serving as a natural fertilizer. This approach not only minimizes waste but also improves soil fertility, contributing to a healthier and more sustainable agricultural cycle.

Overall, the manufacturing of areca leaf plates and bowls incorporates several sustainable practices that help mitigate its environmental impact. The repurposing of water for irrigation and the use of leaf remnants as natural fertilizers support water conservation and enhance soil health. While electricity costs are substantial, exploring renewable energy sources could further improve the sustainability of the production process. These combined efforts contribute to reducing the environmental footprint of areca leaf product manufacturing, reflecting a strong commitment to eco-friendly practices and resource efficiency.

Table 6. Challenges faced by arecanut leaf plate and bowl manufacturers

Constraint	Percentage
Frequent breaks in power supply in the daytime	100
Shortage of areca leaf sheaths in the rainy season	60
Supply of broken leaf sheaths by the farmers	60
Supply of fungal-infected leaf sheaths by the farmers	60
Lack of connectivity to export markets	100

Table 6 outlines the challenges faced by manufacturers of areca leaf plates and bowls. All entrepreneurs reported frequent daytime power supply disruptions, a significant issue affecting manufacturing operations and productivity. They suggested that the government needs to ensure a continuous power supply during the day to support businesses in rural areas. Approximately 60% of entrepreneurs noted a seasonal reduction in the availability of areca leaf sheaths during the rainy season, which lasts nearly three months. This decrease in leaf drop from palm trees highlights a seasonal obstacle impacting raw material availability. To mitigate this, entrepreneurs have proactively stockpiled additional raw materials to use during the off-season. Similarly, 60% of entrepreneurs encountered problems with farmers supplying broken leaf sheaths, affecting the quality of raw materials. Additionally, 60% reported issues with farmers providing fungal-infected sheaths, raising concerns about the quality and suitability of the raw materials. To address this, farmers could be encouraged to adopt a more proactive approach by regularly collecting high-quality fallen sheaths and storing them properly, reducing damage and fungal risk, and ensuring better-quality materials for manufacturing. All entrepreneurs also emphasized the lack of connectivity to export markets, a widespread challenge limiting access to international markets. Forming a society or association of areca leaf plate entrepreneurs and branding their products under a unified label within the district could be instrumental in improving product quality, increasing production volumes, and expanding access to export markets.

CONCLUSION

The study revealed that a one-acre arecanut plantation yields approximately 6,000 leaf sheaths, generating a net return of Rs. 11,400 per acre after accounting for collection expenses. This translates to a net return of Rs. 1.90 per leaf sheath. The manufacturing of areca leaf plates and bowls offers substantial employment opportunities, with a total of

1,825 man-days required annually across various tasks, including drying, storing, washing, preparing, pressing, and packing. Larger-sized plates, such as the 12-inch and 10-inch varieties, have higher manufacturer selling prices, marketing costs, and margins compared to smaller products. Marketing efficiency is highest for the 10-inch plates (2.80), followed by the 12-inch plates (2.67), while smaller sizes like the 8-inch plate and 5.5-inch bowl have lower efficiencies (2.00 each). Producers benefit more from larger plates, with a producer's share of 73.68% for 10-inch plates and 72.73% for 12-inch plates, compared to 66.67% for 8-inch plates and 5.5-inch bowls. Challenges faced by entrepreneurs include frequent power supply disruptions and leaf sheath shortages during the rainy season. They also encounter issues with poor-quality raw materials from farmers and difficulties in accessing export markets.

The study demonstrated that manufacturing areca leaf plates and bowls is a potentially profitable venture with significant employment opportunities within the arecanut plantation context. The industry showed notable efficiency in marketing larger products, such as 12-inch and 10-inch plates, which also resulted in higher producers' shares. However, the sector faces several challenges, including frequent power supply disruptions, seasonal fluctuations in raw material availability, and quality control issues with supplied leaf sheaths. Limited connectivity to export markets further hinders international expansion. Overall, while the industry holds promise, addressing these challenges could enhance both productivity and profitability.

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