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Research Article

Optimizing the Traditional Melinjo Chip Production Process: A Case Study in Bulakwaru Village

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Abstract: The production of traditional melinjo chips in Bulakwaru Village, Tegal Regency, represents an important component of local wisdom–based economic activities and contributes to the livelihood of many small entrepreneurs in the area. However, despite its promising market potential, the production process still encounters several challenges that limit business growth and efficiency. These obstacles include dependence on weather conditions during the drying process, limited and traditional production equipment, fluctuations in the availability of melinjo raw materials, restricted access to business capital, and limited marketing strategies. This study aims to identify these key challenges and propose practical solutions to enhance the efficiency and sustainability of melinjo chip enterprises. The research uses a qualitative descriptive method, collecting data through observation, interviews, and documentation involving melinjo chip entrepreneurs in Bulakwaru Village. The findings suggest several potential strategies, including diversifying drying techniques, modernizing production equipment, establishing partnerships with melinjo farmers, improving human resource skills through training, strengthening business institutions, encouraging collaboration with government agencies, and utilizing digital marketing. These efforts are expected to increase competitiveness and improve the long-term welfare of local melinjo chip entrepreneurs.

Keywords: Agro-Industrial Solutions; Bulakwaru Village; Business Obstacles; Melinjo Chips; Traditional Production.

1. Introduction

Bulakwaru Village is located in Tarub District, Tegal Regency, Central Java Province. The village covers over 300 hectares, encompassing residential areas, rice fields, and plantations. The expansive rice fields are supported by several rivers flowing from the Cacaban Reservoir, the largest reservoir in Tegal Regency. Furthermore, the residents of Bulakwaru Village also utilize the plantation land to cultivate various types of vegetables and fruits. Administratively, the village is divided into two areas: West Bulakwaru and East Bulakwaru, each comprising three neighborhood units (RW) and 31 neighborhood units (RT) (Suraya, Prastiyo, and Jautsani 2022) .

According to local elders, the name "Bulakwaru" originates from a traveler who arrived in the area now known as Bulakwaru Village. It is said that upon his first arrival, the traveler saw a dense expanse of waru trees growing in abundance in the area. Over the course of several months, he cut down thousands of them, creating a vast open space. This change in landscape gave rise to the name "Bulakwaru," a combination of the words " bulak ," meaning open ground, and "waru," referring to the tree species that previously dominated the area. Over time, the name became the village's trademark. Besides its unique origin story, Bulakwaru Village is also known for its diverse traditional culinary offerings, such as "kedai kipas" (fan snacks), "pipis," sapodilla fruit, and "emping melinjo" (melinjo crackers), a local specialty (Lanang Setiawan 2023) .

Emping melinjo (gnetum gnemon) is a traditional processed food product with high economic and cultural value in Indonesia. This product has long been part of the local culinary

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identity and is often found on various occasions, both as a snack and as a side dish, as it contains beneficial health ingredients. However, consumption should be limited, especially for those with gout or high blood pressure (IRM Sari, Zakaria, and Affandi 2015) . In Bulakwaru Village, Tarub District, Tegal Regency, emping melinjo is not only known as a regional specialty but also serves as the main source of livelihood for a large number of households. The production process, which is still carried out manually and traditionally, reflects the community's attachment to the local cultural heritage that continues to be preserved.

In their production activities, communities utilize old melinjo seeds that are manually flattened. However, this process still faces several obstacles, one of which is dependence on weather conditions. The drying stage, which is highly dependent on sunlight, is often a major obstacle. If drying is not optimal, the quality of the resulting chips will decline. The product becomes more susceptible to mold attack and appears less attractive due to cloudy or uneven color (Pranata, Pramana, and Faisal 2019) . Furthermore, other obstacles faced, such as the availability of raw materials, fluctuations in raw material prices, limited production equipment, weather conditions that affect the drying process, and limited labor, are challenges that producers must overcome. These obstacles not only disrupt production continuity but can also reduce the quality and quantity of the product. This is in line with the theory of constraints (TOC) where if a constraint has been found and solved, then the next constraint can be identified and updated which ultimately aims to increase the overall finished product results sold (Throughput), reduce inventory and reduce operational costs (Operational expenses) (Dr. Eliyahu M. Goldratt 1986)

Therefore, it is important to systematically identify the obstacles in the traditional melinjo emping production process in Bulakwaru Village. Furthermore, it is necessary to find relevant and applicable alternative solutions that can be implemented to improve efficiency, product quality, and business sustainability, thereby making this small business more competitive and sustainable. This research is expected to contribute to the development of the traditional melinjo emping business, both in terms of production techniques and community empowerment.

2. Theoretical Study

This theoretical study is built on five main conceptual foundations: the melinjo emping agroindustry, the characteristics of traditional household-scale production, the obstacles to rural agro-industrial businesses, a production management-based solution approach, and optimizing added value within the agro-industrial system. These five foundations are integrated to explain the dynamics of traditional melinjo emping production and the urgency of optimizing the production process to strengthen business sustainability at the rural level.

Agroindustry is essentially an agricultural processing system aimed at increasing the added value of primary commodities through a series of production processes, resulting in products with higher economic value. In the context of melinjo chips, production activities are generally carried out on a household scale, characterized by simple technology, the use of family labor, and a limited capital structure. The melinjo chips agroindustry plays a crucial role in supporting the rural economy by creating jobs and increasing household income. Research shows that the added value generated from processing melinjo into chips contributes significantly to business owners' income, although the amount of added value depends heavily on the efficiency of the production process and the applied cost structure (Setiani, 2025; Lestari, Affandi, & Nugraha, 2020). Thus, melinjo chips are understood not only as a traditional food product but as an agro-industrial system with a value chain, cost structure, and production dynamics that require managerial analysis.

Traditional production in the household-scale agro-industry is characterized by the use of simple technology, the dominance of manual labor, minimal process standardization, and relatively small production capacity. In the melinjo chips industry, production stages include roasting melinjo seeds, peeling, flattening, drying, and packaging. This process is highly dependent on worker skills and environmental conditions, particularly weather conditions during the drying process. This dependence often leads to output fluctuations and inefficiencies in the production flow. MSME production management literature indicates that traditional production systems tend to have bottlenecks in manual and time-consuming stages, thus limiting overall production capacity (Anugerah et al., 2024; Muliyah & Supar,

2024). Therefore, understanding the characteristics of traditional production is crucial as a basis for identifying the process elements that most determine production system performance.

In practice, rural agro-industry is inextricably linked to various business obstacles that impact production sustainability. These obstacles can be understood across three main dimensions: technical, managerial, and structural. Technically, limited equipment, manual processes, and dependence on weather conditions hamper production stability. Managerially, business actors often fail to systematically record costs, accurately calculate production costs, and lack structured capacity planning. Meanwhile, structural obstacles include limited market access, fluctuating raw material prices, and limited business capital. Research on agro-industry MSMEs shows that internal obstacles, particularly in production management and business administration, often dominate over external factors (Kusnandar et al., 2023; Saefullah et al., 2021). This suggests that improving business performance can begin with improving internal systems before undertaking expansion or more complex external interventions.

One relevant conceptual approach to analyzing production constraints is the Theory of Constraints (TOC). This theory asserts that every production system has one or more bottlenecks that limit the overall performance of the system (Goldratt, 1986). Until these bottlenecks are identified and optimized, improvements in other parts of the system will not significantly impact total output. In the context of MSMEs, the application of bottleneck identification has been shown to increase production capacity by optimizing available resources without requiring significant investment (Ukey et al., 2025). This approach emphasizes the importance of reorganizing workflows, prioritizing production, and streamlining process times. Furthermore, cost efficiency analysis and calculating added value are also important strategies for increasing the competitiveness of the agro-industry (Nur Arifani & Mahfudz, 2024). Therefore, solutions for the melinjo chips agro-industry are more relevant, directed at optimizing the existing production system rather than costly, comprehensive modernization.

Optimizing added value is a crucial aspect in maintaining the sustainability of agro-industrial businesses. Added value not only reflects the difference between output value and input costs but also reflects the effectiveness of production process management. Increased added value can be achieved through process efficiency, reducing unproductive costs, improving product quality, and improving business management. Empirical studies show that small-scale agro-industries that improve their production and management systems are able to increase profit margins without significantly expanding their business scale (Shakila, 2025; Widadie et al., 2024). This confirms that an internal optimization strategy is a realistic and sustainable approach for household businesses.

In the context of Bulakwaru Village, optimizing the melinjo chip production process is a relevant strategy for strengthening business resilience and sustainability. This approach emphasizes identifying production constraints, improving process efficiency, and strengthening cost management as a basis for increasing added value. Therefore, this theoretical study provides a conceptual foundation for empirical analysis on optimizing the traditional melinjo chip production process within the framework of strengthening rural agro-industry.

3. Research Method

(Dr. Eliyahu M. Goldratt 1986) Theory of constraints , the core of this theory is a method used to identify the most important limiting factors (i.e. constraints) that prevent an organization from achieving its goals and then systematically improve its performance until these factors are no longer limiting. Factors that hinder or hinder an organization from achieving its goals, both internally and externally, are a form of constraint. The most critical limiting factors are called constraints and must be the focus of attention. By controlling constraints In this way, performance can be improved. To control constraints , they must be identified and exploited (e.g., performance must be maximized under the constraint). All other actions will follow (be subordinate to) this exploitation decision. Ultimately, to improve performance, constraints must be elevated . This process will be repeated continuously until the constraint is eliminated. The main idea is that every system has at least one constraint that limits its performance. This constraint serves as the basis for managing and improving the system (Orue, A., Lizarralde, A., Amorrotu, I., & Apaolaza 2021).

This type of research is field research (field research) is a research that collects data conducted in the field with the method used being descriptive qualitative which describes a phenomenon or condition based on data obtained accurately and analyzed systematically (Sahir 2021) namely a case study in Bulakwaru Village, Tarub District, Tegal Regency. This approach is used to describe something. The data collection methods used are observation, interviews and documentation, with primary data sources obtained directly from the research object (Suryanton 2007) namely melinjo chip business actors as informants, as well as documentation of the production process (Hafsiah Yakin 2023) .

Data analysis was conducted by reducing, presenting, and drawing conclusions from field findings. Obstacles identified were categorized based on production aspects (raw materials, labor, equipment, weather, and time), while alternative solutions were developed based on suggestions from business actors, direct observations, and relevant literature supporting the development of agro-industry based on local wisdom.

4. Results and Discussion

Research result

Production process

The production process is a number of steps or methods carried out to produce a product, as well as increase the utility value of goods or services by utilizing available resources (Zainul 2019) . According to Supriyatin (2013) , the production process is an operational activity that is essentially a series of activities to transform inputs into outputs. Production can be defined as an activity aimed at adding utility value or creating new benefits. These benefits can be in the form of changes in form, location, time, or a combination of the three (R. Sari 2019) .

Interviews with Atun, Ilah, and Wanisah revealed that the sustainability of the melinjo emping business in Bulakwaru Village is highly dependent on the availability and management of production factors. These factors include raw materials in the form of melinjo seeds, skilled labor, production equipment, and environmental and weather conditions that support the drying process. Therefore, it can be concluded that all of these elements are interconnected and determine the smoothness and final results of the melinjo emping production process, which is still made traditionally.

Raw material

Melinjo (Gnetum gnemon) is the main ingredient in making melinjo chips, which is the hallmark of this traditional food. The melinjo fruit is chosen because it has a distinctive texture and flavor, making it very suitable for processing into chips (Nur'aini 2013) . The presence of melinjo as a raw material is not only important in terms of taste, but also determines the quality and taste of the resulting chips. Therefore, the availability of good and high-quality melinjo is one of the key factors in the sustainability of traditional melinjo chip production.

The raw material for melinjo is generally quite easy to find, as this plant generally grows naturally and is widespread in various rural areas. Melinjo trees are often found in people's yards, gardens, and vacant land. The presence of melinjo trees in rural areas makes it easier for communities to obtain raw materials and also reflects the sustainable use of local resources to support traditional emping production.

From the interview results, it was found that in the production of melinjo chips, the melinjo chip makers generally obtain melinjo by purchasing it from melinjo traders/collectors, commonly called "bakul," one of which is a melinjo trader/bakul from Jatinegara Village, Tegal Regency, which is known as one of the melinjo producing centers. The availability of melinjo from Jatinegara helps maintain the continuity of the emping production process in traditional processing centers such as in Bulakwaru Village.

Melinjo Chips Production Equipment

In the production process of melinjo chips, a number of simple tools are required before starting processing. These tools have their own functions and are crucial for the smooth running of each stage of production. Some of the tools commonly used by artisans include:

1) Flat stone measuring 50 cm x 50 cm x 20 cm
2) Iron Hammer / Iron Pestle
3) Wok
4) Clean Sand
5) Drain

6) Furnace
7) Wood
8) Woven Bamboo Tray

This is as expressed by Mrs. Atun, that the production process for melinjo chips still uses simple traditional tools and methods, so patience and perseverance are needed in making melinjo chips.

The Process of Making Melinjo Crackers

The process of making melinjo chips is a traditional food preparation method that utilizes natural ingredients and simple methods. Despite the use of less modern equipment and techniques, this process still produces a product with a distinctive flavor and is widely enjoyed.

(Sunanto 1992) There are two known methods in the process of making melinjo chips, namely

1) Roasting

This process is done by frying in an aluminum pan or a pan made of clay (layah, cauldron) without adding cooking oil which is replaced by sand through a roasting process.

2) Boiling

In general, the process of making melinjo chips uses a frying method with sand, so that the fried melinjo seeds will be able to cook evenly because the sand is quick to absorb heat (from the fire of the stove or stove). The step is to mix the melinjo seeds mixed with hot sand while turning them over, the way of frying the roasted so that the aroma and substances contained in the melinjo seeds are not lost, so that you will get melinjo chips that taste delicious, unlike when boiled, the aroma and substances contained in the melinjo seeds will dissolve in the boiling water, this causes the taste of the emping to be less delicious and its distinctive aroma is greatly reduced (Sunanto 1992)

Based on observations and interviews with Mrs. Atun, the steps involved in making melinjo chips begin with roasting the melinjo seeds in hot sand in an iron pan for about two minutes. This helps remove the outer skin of the melinjo and maintains the seeds' texture. After roasting, the cooked seeds are removed and the skins are manually peeled off. The seeds are then carefully pounded on a flat stone to achieve the desired size and thickness, crucial for the quality of the chips.

After being pounded, the emping are dried in the sun for 1 to 2 days to reduce the water content, ensuring a crispy texture and good shelf life. Once dry, the emping are packaged in a simple manner, maintaining hygiene and increasing the product's appeal and durability when marketed. Packaging is usually simple but maintains product cleanliness and tidiness. This step aims to protect the emping from damage, maintain quality, and facilitate distribution and sales. With proper packaging, melinjo emping are not only more attractive to consumers but also have a longer shelf life, making them suitable for marketing in various regions.

Discussion

Optimization is a person's effort to improve an activity or job in order to minimize losses or maximize profits in order to achieve the best possible goals within certain limits (Andri Rizki Pratama 2013) . (KBBI 2020) Optimization is an action, process, or methodology to make something (as a design, system, or decision) more/completely perfect, functional, or more effective. Based on the results of observations and interviews, the typical melinjo emping from Bulakwaru Village in making melinjo emping begins by roasting the melinjo seeds using hot sand for two minutes. After that, the skin is peeled and the seeds are ground to reach the desired size. Next, the emping are dried in the sun for 1 to 2 days to reduce the water content. After drying, the emping are simply packaged to maintain cleanliness and increase shelf life and attractiveness when marketed.

Besides its crunchy texture and slightly savory, sweet, or spicy flavor, depending on the variant, these melinjo chips undergo a unique production process to transform the raw seeds into a consumable product. The melinjo production process involves a series of steps. This includes transforming the raw materials into the final product using resources such as materials, labor, and equipment. Successful production depends on the availability of melinjo seeds, skilled labor, appropriate equipment, and a supportive environment.

Melinjo, the main ingredient, has a distinctive texture and flavor, and its quality is crucial to the flavor of emping. Melinjo is usually easy to find because it grows naturally in rural areas and is often found in yards and vacant lots. Emping makers obtain melinjo from traders or collectors, such as melinjo traders from Jatinegara Village, who help smooth production in Bulakwaru Village. Simple equipment needed in the melinjo-making process includes a flat stone, hammer, pan, sand, scoop, stove, wood, and winnowing basket. Crafters like Ibu Atun use traditional tools, which require patience and perseverance.

Obstacles in the Process of Making Melinjo Chips

Based on observations and interviews with melinjo chip makers in Bulakwaru Village, several major obstacles were identified that directly impact production quality and quantity. These obstacles include:

Limited Capital and Access to Financing

Household-scale melinjo chip makers generally rely on limited personal capital, without the support of financial institutions such as banks or cooperatives. This limited access to financing is a significant obstacle to business development. With minimal capital, artisans struggle to innovate, such as modernizing production equipment, increasing business capacity, or expanding their market. As a result, their businesses tend to stagnate and become less competitive in an increasingly competitive market. Adequate capital support is a pressing need for the sustainable growth of melinjo chip makers.

Marketing is still limited

The melinjo chips produced by artisans in Bulakwaru Village are generally marketed traditionally within the local community. Sellers typically sell their products by traveling from village to village, targeting consumers in the surrounding area. This simple sales method allows melinjo chips to be known and consumed by the local community, but also limits their reach to a broader market. Furthermore, this method relies on direct interaction between sellers and buyers, fostering close relationships within the local community. However, this limited local marketing strategy presents challenges in increasing sales volume and expanding the market for melinjo chips.

Availability of Raw Materials

Melinjo, the primary raw material for melinjo chips, has an unstable supply throughout the year. This supply fluctuation is heavily influenced by the harvest season and weather conditions. As Ramadan approaches, demand for melinjo chips increases sharply, leading to a corresponding surge in raw material demand. Consequently, melinjo prices in the market increase significantly, and availability becomes limited. This situation makes it difficult for artisans to obtain sufficient and high-quality raw materials, ultimately impacting the smooth running of the production process and their ability to meet market demand.

Production Equipment Limitations

Most melinjo chip producers in Bulakwaru Village still rely on traditional equipment for their production, such as manual flatteners and wood-fired stoves. While these tools have been used for generations and are quite effective for household use, their use has several limitations. One impact is limited production capacity, as the process is manual and requires more time and energy. Furthermore, the use of traditional tools increases the risk of inconsistent production results, both in terms of chip thickness, doneness, and final product quality. This presents a challenge in maintaining quality and meeting increasing market demand.

Weather Dependence

The drying process for melinjo chips is highly dependent on sunlight. In sunny weather, the drying process can proceed smoothly, producing perfectly dry, crispy, and attractively colored chips. However, during the rainy season or cloudy weather, this process is hampered. The lack of sunlight makes it difficult for the chips to dry optimally, leaving them damp, at risk of mold, and looking dull. These conditions not only affect product quality but also reduce the product's attractiveness and market value.

There is no next generation of melinjo chip makers

With the increasingly developing era and technology that greatly influences the younger generation, it also has an impact on the melinjo emping makers in Bulakwaru Village, where the culture of making melinjo emping has been interrupted due to the lack of interest of the younger generation in making melinjo emping, which has become an obstacle to the continued survival and development of the melinjo emping business in Bulakwaru Village.

Lack of collaboration with other stakeholders

The lack of collaboration and involvement from other stakeholders in this case, such as the Bulakwaru village government and MSME stakeholders, has a huge impact and is an obstacle in itself, where stakeholders will function as a "getok tular" promotional media which can have an impact on increasing orders for melinjo chips in Bulakwaru Village.

Solution Found

To overcome various obstacles faced in the production process of melinjo chips, there are several potential solutions that can be implemented, as follows:

Strengthening of business group institutions

This institution is a crucial solution for driving the progress of melinjo chip production at the local level. By forming and strengthening organizations or joint business groups, entrepreneurs can more easily access raw materials collectively at more stable and affordable prices. Furthermore, collective ownership of production equipment can increase efficiency and reduce operational costs. In terms of marketing, a collective approach allows melinjo chip products to be marketed more widely with a coordinated strategy, thereby increasing market competitiveness. Through a solid institution, artisans also have a greater opportunity to receive support from the government, financial institutions, and other business partners.

Digitalization of Marketing

Utilizing social media and e-commerce platforms is an effective strategy for expanding the marketing reach of melinjo crackers. Through digital media, businesses can promote their products to a wider audience, extending beyond local areas. Social media platforms like Instagram, Facebook, and WhatsApp can be used to showcase the manufacturing process, product uniqueness, and even customer testimonials. Meanwhile, e-commerce allows for convenient transactions and reaches both regional and national markets. With digital marketing, melinjo crackers have a greater opportunity to grow and compete in the modern era.

Partnership with Melinjo Farmers

Establishing direct collaboration with melinjo farmers is a strategic step to ensure the sustainable availability of raw materials. Through this partnership, melinjo chip producers can obtain a supply of raw materials with more assured quality and more stable prices, especially when demand increases ahead of Ramadan or during the lean season. Furthermore, farmers also gain market certainty for their crops, creating a mutually beneficial relationship. This collaboration not only strengthens the supply chain but also encourages more equitable and sustainable local economic growth.

Modernization of Production Tools

The role of the village government and related agencies is crucial in supporting the development of the melinjo chips business in Bulakwaru Village. One form of assistance that can be provided is the provision of more modern production equipment, such as automatic pounders and drying machines. The use of automatic pounders will help speed up the flattening process and reduce reliance on manual labor, thereby increasing time and energy efficiency. Meanwhile, drying machines can be an effective solution to overcome drying difficulties during unfavorable weather, especially during the rainy season. With this assistance, business owners can increase productivity, maintain product quality, and expand market opportunities more optimally. as an alternative to drying during unfavorable weather.

Diversification of Drying Methods

Using a simple drying oven or greenhouse can be an effective alternative solution to overcome the challenges of drying melinjo chips during unfavorable weather, especially during the rainy season. With this tool, the drying process is no longer entirely dependent on sunlight, so product quality can be maintained even in less than ideal weather conditions. A drying oven or greenhouse also allows for faster and more even drying times, and reduces the risk of the chips becoming damp or moldy. This simple innovation can help increase production efficiency and maintain product durability, while also adding value to the sustainability of the melinjo chips business.

Human Resources Training and Regeneration

Skills and entrepreneurship training for the younger generation is a strategic step in maintaining the sustainability of the melinjo chips business in Bulakwaru Village. Through this training, young people are equipped not only with technical knowledge of the production process but also with an understanding of business management, product innovation, and

marketing strategies. The goal is to foster interest and a sense of ownership in local potential, thus encouraging the younger generation to get involved and continue the melinjo chips business, which has been passed down through generations. With the active involvement of the younger generation, it is hoped that the melinjo chips business will not only survive but also thrive and adapt to changing times.

Collaboration with village or local government

Collaboration between melinjo chip producers and village and local government officials is a crucial step in strengthening the foundations of small-scale businesses. Through this partnership, entrepreneurs gain access to assistance with modern, more efficient production equipment and the opportunity to obtain microfinance to increase their capital. Government support not only encourages increased production capacity but also paves the way for more sustainable business development. This collaboration reflects the synergy between the community and the government in empowering local potential and improving the welfare of entrepreneurs at the village level.

5. Conclusion and Suggestions

Traditional melinjo chip production in Bulakwaru Village faces various technical, structural, and managerial challenges. The main obstacles include dependence on weather during the drying process, limited equipment and capital, difficulty obtaining raw materials, especially when demand increases, and limited marketing strategies. Nevertheless, there are opportunities for development through the application of simple technology, strengthening human resource capacity, strategic partnerships, and institutional support and digitalization of marketing. The sustainability of the melinjo chip business depends heavily on the ability of business actors to adapt to these challenges through synergy between the community, government, and other supporting sectors.

To improve the efficiency and sustainability of melinjo chip production in Bulakwaru Village, more concrete intervention is needed from the village government and relevant agencies. One such intervention is the provision of alternative drying facilities, such as solar dryer domes, to address the weather-dependent nature of the drying process. Furthermore, ongoing training and mentoring for business owners is crucial, particularly in production management and marketing, to enable them to adapt to market developments and increase product competitiveness.

Furthermore, institutional strengthening through cooperatives or joint venture groups needs to be encouraged as a collective strategy to increase production efficiency, strengthen distribution networks, and facilitate access to capital and raw materials. To ensure that each step in business development is carried out appropriately and measurably, further studies on cost and value-added analysis are also necessary. This study is crucial for providing a more comprehensive picture of potential profits and economic efficiency, ensuring that the strategies implemented can truly have a significant impact on improving the welfare of melinjo chip entrepreneurs as a whole.

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