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Simulation of Agropasture Carrying Capacity in Supporting Cattle Production System

Fellyanus Haba Ora[1*]
University of Nusa Lontar, Rote Ndao, Indonesia[1*]
iho180285@gmail.com[1*]

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Abstract
Purpose: This study aimed to simulate the carrying capacity of existing agropastures to support cattle production systems.
Research Methodology: Research materials consisted of forage vegetation in agropasture and 120 farmers respondents. This research was descriptive in nature and had a cross-sectional design. The data include both primary and secondary sources. Data collection techniques were conducted through observations and documentation. Data analysis was performed using Powersim to simulate a nine-year projection.
Results: A nine-year simulation projected a significant degradation of the cattle population, resulting in excess forage availability in agropasture. Biophysically, agropasture on Timor Island has an adequate carrying capacity; however, this potential is not optimally utilized due to inefficiencies in the cattle production system, including high mortality rates of calves and adult cattle, low reproductive performance of female cattle, cattle removals that disregard regional carrying capacity, and a high incidence of livestock disease outbreaks.
Conclusions: The existing conditions and carrying capacity of feed quantity in the agropasture of Timor Island are very low to support the cattle production system, resulting in overgrazing and disruptions to livestock production and health. If this condition persists, it will lead to the degradation of the cattle population, although it may eventually be followed by excess forage availability.
Limitations: This study did not present a dynamic system intervention simulation of the existing carrying capacity of agropastures to support the cattle production system.
Contributions: This research contributes to the planning and policy aspects of agroecosystem-based area development, particularly agropasture, in supporting livestock production systems.

Keywords: *Carrying Capacity, Dynamic Simulation*, *Production System*

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1. Introduction

Agrotechnology as a field of study emphasizes the integrated management of agricultural resources through a systems approach, with a primary focus on optimizing land use, ensuring agroecosystem sustainability, and enhancing agricultural productivity based on the biophysical and socio-economic conditions of the region. In dryland areas such as Timor Island, the development of adaptive and sustainable agricultural systems presents a major challenge owing to limited rainfall, low soil fertility, and fluctuations in forage biomass availability throughout the year.

The agropasture system is an agrotechnological approach that integrates crops, grazing land, and livestock into a unified production system. This system has the potential to improve land-use efficiency, enhance nutrient cycling, and increase production stability in the dryland agroecosystems. However, the success of the agropasture system is highly dependent on the land carrying capacity, which refers to the land's ability to provide forage biomass sustainably without degrading soil and vegetation quality (Jonathan, Apriyadi, & Saputra, 2024). The cattle production system is influenced by feed availability, genetic factors, herd management, agroecosystem conditions, and socio-economic characteristics of farmers. Imbalances among these factors reduce productivity, reproductive efficiency, and overall animal health. However, feed represents the main constraint, with the largest percentage contribution to limiting the performance and sustainability of the cattle production system.

On Timor Island, cattle development largely depends on natural grazing and marginal agricultural lands that are traditionally managed. The mismatch between the number of cattle and the land carrying capacity often results in excessive pressure on vegetation, land degradation, and a decline in overall production system productivity (Hardianto & Anggriawan, 2023). This situation highlights the need for an agrotechnological approach that can quantitatively and measurably integrate the land's biophysical aspects with the dynamics of the cattle production system.

The carrying capacity for Bali cattle in the agroecosystem of Timor Island ranges from 1.2 to 1.5 livestock units per hectare per year; however, the existing carrying capacity index is <0.2, indicating that feed availability is extremely limited relative to livestock requirements (Haba Ora, Fuah, Abdullah, Yani, & Purwanto, 2020). Dry matter forage production at the end of the dry season is only approximately 0.61 tons/ha, which is substantially lower than that during the rainy season, when it ranges from 2.66 to 4.33 tons/ha (Haba Ora, Fuah, Abdullah, Yani, et al., 2020). This indicates that land capacity is highly constrained in supporting livestock forage production.

Simulation and system modeling approaches in agrotechnology provide opportunities to analyze the relationship between land carrying capacity and production systems more comprehensively than traditional methods. Through simulation, various agropasture land management scenarios, such as changes in land area, biomass productivity, and utilization intensity, can be evaluated to predict the ability of the land to sustainably support cattle production. This approach enables data-driven decision-making while minimizing the risk of land degradation due to management practices that exceed ecosystem capacity (Godde, Mason-D'Croz, Mayberry, Thornton, & Herrero, 2021).

Although the agropasture system has been extensively studied as a crop-livestock integration approach, most existing research focuses on conventional livestock aspects, such as cattle production performance, feed availability, or partial management of cattle husbandry. These studies generally do not consider land as a primary subsystem within an integrated agroecosystem framework, however. Research on land carrying capacity in agropasture systems is generally conducted using static and descriptive approaches, relying on estimates of livestock stocking capacity based on forage biomass availability at a single point in time. This approach cannot capture the temporal dynamics of the system, particularly in dryland areas such as Timor Island, which experience high seasonal climate variability and significant fluctuations in biomass production.

Furthermore, studies that specifically apply simulation and system modeling approaches from an agrotechnology perspective remain limited. Most of the models developed have not comprehensively integrated the interactions between land productivity, biomass utilization, and the sustainability of agropasture systems (Riwu Kore, Marnisah, Haba Ora, & Yustini, 2021). Consequently, land management recommendations are often not based on system analyses that are adaptive to local biophysical conditions.

In addition, agropasture research in the Timor Island region is still dominated by descriptive studies and has rarely developed models based on dryland localities that consider the specific characteristics of soil, vegetation, and land use patterns of local communities. This indicates a gap between the need for sustainable land management and the availability of applicable and contextual agro-technology models.

Therefore, research on simulating the carrying capacity of agropastures to support cattle production systems on Timor Island is essential within the framework of agrotechnology. This study is expected to provide a scientific basis for more efficient agropasture management, adaptation to dryland conditions, and orientation toward agroecosystem sustainability and the enhancement of integrated crop-livestock production in the Timor Island region.

2. Literature Review

2.1 Carrying Capacity

Carrying capacity is the ability of an agroecosystem to provide forage according to the total cattle (Haba Ora, Fuah, Abdullah, Yani, et al., 2020), which is closely related to livestock type, forage production, season, and agroecosystem area (Haba Ora & Riwu Kore, 2017; Riwu Kore & Haba Ora, 2019c) carrying capacity is highly influenced by the interaction between climate, plants, and livestock. Meanwhile, (Li, Cundy, Chen, Liu, & Lv, 2020) define carrying capacity as the quantitative production limit of agroecosystem indicators resulting from the interaction between soil, vegetation, water, and management practices. Therefore, the carrying capacity is dynamic owing to the influence of biophysical factors, climate, and management practices.

Several studies have indicated that a mismatch between the total cattle population and carrying capacity results in undergrazing or overgrazing, leading to slow cattle growth and a decline in land production quality (Abadi et al., 2025), reduced vegetation cover (Parahita, Baskoro, & Darmawan, 2022), soil degradation and decreased land quality (Ngaku, 2023), and disruption of the agroecosystem (Priyanto et al., 2020).

The approach to calculating carrying capacity is based on the Ruminant Livestock Population Increment Capacity (KPPTR) using the principles of (Nell & Rollinson, 1974), as follows:

1. Total Forage Production (TFP)
   (15 × Land Area × Equivalent Conversion TFP) × (Harvest Area × Equivalent Conversion of Crop Residue). The value 15 represents a forage production coefficient used to convert land area (hectares) into an estimated annual forage production expressed in dry matter units Haba Ora (2015).
2. Land's capacity to support livestock
   $\frac{\text{TFP}}{\text{2.3 ton}}$ where each livestock unit (LU) requires 2.3 tons of dry matter per year
3. Carrying Capacity
   Regional Carrying Capacity – Total Livestock Units (LU)

2.2 Agropasture

Agropasture is an integrated farming system that combines crop cultivation (agricultura) and livestock (pasture) on the same land sustainably. This system is particularly suitable for optimizing dryland or marginal land and for increasing farmers' income (Lestari & Zulkarnain, 2024) (Apriyani, Jayanti, & Nearti, 2025).

Conceptually, agropasture is defined as a combination of agricultural and livestock activities. This combination creates a closed-loop system in which crop residues are used as feed and livestock provide outputs in the form of meat/milk and manure. Marnisah et al. (2022) and Irmayani, Adnin, and Irwan (2025) note that agropasture contributes to land continuity, improves soil fertility, reduces erosion, and minimizes waste, making it an environmentally friendly farming system.

Fuah et al. (2020) explain that the crop-livestock integration in agropasture enhances land productivity because the system allows for more diverse outputs, both for commercial and household consumption, compared to monoculture methods. Riwu Kore, Purwanto, et al. (2020) argue that agropasture on Timor Island is viewed as an adaptive approach to water scarcity and low soil fertility, as vegetation diversification and land management can increase system resilience to climate variability. Nevertheless, seasonal fluctuations in forage biomass production remain a challenge for the stability of agropasture systems.

In dynamic systems, nutrient cycling occurs through feedback interactions among livestock, feed, and land. Nutrients consumed by livestock are partially returned to the soil through feces and urine, enhancing soil fertility and forage production. Crop residues are utilized as livestock feed, creating a nutrient flow from the land to livestock. The balance of this cycle depends on the livestock population, land carrying capacity, and feed management; disturbances in any component will affect the overall sustainability of the livestock production system.

2.3 Cattle Production System

The cattle production system is an effort to integrate resource utilization effectively for the sustainable production of cattle, encompassing breeding, feed provision, and land and livestock management. This livestock production system functions as a subsystem of the agroecosystem and is influenced by the carrying capacity, forage biomass, and production stages.

According to Riwu Kore and Haba Ora (2019a), the cattle production system, from the perspective of carrying capacity and agropasture, is determined by the management system: extensive, intensive, or semi-intensive. In the extensive system (pasture), cattle are grazed on large grasslands, utilizing natural forage as the main feed; this represents a traditional system with low capital requirements and low production costs. In the intensive system (feedlot), cattle are confined in pens and provided concentrated feed (grains and forage) to accelerate growth and meat formation. The semi-intensive system combines extensive and intensive approaches, where cattle are fed in pens but still have access to pastures or are given supplementary feed in the pen.

From the perspective of production stages based on the life cycle, cattle production systems can be divided into three categories: cow-calf, stocker/grower, and finisher/feedlot (Riwu Kore & Haba Ora, 2018). The cow-calf system focuses on producing weaned calves for subsequent programs. The stocker/grower system aims to produce replacement heifers and bulls (for herd renewal) or young cattle for fattening purposes.

In a 9-year simulation, herd dynamics are a key component of modeling the cattle production system. Changes in livestock population are mainly determined by the birth rate as the primary inflow and the mortality rate and off-take as the outflows. In the Powersim model, these parameters act as the main driving forces of population change, as they are strongly influenced by feed availability, health, and herd management. Calf mortality in Timor Island reaches 29.6% per year, cow mortality reaches 14.1% per year, and the average calving interval is around 22 months (Fuah et al., 2020)

2.4 Research Development

Timor Island is a dryland region where feed scarcity is a major constraint on cattle productivity. In fact, the agroecosystem (crops and land) on Timor Island has the potential to be a feed source, derived from both irrigated and non-irrigated agricultural residues, covering an area of 317,279 ha. If utilized properly, these resources can enhance cattle production.

Several studies have reported that the utilization of crop residues from agricultural and plantation agroecosystems as feed sources for livestock is <45.6% per year, despite a carrying capacity index of >2 or surplus feed (Fuah et al., 2020); (Mulyadi et al., 2024); (Nurlukman et al., 2025). The inclusion of rice straw residues at 10–50% in the ration increases cattle daily weight gain by 0.5–0.7 kg per head and average feed intake by 4.2 kg per head per day (Riwu Kore & Haba Ora, 2018; Wulandary, Fitriyah, Aqidah, Asrul, & Aras, 2025). (Fuah, Priyanto, Riwu Kore, & Haba Ora, 2021) and (Tiemann & Douxchamps, 2023) report that fattening cattle with corn and sorghum straw residues can increase daily weight gain by 0.9–1.5 kg per head.

The underutilization of agroecosystem land means that feed remains a limiting factor in cattle production. The application of agropasture on Timor Island holds potential for developing cattle production based on carrying capacity, with potential derived from land cover and land use ranging from 60.7% to 86.96% of the agricultural land. Land that is difficult to convert for cattle production development accounts for 13.04–39% of the total land, including state forests, settlements, and water bodies (Haba Ora, 2020).

The carrying capacity is highly dependent on variations in land-use conversion, particularly the conversion of cultivated land into settlements, which occurs at a high rate of 4.7% per year (Riwu Kore & Haba Ora, 2018);(Riwu Kore & Haba Ora, 2019b); (Nurlukman et al., 2025). These conditions constantly change over time, requiring complex calculations involving multiple factors to generate comprehensive solutions.

2.5 Novelty

The novelty of this research lies in the development of a simulation model for the carrying capacity of agropastures based on an agrotechnology approach, which positions land as a core component within an integrated production system. Unlike previous research, which was static in nature, this study dynamically examines carrying capacity through the simulation of relationships between biomass availability, land-use intensity, and the cattle production system.

This study also offers a dryland agroecosystem approach tailored to the specific conditions of Timor Island. The developed model considers not only production aspects but also land sustainability through biomass management and the balance between land carrying capacity and livestock utilization pressure.

Furthermore, the novelty of this research lies in the integration of system modeling within the agrotechnology framework, linking biophysical land variables with livestock production as the system output. This approach provides a scientific basis for formulating adaptive, predictive, and data-driven strategies for agropasture land management, serving as a reference for developing integrated agricultural systems in dryland regions. Therefore, this study is expected to contribute to the advancement of agrotechnology, particularly in managing dryland agropasture agroecosystems through a contextual and sustainable carrying capacity simulation approach.

3. Methodology

This study was conducted on Timor Island, East Nusa Tenggara Province, over a period of six months (June–December 2025). The research sites were purposively selected based on land physical characteristics, availability and total cattle population, and socio-cultural factors, resulting in Kupang Regency and Kupang City as the study locations. The research materials consisted of forage vegetation in agropastures and 120 cattle farmers as respondents. This research was descriptive in nature, with a cross-sectional design. The data collected included both primary and secondary data. Primary data were obtained using destructive sampling and quadrant sampling techniques to determine forage production in agropastures.

Field observations and direct interviews using structured questionnaires were also conducted. The technical coefficients derived from primary data included livestock feed consumption and production in the agroecosystem, reproductive status of cattle, mortality and birth rates, and physiological parameters of the female cattle. Secondary data were obtained from relevant institutions, such as the Kupang Regency Livestock Service, Kupang City Agriculture Service, and the Central Statistics Agency of Kupang Regency and City.

The collected data included (1) total cattle population by age structure (calves, young, adult, and culled) along with annual growth, (2) agropasture area and land conversion, and (3) forage production in agropasture land. Data analysis was conducted by developing a dynamic system using Powersim and interpreting the simulation results over a 9-year period.

3.1 System Conceptualization and Problem Solving

The analysis of the simulation of cattle carrying capacity in agropasture on Timor Island involves multiple factors, including the total cattle population and its growth rate, which must be designed to increase livestock numbers; feed requirements for each cattle population based on different age structures; productive age of cattle affecting cattle performance; population growth influenced by mortality, birth rates, and the reproductive status of female cattle; agropasture area with dynamic land-use changes, either expansion or reduction; and forage production in agropasture, which is affected by grazing management dynamics and climate. These issues are highly complex and continuously change and evolve. Priyanto et al. (2020) Riwu Kore, Yani, et al. (2020a) state that the appropriate solution is to apply a dynamic system approach using Powersim.

3.2 System Identification and Problem Solving

System identification is a design process used to generate a representation of the interconnections among elements (entities) and the input-output relationships of system operations (Haba Ora, 2020). Feed availability in agropastures is strongly influenced by the total cattle population, dry matter production, dry matter requirements based on the cattle population structure, and environmental factors (climate and grazing duration).

The cattle population is affected by the number of calves produced by female cattle, availability of bulls/inseminators, reproductive status of females (Purba et al., 2025), mortality within each population structure, and cattle births. All information and data for system identification and problem-solving are presented in Table 1.

Table 1. Technical coefficients for system identification and problem solving

No.	Technical Coefficient	Cattle Population Structure			
		Calf < 1 year	Heifer/Steer 1-2 year	Cow/Bull 2-3 year	Culled > 3 years
1	Population (heads)				
	Male	135	485	233	55
	Female	275	342	146	38
2	Mortality (%)				
	Male	32.5	12.4	8.5	-
	Female	27.3	9.6	4.5	-
3	Physiological Status (%)				
	Pregnant	-	25	18	-
	Parturition	-	13	35	-
	Lactation	-	27	7	-
4	Conception Rate	-	56.2	55.4	-
5	Calving Interval	-	2.1	2.1	-
6	Cattle Sales (%)				
	Male	-	7.8	38.9	87.5
	Female	-	27.2	41.4	35.8

Table 2. Agropasture carrying capacity

No.	Description	Unit	Value
1	Forage Production	Kg/ha/year	6511
2	Land Area	ha	264
3	Dry Season Duration	months	8
4	Land Degradation	%	1.3

3.3 Flow Diagram of the Model (Model Structure)

The model structure provides a framework for the system and defines the characteristics that influence the system behavior. This behavior is shaped by a combination of feedback loops (causal loops) that comprise the model structure. Regardless of the model’s complexity, all behaviors can be simplified into a basic structure, namely, the mechanism of inputs, processes, outputs, and feedback. These mechanisms operate over time and are dynamic, with observable behaviors in the form of the performance levels of a dynamic system model. The development of the flow diagram of the model (model structure) is based on dynamic system equations, which include states (levels), flows, auxiliaries, and constants, and is illustrated using symbols and relationships, as shown in Figure 1.

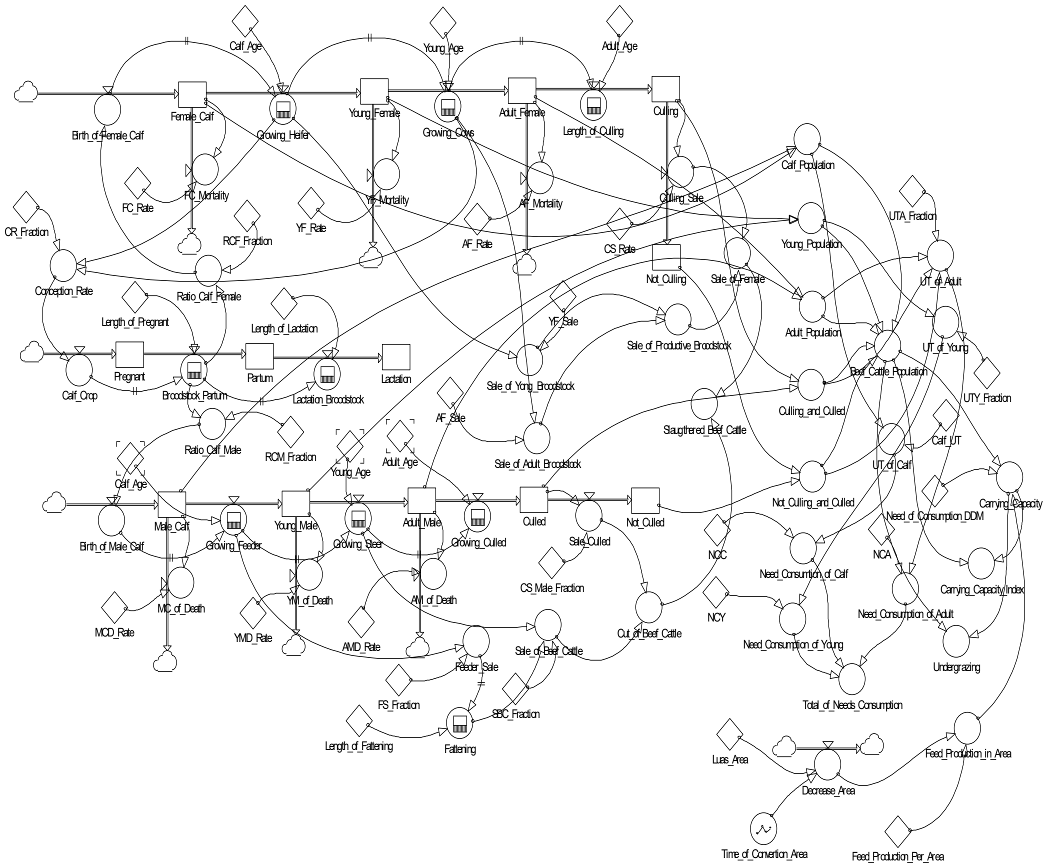

Figure 1. Model structure

4. Results and Discussions

The simulation of the cattle population using Powersim indicates that the cattle population in the agropasture on Timor Island will continuously decline over the next nine years, from an initial population of 799.68 cattle in 2025 to 372.16 cattle in 2034. The average annual decline in the cattle population in Timor Island agropasture is approximately 5.2% per year. These simulation results assume that cattle farmers will maintain their current livestock management practices.

The factors contributing to the decline of the cattle population in Timor Island agropasture include: (1) high calf mortality, averaging 29.9% per year, with female calves at 27.3% per year and male calves at 32.5% per year; (2) high adult cattle mortality (average 7.5% per year), which affects the ability of female cattle to produce new generations; and (3) low reproductive performance of cows, where the proportion of pregnant cows ranges only between 7.3–12.3% of the productive cow population.

Although the conception rate is relatively high (55.4–56.2%), parturition rates are only 13.2% per year for young pregnant cows and 35.2% per year for adult pregnant cows. This condition indicates that calf mortality due to abortion is relatively high in the agropasture system; (4) long calving interval, reaching 2.1 years for cows to become pregnant again, which further limits population growth; (5) high sales of young cattle leaving the agropasture, averaging 27.2% per year, accelerating population decline; and (6) high removal of adult male cattle, averaging 41.4% per year of the total adult cattle population, which is considered inefficient and does not account for agroecosystem capacity. Agropastures have a high proportion of non-productive females, compounded by high adult mortality. Overall, the simulation results indicate that if cattle farmers and livestock stakeholders (both governmental and private) continue to manage cattle under existing conditions, the agropasture system is likely to experience degradation of the cattle population, potentially leading to local extinction.

These findings are consistent with several similar studies reporting that the cattle population in Timor Island, Indonesia, remains low due to the following factors: (1) high calf mortality, averaging 37.5% per year (Haba Ora, Fuah, Abdullah, Yani, et al., 2020); (2) high adult cattle mortality, averaging over 23.2% per year (Riwu Kore, Fuah, et al., 2021); (3) slaughter of productive females at slaughterhouses exceeding 70% of total daily slaughters (Haba Ora et al., 2019a); (4) Timor Island as a feed-critical area, with the rainy season lasting only 2–3 months per year (Riwu Kore, Yani, et al., 2020b); (5) extensive and uneconomical cattle management, resulting in low production inputs and limited farmer motivation (Nurlukman et al., 2025); (6) brucellosis pandemic on Timor Island, causing abortions and 27.7% annual mortality in cattle (Nguyena et al., 2023); (7) low policy support for cattle development, with insufficient monitoring of regional capacity to supply livestock for slaughter, leading to population degradation (Asmara et al., 2025); and (8) limited government intervention in improving livestock management and capacity through extension services and farmer institutions (Haba Ora, 2015).

The rate of cattle population growth directly affects the value of natural increases. Darmawan, Chang, and Wu (2023) state that the magnitude of natural increase is determined by mortality within the population, where higher mortality leads to population decline, and an increase in natural increase results in population growth within a region. Low natural increase affects the availability of replacement stock and overall cattle production in a specific area. Slow population growth is also influenced by long calving intervals. Haba Ora et al. (2019b) explained that prolonged calving intervals occur when cows wean their calves slowly. Extended calving intervals result from delayed weaning, leading to a longer period before the first postpartum estrus, delayed mating, a high number of services per conception, and slow estrus detection.

Improving the quality and quantity of cattle productivity can be achieved by shortening the calving interval, rescuing productive females, delaying cattle slaughter, applying Artificial Insemination (AI) or controlled mating to increase the conception rate, improving farmer practices in cattle reproductive management, and restricting livestock removal according to the regional capacity. Cattle population size is closely related to the total population (male and female), birth and mortality rates, and the uncontrolled removal of livestock.

Birth and mortality within an agroecosystem directly affect natural increase; a high natural increase indicates that the agroecosystem has a sufficient number of effectively managed productive females. Conversely, high mortality reduces natural increase and further depletes the population, particularly when female reproductive status is low. Similarly, removing livestock from a region without considering it carrying capacity accelerates population degradation.

Table 3. Results of the dynamic simulation of carrying capacity in the agropastoral system of Timor Island

Time	**Year**	**Population**	**Carrying Capacity**	**Carryng Capacity Index**	**Feed Balance (LU)**
0	2025	799,68	1.239,79	1,6	-440,11
1	2026	722,74	1.371,77	1,9	-649,03
2	2027	656,49	1.510,22	2,3	-853,73
3	2028	598,96	1.655,26	2,8	-1.056,30
4	2029	548,68	1.806,96	3,3	-1.258,28
5	2030	504,46	1.965,36	3,9	-1.460,90
6	2031	465,37	2.130,41	4,6	-1.665,04
7	2032	430,68	2.302,01	5,4	-1.871,33
8	2033	399,78	2.479,97	6,2	-2.080,19

9	2034	372,16	2.664,01	7,2	-2.291,85

The simulation of the carrying capacity of cattle, with an initial population of 799.68 heads in Timor Island agropasture, indicates that under current conditions, the cattle population already exceeds the carrying capacity by 440.11 heads, compared to the agropasture's capacity of 1,239.79 head. The population decline projected until 2034 will affect the reduction of this overcapacity. During the 9-year period from 2025 to 2034, overcapacity persists; however, the declining rate of the cattle population gradually reduces overcapacity and increases the agropasture's carrying capacity. The increase in carrying capacity influences the carrying capacity index, indicating that feed availability in agropastures becomes excessive. The decline in the cattle population renders the carrying capacity ineffective, as the land as a feed resource becomes overly extensive, while the total cattle population remains insufficiently balanced.

The factors influencing the carrying capacity of Timor Island agropasture include: (1) cattle population, where simulation results indicate a decline in the cattle population, leading to excessive feed availability; (2) land conversion or reduction in agropasture area, which does not significantly affect feed availability because it is accompanied by a substantial decline in the cattle population; (3) forage production, which is highly dependent on seasonal variation and crop harvests in the agropasture; and (4) reduction in grazing pressure, resulting from the lower cattle population.

Nurlukman et al. (2025) state that the carrying capacity of agropasture in relation to the development of cattle population is influenced by land area, population size and density, the ratio of land to human and livestock populations, land use, basic development patterns, climate, and irrigation infrastructure. In cattle production, land serves as the basis of the enterprise or as a production factor that provides essential resources. Land functions as a site where production activities are carried out.

The requirement of land for ruminant livestock development, such as cattle, is particularly important as a source of feed, including grasses (Graminae), legumes, and other forage plants (Haba Ora, Fuah, Abdullah, Priyanto, et al., 2020). Haba Ora and Riwu Kore (2017) emphasized that the land quality aspects that need to be considered for livestock production include: (1) availability of all elements required for plant growth; (2) climatic suitability affecting livestock; (3) availability of drinking water for cattle; (4) nilai nutrisi rumput; (5) Nutritional value of grasses; (6) Toxic properties of grasses; (7) Prevalence of livestock diseases; and (8) Erosion resistance due to grazing activities.

In general, the results of this study indicate that a decline in the cattle population will increase the capacity of agropasture to accommodate cattle, followed by an increase in the carrying capacity index. The reduction in the cattle population causes grazing pressure on the agropasture to become low. The findings also show that cattle production in Timor Island agropasture is inefficient, ineffective, and unprofitable. Preventive and curative measures need to be taken to maintain or increase the cattle population and agropasture land resources, including (1) improving the genetic quality of cattle to produce superior replacement stock, (2) applying artificial insemination techniques to increase the percentage of successful mating or importing productive females to replace unproductive agropasture cows, (3) providing extension services to farmers and industry on beef cattle production techniques, and (4) providing livestock infrastructure, such as feed industry facilities, cattle production equipment, and veterinary medicines.

5. Conclusions

5.1 Conclusion

Dynamic system simulation revealed that the cattle population in Timor Island's agropasture is projected to decline significantly over the next nine years. This collapse leads to an "artificial surplus" of forage, where feed availability becomes excessive not due to land improvement, but due to the diminishing number of livestock in the region. This regressive trend is driven by high calf and adult mortality rates, poor reproductive performance, unregulated cattle removal, and persistent epidemics. Without strategic intervention, the current management practices will lead to systemic failure, where the agropasture land's potential remains severely underutilized.

5.2 Research Limitations
This research has not yet presented scenarios of agropasture management for improving the existing conditions of agropastures to support the cattle production system in terms of carrying capacity.

5.3 Sugestions and Directions for Future Research
Based on the simulation results, the physical land carrying capacity is relatively high, with the ability to support up to approximately 2,600 heads of cattle by 2034. However, the simulation also indicated a sharp decline in the cattle population over the analysis period. This finding demonstrates that the main problem lies not in low land carrying capacity, but rather in the failure of the cattle production system to effectively utilize the existing capacity.

Population decline reflects the weak performance of key production subsystems, particularly herd dynamics, feed management, animal health, and decision-making related to cattle off-take. In other words, the biophysical potential of the land has not been translated into production output because of structural and functional inefficiencies within the cattle production system. Therefore, improvement efforts should focus on strengthening production and management systems, rather than merely increasing the physical carrying capacity of the land.

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