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A Comparison of Javan Cut-and-Carry Systems and Pastoral Practices in the Production of Beef Cattle

Dr. Jonathan Miller[1], **Dr. Amanda Brooks**[2]
[1]Department of Agricultural Sciences, University of California, Davis, USA
[1]Department of Agricultural Sciences, University of California, Davis, USA

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Abstract

This research examines the contrasting beef cattle farming systems in Java and Sumba, Indonesia. A survey method was employed across three districts two in Central Java and one in Sumba Island, NTT. The study utilized a descriptive qualitative approach, incorporating the CATWOE Analysis framework to capture stakeholder perspectives on the cattle farming industry. In Java, cattle farming primarily follows a cut-and-carry system, whereas in Sumba, a pasture-based grazing system is predominant. The findings indicate that in Java, cattle rearing is primarily aimed at generating household income, leading to a growing focus on fattening and enlargement enterprises. Conversely, in Sumba, cattle are mainly raised as a form of traditional savings, with minimal supplementary feeding to reduce maintenance expenses. Farmers continue to struggle with pricing disparities and market inequities. The study concludes that farmers exhibit adaptability in resource allocation to maximize profits. Recognizing the distinct farming approaches is essential for designing effective livestock development programs.

Keywords*: beef cattle, CATWOE framework, cut-and-carry system, pasture grazing*

1.Introduction

Beef farming plays a vital role in Indonesia's meat production industry. However, it remains a dynamic and complex sector, largely due to the predominance of smallholder farmers. Approximately 6.5 million rural farmers are engaged in cattle rearing, contributing around 90% of the nation's total beef cattle production. Smallholder farming remains a cornerstone of the industry (Agus & Widi, 2018). However, productivity in this sector tends to be low, often due to challenges such as inadequate feeding, disease outbreaks, and limited adoption of modern production technologies (Hadi et al., 2002; Patrick et al., 2010). As of 2022, Indonesia's beef cattle population stood at approximately 18.6 million, an increase from 17.4 million in 2020 (Agus & Widi, 2018). Despite this growth, domestic beef production only meets around 45% of the national demand (Bremer et al., 2022)(1).

The increasing population, evolving dietary habits, and shifting consumption patterns are key drivers of rising food demand (Hovhannisyan & Devadoss, 2020). By 2023, Indonesia's population was projected to exceed 278 million, a steady increase from 255 million in 2015. More than half of this population resides on Java Island, making it the most densely populated region, with over 1,000 people per square kilometer (Statistics Indonesia, 2023b). As the country's primary beef consumer, Java relies on live cattle imports from the eastern regions of Indonesia, particularly Sumba Island, which serves as one of the key suppliers.

Given Java's limited land availability, smallholder farmers predominantly adopt a zero-grazing system, commonly referred to as the cut-and-carry method. This practice is widespread among farmers with restricted land access, where cattle are housed in sheds, and fodder is manually gathered from forests, fallow lands, roadsides, wastelands, and post-harvest fields (Devendra, 2007). Since farmers must collect and transport forage daily, this method is highly labor-intensive, often restricting the number of cattle they can raise. Consequently, successful implementation requires substantial knowledge regarding forage selection, quality assessment, and optimal daily feeding amounts.

In contrast, Sumba has a significantly lower population density approximately one-tenth of Java's allowing ample land for cattle farming. Livestock holds deep cultural and economic significance for the Sumbanese, playing a crucial role in traditional ceremonies and rituals(2). Due to the availability of extensive grazing land, most cattle farmers in Sumba practice pastoralism. Under this system, cattle primarily graze on natural pastures with little to no supplemental feeding. As a result, pasture management becomes a critical factor in ensuring sustainable farming. Compared to Java's cut-and-carry system, pastoral farming requires less labor, enabling farmers to manage larger herds. However, without proper pasture maintenance, this system remains vulnerable to land degradation, social disputes, and declining productivity.

This study seeks to examine and compare the functioning of cut-and-carry and pasture-based cattle farming systems. Understanding the day-to-day farming activities is crucial to untangling the complexities of these systems. By adopting a systems thinking approach, this research analyzes the interdependence between cattle farming in Sumba and Java, illustrating how developments in one region influence the other.

2.Literature Survey

Beef cattle farming systems differ considerably due to geographical, economic, and cultural differences. In Indonesia, two prevailing systems are extensively practiced: the cut-and-carry (zero-grazing) system, mostly practiced in Java, and the pastoral grazing system, mainly practiced in Sumba and other eastern provinces. Farmers' socio-economic goals, climate patterns, and land availability determine the adoption of a farming system (Agus & Widi, 2018).

Cut-and-Carry System in Java

Java, being the most populous island in Indonesia, is land-constrained and has limited open grazing spaces. Therefore, farmers have to depend on the cut-and-carry system, where cattle are confined to enclosures and fed by hand with forages like elephant grass (Pennisetum purpureum), rice straw, and farm residues (Devendra, 2007).

The system is labor-intensive but enables farmers to combine cattle farming with crop production, ensuring optimal use of land (Widyas et al., 2022) (3).

One of the greatest challenges confronting smallholder farmers who practice the cut-and-carry system is scarcity of forage, especially during the dry season. To supplement, farmers usually turn to rice straw, wheat bran, cassava starch residues (onggok), and palm kernel meal to sustain cattle nutrition (Seruni et al., 2021). Research shows that feed supplementation enhances cattle growth rates and farm productivity, but most smallholder farmers have difficulty with feed costs and access to quality supplements (Greenwood, 2021).

Moreover, there is a discernable trend away from breeding to fattening systems within Javanese farmers. Many smallholder farmers prefer the fattening operation because of the shorter production phase and quicker payment, enabling them to acquire income more recurrently (Setianto et al., 2014). Nevertheless, it poses concerns in terms of the long-run sustainability of the cattle population given that fewer numbers of farmers remain involved in the breeding enterprise, which would result in stock shortages (Bremer et al., 2022).

Pastoral Cattle Farming in Sumba

Unlike Java, Sumba has large grazing areas, thus pastoralism is the prevailing system of cattle farming. Farmers hardly give supplemental feed, leaving cattle to graze freely in communal pastures, where they feed on native grasses and shrubs (Mayberry et al., 2021). Although this system is less intensive than the cut-and-carry system, it is very rain-dependent and depends on pasture management (Oosting et al., 2022) (4).

Sumba pastoral farming is tradition and social habit-bound. Cattle are not only economic resources but also wealth and status symbols. In most cultural rituals and social exchanges, cattle are utilized as dowry, gifts, or offerings (Delon, 2018). Sumbanese farmers are therefore less interested in customary cattle sales and tend to sell animals only when there are pressing financial needs. This is in stark contrast to Javanese farmers, who practice systematic cattle sales in order to ensure cash flow (Patrick et al., 2010).

Pastoral farming may have low input costs, but there are difficulties. In the dry season, pasture quality decreases, resulting in reduced weight gain and increased mortality (Hadi et al., 2002). Uncontrolled grazing can also result to land degradation, which calls for improved pasture management practices to achieve long-term sustainability (Herrero et al., 2013)

3.Materials and Methods

Participants and Sampling Approach

This study was conducted on two distinct beef cattle farming systems: zero-grazing and pastoral farming. The zero-grazing system was represented by farmers in Kabupaten Banjarnegara and Kabupaten Banyumas in Central Java

Province, while the pastoral system was represented by farmers in Kabupaten Sumba Barat Daya in East Nusa Tenggara Province. A cluster sampling method was employed to select participants, resulting in a sample of 45 farmers 30 practicing zero-grazing and 15 engaged in pastoral farming.
In the zero-grazing (cut-and-carry) system, cattle are housed in confined areas such as barns or feedlots, where farmers manually provide feed and water (Greenwood, 2021). Conversely, the pastoral system involves cattle grazing on natural pastures, relying on available vegetation in rangelands a traditional farming method that has been practiced for centuries in various regions worldwide (Oosting et al., 2022).

Research Design and Data Analysis

This research adopts a qualitative methodology underpinned by a systems thinking approach. Systems thinking provides a holistic perspective, examining an entire system rather than analyzing its components in isolation (Arnold & Wade, 2015; Setianto et al., 2019). This approach ensures that all relevant aspects are considered, preventing oversights and unintended negative consequences when making decisions about production systems (Bremer et al., 2022).
The study followed a structured research process involving the following steps:
Identifying daily farming activities – This included both cattle-related and other livelihood activities, the resources available for these activities, and the pressures affecting both resources and farming practices.
Analyzing key challenges – Investigating the major issues faced by farmers within the two farming systems.
Organizing and structuring challenges – Categorizing the identified issues systematically to understand the broader complexities.
A combination of direct field observations, semi-structured interviews, and focus group discussions (FGDs) was utilized to gather in-depth insights into the complexities of beef farming.
To understand farmers' mental models, the study employed CATWOE analysis, a framework from the Soft Systems Methodology (Ackermann, 2012). The goal was to analyze how each farming system operates and sustains itself. The six components of CATWOE were examined to gain a comprehensive understanding of the beef farming business:
Customers – The target beneficiaries, their needs, and preferences.
Actors – The key stakeholders in the process, including suppliers, laborers, and collaborators.
Transformation – The core farming process, from production to outcomes.
Worldview – The values, beliefs, and perspectives that influence farming decisions.
Owners – The primary farm owners, their interests, and potential conflicts.
Environment – External factors affecting farming, including environmental impacts, policies, risks, and opportunities.

4. Results and Discussion

System Overview

This study was conducted in three distinct locations: Kabupaten Banyumas and Kabupaten Banjarnegara in Central Java, representing Java Island, and Kabupaten Sumba Barat Daya in East Nusa Tenggara Province, representing Sumba Island. Java is characterized by a high population density, exceeding 1,000 people per square kilometer, creating challenges for cattle farmers who struggle with limited land for forage cultivation. As a result, many farmers have shifted towards fattening beef cattle (Setianto et al., 2014), as this method requires less forage while ensuring faster income generation.
Beef farming in Java is often integrated into mixed agricultural systems, where livestock are raised alongside staple crops such as rice, corn, and soybeans (Widyas et al., 2022). Most farmers in Java operate on a small scale, managing herds of one to five cattle per household. The dominant breed in Java is the Australian Commercial Cross, selected primarily due to its availability in the market, ability to adapt to concentrate feed, and superior weight gain performance(5).
In contrast, Sumba Island has vast tracts of land conducive to pastoral cattle farming. Farmers practice free-range grazing, allowing cattle to roam over extensive communal pastures. In some areas, cattle are herded during the day and confined in enclosures at night for safety (Mayberry et al., 2021). The region is a key supplier of live cattle to Java (Riwukore, 2020). Unlike Java, Sumbanese farmers favor a cow-calf operation, allowing natural breeding on pasture lands with minimal feed supplementation to reduce costs. The predominant breed in Sumba is the Sumba Ongole, which has adapted well to local environmental conditions.

From a systems thinking perspective, these observed differences represent only the visible elements of a broader farming structure. To gain deeper insights, this study employed CATWOE analysis, incorporating participatory discussions with farmers, local authorities, and cattle traders.

CATWOE Analysis

CATWOE analysis provides a multi-stakeholder perspective, incorporating inputs from customers, actors, and owners of the system. This method was applied to examine the challenges and dynamics of beef farming in Java and Sumba, as summarized in Table 1. CATWOE aids in identifying key players, beneficiaries, and external influences, allowing for a thorough assessment of how interventions might impact system performance.

Farmer Demographics and Decision-Making

The household head typically oversees all farming-related decisions, including the allocation of resources. In Java, around 40% of household heads have completed elementary education (year 6), 25% have finished junior high school (year 9), and the rest have attained higher education (year 12 or beyond). In contrast, Sumbanese farmers have lower exposure to formal education, with most only completing elementary school. Education plays a crucial role in helping farmers adopt and adapt to new agricultural technologies (Paltasingh & Goyari, 2018). These findings highlight the need for extension services to assist farmers in enhancing productivity.

Economic and Cultural Role of Livestock

In both Java and Sumba, agriculture is the primary source of income for approximately 70% of households. However, in Sumba, livestock plays a dual role, serving both economic and cultural functions. Unlike in Java, where cattle are raised primarily for sale, in Sumba, livestock is deeply embedded in traditional customs(6).

Cultural traditions in Sumba require the slaughter of multiple animals including buffaloes, pigs, cattle, goats, and poultry for ceremonies. Each wedding, funeral, or religious event typically involves two to five livestock slaughters, significantly more than in Java (Delon, 2018). Livestock is also commonly exchanged as gifts during weddings or as a sign of respect at funerals. The number of animals sacrificed often reflects an individual's social status within the community.

In Java, agriculture is primarily a means of generating income. Farmers engage in diverse agricultural activities, including rice, corn, groundnut, soybean, and fish farming. Due to limited land availability, many farmers practice intercropping, cultivating multiple crops on the same land such as rice with corn, soybeans, or fish ponds with chili and sweet potatoes. Java's farmers optimize their limited resources efficiently (Ubabukoh & Imai, 2023), often rotating crops across the seasons. For instance, a typical cropping sequence might include rice-rice-corn/groundnuts or rice-corn/groundnuts-rice, depending on weather predictions.

In Sumba, agriculture serves both economic and subsistence purposes. Farmers prioritize corn cultivation to ensure household food security, storing supplies to last at least six months, especially during the dry season. A traditional Sumbanese house typically consists of three levels:

Ground level – Used for storage and keeping livestock (pigs, goats, poultry).

Middle level – The living quarters for the household.

Upper level – Used for storing staple foods, such as corn and dried cassava.

This practice reflects the community's traditional strategies for ensuring food security. However, there is a growing need to address nutritional balance within households to prevent dietary deficiencies (Sibhatu & Qaim, 2017).

The Role of Livestock in Rural Households

Agriculture remains a critical component of household security, with farmers strategically combining multiple commodities to sustain a steady food supply. However, livestock plays a multifaceted role, extending beyond economic benefits to social and cultural dimensions (Herrero et al., 2013).

In Java, 90% of farmers consider rice to be the most essential crop for household survival. Livestock, on the other hand, is mainly reared for commercial purposes, making beef consumption rare among farmers themselves.

In Sumba, livestock is primarily raised for cultural rather than economic reasons. Meat is mainly consumed during traditional ceremonies, with raw meat often distributed among family members. These cultural practices help ensure protein intake for the community(7).

It is evident that livestock plays a vital role in rural livelihoods, not only as a financial asset but also as a symbol of social status and tradition.

The Farming

Within the beef cattle industry, farmers typically engage in one of two primary farming systems: breeding or fattening, each with distinct objectives. Breeding focuses on producing calves, with cows serving as a form of household savings and security rather than a steady source of income. In this system, livestock are fed mainly on forage and rice straw, without supplementary concentrates.

On the other hand, fattening prioritizes weight gain, with the primary goal of generating regular income. Farmers involved in fattening perceive cattle as economic assets, ensuring a continuous cash flow rather than as a long-term investment. To accelerate weight gain, they incorporate nutritional supplements such as wheat pollard, rice bran, cassava starch, and coconut meal into the diet.

For breeding purposes, farmers commonly prefer artificial insemination (AI) over natural mating, as AI allows them to use superior exotic breeds like Simmental and Limousin, which produce higher-value calves. The widespread availability of AI services in rural areas has facilitated this process, ensuring timely insemination without delays.

Shifting Trends in Java

In Java, there has been a noticeable shift from breeding to fattening in recent years. Interviews with inseminators and data from local livestock offices confirm that more farmers are opting for fattening. Several factors contribute to this trend, including the growing economic importance of cattle, increasing farmer knowledge about feed composition and preservation, and perceived higher profitability of fattening(8).

Farmers reported that the role of cattle has evolved over time. Initially, cattle were valued primarily for social security and financial stability, but today, they are increasingly seen as commercial commodities. Approximately 88% of surveyed farmers confirmed this shift in perception.

Traditional Cattle Management in Sumba

In Sumba, cattle continue to function as a form of savings and a symbol of social status. Farmers generally do not follow a fixed selling schedule, instead selling cattle only when they require immediate cash. As a result, Sumbanese farmers are less responsive to fluctuations in cattle prices, with over 85% preferring the cow-calf system rather than fattening. Breeding operations are considered more cost-effective because they require minimal investment in feed and maintenance compared to fattening.

Farmers who depend on cattle sales for their livelihoods typically sell two to three cattle per year. However, given their small-scale operations and limited financial capital, they are highly vulnerable to price volatility. When market prices rise, farmers tend to purchase more cattle, hoping to profit from the trend. Conversely, when prices drop, they rush to sell cattle, fearing further depreciation (Aimin, 2010). This pattern often results in financial instability, as farmers are frequently subject to unpredictable market forces beyond their control.

Government-Supported Breeding Programs

In Java, approximately 25% of surveyed farmers still practice breeding, often due to participation in government-sponsored programs. These farmers belong to organized groups that receive government grants, making breeding a mandatory activity.

A discussion with a group secretary (responsible for cattle marketing) revealed that many farmers preferred to purchase pregnant cows. Once the calves reached six to seven months old, both the cows and calves were sold, allowing the group to reinvest in new pregnant cows. This approach ensured a yearly cash flow while complying with government regulations. However, most farmers expressed a preference for fattening, but continued breeding to fulfill grant program requirements.

Java: Cut-and-Carry System

In Java, all farmers utilize the cut-and-carry feeding system, a labor-intensive practice in which fresh forage is cut daily and brought to housed cattle (Seruni et al., 2021). The cattle remain in enclosures year-round, with forage and rice straw being gathered daily from surrounding areas.

To supplement their cattle's diet, farmers occasionally add byproducts such as rice bran, cassava starch residue (onggok), and wheat pollard. While elephant grass (Pennisetum purpureum) is commonly grown as a forage source, its production is insufficient to meet daily feeding needs. As a result, farmers resort to collecting grass from forests, riverbanks, and harvested rice fields, sometimes using fresh or ammoniated rice straw as a substitute.

Sumba: Pasture-Based System

In contrast, farmers in Sumba rely on traditional extensive grazing, where cattle roam freely on communal pastures throughout the year, particularly during the rainy season. These pastures are shared with other livestock, including horses, buffaloes, and goats.

Despite having larger landholdings compared to Java, Sumbanese farmers face low pasture productivity due to their reliance on natural rainfall. To counteract this, during the dry season, farmers convert their fallow agricultural land into private pastures, allowing for more controlled grazing(9).

This practice reflects the farmers' strategic approach to resource allocation, ensuring optimal benefits for their households despite seasonal challenges.

The Market

Farmers in Java and Sumba have several options when buying or selling cattle, including local traders, livestock markets, and transactions with neighboring farmers. However, local traders are the preferred choice due to their convenience and cost-efficiency. By dealing with traders, farmers eliminate transportation challenges associated with taking cattle to the market.

Transporting cattle involves various vehicle types based on capacity, including small pickups, medium pickups, light trucks, and large trucks, which can carry up to 3, 4, 8, and 14 cattle, respectively. Transportation costs vary accordingly:

Small pickup: Rp150,000–200,000

Medium pickup: Rp200,000–250,000

Light truck: Rp300,000–400,000

Large truck: Rp400,000–500,000

Since most livestock markets are located within 30 km of farms, these transportation costs remain relatively manageable. Many farmers prefer to sell cattle through local traders to avoid these expenses altogether.

Unfair Pricing Practices in Cattle Trading

One of the major challenges faced by farmers is the lack of accurate weight measurement systems at cattle markets. Most transactions rely on traders' visual assessments of cattle weight and body condition, as scales are not widely available (Setianto et al., 2014). Since traders possess the expertise to estimate cattle weight, farmers often end up receiving lower prices than their cattle's actual worth, resulting in unfair pricing practices.

In Java, there is a growing trend toward weight-based pricing, where prices are determined per kilogram of body weight. This system provides a more objective and fair method of valuation, reducing reliance on traders' estimations. However, only larger-scale farmers can benefit from this system, as it requires an investment in body weight scales, which many smallholder farmers cannot afford.

Farmers' Buying and Selling Preferences

When purchasing cattle, farmers often base their decisions on physical appearance rather than economic factors. Characteristics such as coat color and body shape play a significant role in selection, as cattle are not only seen as financial assets but also as symbols of status and pride. This historical and cultural attachment to visually appealing cattle sometimes leads to overvaluation, making it difficult for farmers to sell their livestock at reasonable prices.

Farmers typically sell cattle when they require cash, often without regard for market conditions. For instance, during the school enrollment period (June–August), when many farmers need money for their children's education, traders tend to offer lower prices, capitalizing on farmers' financial urgency. This further disadvantages smallholder farmers, as they often lack the financial flexibility to wait for better market conditions.

Cash Transactions in Livestock Markets

Both in Java and Sumba, cash transactions remain the dominant method of payment in cattle markets, with bank transfers being uncommon. Even though mobile banking units are available at some markets, most farmers and traders prefer physical cash. Traders argue that holding cash gives them stronger bargaining power, while farmers find it more practical to have immediate access to money(10).

Role of Market Brokers (Tukang Panteng)

A distinctive figure in the livestock market is the broker, locally known as the "tukang panteng." Their role is to assist in selling cattle by:

- Unloading cattle from transport vehicles upon arrival.
- Negotiating with farmers to determine an initial selling price.
- Walking the cattle around the market to attract potential buyers.
- Finalizing deals with buyers while ensuring the best possible price.
- The tukang panteng earns a commission based on the difference between the initial price and the final selling price. These brokers operate in both Java and Sumba, playing a crucial role in market transactions by facilitating negotiations and connecting sellers with buyers.

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5.Conclusion and Future work

This study highlights the distinct characteristics of beef cattle farming systems in Java and Sumba, Indonesia. The cut-and-carry system in Java is an intensive, labor-driven approach that allows smallholder farmers to integrate cattle farming with crop production, ensuring higher productivity but requiring significant time and resource investments. In contrast, the pastoral grazing system in Sumba relies on natural pastures, making it less labor-intensive but highly dependent on seasonal rainfall and communal land management.

The findings reveal that economic objectives and cultural values shape farmers' decisions in both regions. In Java, farmers primarily focus on income generation, leading to a shift from breeding to fattening systems for quicker financial returns. Meanwhile, in Sumba, cattle are viewed as assets for social and cultural purposes, with many farmers prioritizing cow-calf operations rather than systematic fattening programs.

Market accessibility and pricing mechanisms present significant challenges for farmers in both regions. In Java, there is a growing adoption of weight-based pricing, particularly among larger-scale farmers, while smallholders remain vulnerable to price manipulation by traders. In Sumba, traditional pricing and limited market structure make cattle sales inconsistent, often driven by urgent financial needs rather than market conditions. Additionally, the lack of modern breeding techniques and structured extension services affects cattle quality and productivity.

Overall, the study underscores the need for tailored interventions that consider regional differences in farming systems. Strengthening extension services, improving pasture management, ensuring fair pricing mechanisms, and expanding access to technology can enhance the sustainability and profitability of beef cattle farming in both Java and Sumba.

Future Work

Future research should focus on developing adaptive strategies to improve cattle farming sustainability across different ecological and socio-economic conditions. Key areas for further exploration include:

Sustainable Feed Solutions Research on alternative feed sources, forage conservation techniques, and feed supplementation strategies to improve cattle nutrition and mitigate seasonal shortages in both Java and Sumba.

Pasture and Land Management Investigation into sustainable pasture management practices to prevent land degradation in Sumba’s extensive grazing system, while identifying solutions for maximizing forage production in Java’s limited land areas.

Market and Pricing Transparency Analysis of innovative pricing models, such as digital livestock markets or blockchain-based trading systems, to ensure fair cattle valuation and reduce trader dominance.

Technology Adoption and AI Accessibility – Expanding research on cost-effective artificial insemination (AI) programs, breed improvement initiatives, and low-cost technology solutions that cater to smallholder farmers in remote regions.

Impact of Climate Change – Investigation into climate resilience strategies for both farming systems, including drought-resistant forage species, water conservation techniques, and climate-adaptive breeding programs.

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Conflicts of interest

The authors have no conflicts of interest to declare

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