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# Analysis of Development of Cattle Population in Nusa Tenggara Timur Province of Indonesia (Case Study in Timor Island Forest Agroecosystem)

[1]Jefirstson Richset Riwukore, [2]Ahmad Yani, [2]Rudy Priyanto, [2]Bagus Priyo Purwanto, [2]Luki Abdullah, [2]Asnath Maria Fuah and [3]Fellyanus Habaora

*[1]Universitas Indo Global Mandiri, Jl. Jenderal Sudirman, No.629, Palembang, Indonesia*
*[2]Faculty of Animal Husbandry, Bogor Agricultural University, Kampus IPB Dramaga Bogor, Street in Raya Dramaga, Gedung Sekolah Pascasarjana IPB, 16680, Jawa Barat, Indonesia*
*[3]Bogor Agricultural University, Kampus IPB Dramaga Bogor, Street ini Raya Dramaga, Gedung Sekolah Pascasarjana IPB, 16680, Jawa Barat, Indonesia*

**Key words:** Bef cattle population, female cattle, male cattle, dynamics system, livestock

**Corresponding Author:**
Jefirstson Richset Riwukore
*Universitas Indo Global Mandiri, Jl. Jenderal Sudirman, No.629, Palembang, Indonesia*

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**Abstract:** The purpose of the research was to analyze the development of beef cattle population in Timor Island in supporting the role of Nusa Tenggara Timur as a beef cattle production area in fulfilling national meat needs. This research was conducted for 1 year, starting in January-December 2019 with the approach of agroecosystem location by purposive sampling based on physical criteria (land area), biology (availability and population of beef cattle) and socio-culture, so that, the sampling locations representing forest agroecosystems in Timor Tengah Selatan district. The material used was 136 beef cattle in the age range of 3-4 years involving 102 respondents beef cattle farmers. Respondents were interviewed using prepared questionnaires. In addition, field observations were carried out to determine the physiological status of beef cattle. This research uses primary and secondary data. Data analysis is done by building a dynamic system using Powersim and interpreting simulation results for the next 30 years. The results showed the role of Timor Island as an area of beef cattle production centers in supporting government policies to fulfill national meat needs to be considered in the aspect of beef cattle export from the province of Nusa Tenggara Timur because it would be problematic in aspects of beef cattle population on Timor Island. This is influenced by factors of calf mortality and brood stock mortality that are still high, low reproductive status of livestock and export of beef cattle that have not considered the ability of the region. Based on the results of dynamic system analysis shows that the government needs to reduce livestock quota according to the ability of agroecosystems to prevent the decrease in cattle population.

## INTRODUCTION

Beef cattle productivity in Indonesia is still low, so it has not been able to fulfill beef needs nationally[1-4]. Habaora *et al*.[5] reported the development of beef cattle population in Indonesia is only an average of 2.9% per year so the Government continues to import cattle and beef to cover the national beef production shortage of 8.76% per year from cattle imports and an average of 9.74% per year for beef imports. Domestic beef demand is mostly (60%) concentrated in the provinces of DKI Jakarta, West Java and Banten. The need for beef cattle for the production of meat needs in the three provinces is 750 head per day which is supplied from Australian imports and comes from the provinces of East Java, Central Java, Bali, West Nusa Tenggara and Nusa Tenggara Timur[6].

Timor Island is the highest supplier area for beef cattle distribution from NTT because 65.97% of the beef cattle population in NTT is in Timor Island from the total beef cattle population[6]. In general, Timor Island is an area of a dry land type, so that, the lack of feed is a major factor in inhibiting cattle productivity. In fact, the agroecosystem (plants and land) on Timor Island has potential as a feed source. One of the potential agroecosystem areas is the forest agroecosystem with an area of ±470,235.3 ha. Some research results report that the average body weight gain of beef cattle in forest agroecosystem is 0.45 kg/head/day if management properly. Variation of the value of beef cattle body weight is influenced by the characteristics of on-farm to off-farm maintenance[7, 8]. An agroecosystem is a component of forming an ecosystem (abiotic or biotic) to get the maximum benefit by considering aspects of productivity, stability, sustainability and equity. Agroecosystem components in animal husbandry consist of land/environment, plants, livestock, breeders and management/technology including supporting factors of agroecosystems such as institutions, facilities and policies[8].

Utilization of forage in the forest agroecosystem as a feed provider for cattle only reaches 24.2% per year. Yuhendra and Gunawan reported the use of agroecosystem based feed sources is still below 18.25% per year. Forest use is dominated for firewood (96% per year). The potential of agroecosystems that have not been utilized properly is likely to will problems with beef cattle populations and affect the role of Timor Island as a beef cattle production area in Indonesia.

This research aims to analyze the development of beef cattle population in Timor Island in supporting the role of NTT as a beef cattle production area in fulfilling the national beef needs. The analysis was carried out for the development of female cattle population as supporting beef cattle population and male cattle population as supporting national beef production policy. The population development of female and male cattle is greatly influenced by many factors including mortality, birth, cattle export, reproductive status and age of livestock production.

## MATERIALS AND METHODS

This research was conducted for 1 year, starting in January-December 2019 with the approach of agroecosystem location by purposive sampling based on criteria of physical (land area), biology (availability and population of beef cattle) and socio-culture so that the sampling locations representing forest agroecosystems in Timor Tengah Selatan (TTS) district. The material used was 136 beef cattle in the age range of 3-4 years involving 102 respondents of beef cattle farmers. Interview respondents used a prepared questionnaire. In addition, field observations were carried out to determine the physiological status of beef cattle. This research uses primary and secondary data. Primary data is used to determine the input in the system is built. Secondary data were obtained from related institutions such as the East Nusa Tenggara Animal Husbandry Office and the East Nusa Tenggara Statistics Agency. Data collected consists of: beef cattle population (male and female), livestock reproduction status data (pregnant cattle, partum broodstock, lactation broodstock, livestock birth ratios, mortality, conception rate and age of cattle production) and cattle that come out of agroecosystem as export cattle. Data analysis is done by building a dynamic system using Powersim and interpreting simulation results for the next 30 years.

**System conceptualization and problem solving:** The problem of the analysis of the development of cattle population to the Governor of NTT's policy on the export quota of beef cattle involves many elements such as cattle population (male and female) based on age structure (calves, young, adult and culling), physiological status of the broodstock (pregnant, partum, lactasion), birth ratio (ratio of male calf to female calf), livestock mortality in every structure of cattle population, conception rate, age of production from cattle born to cattle of culling, and cattle sold as export cattle. The development of cattle population structure is influenced by the birth rate of female calves that will grow and develop into a heifer and continue to adult until the cull. Factors affecting female livestock on the development of cattle population in agroecosystems are conception rate, calving interval,

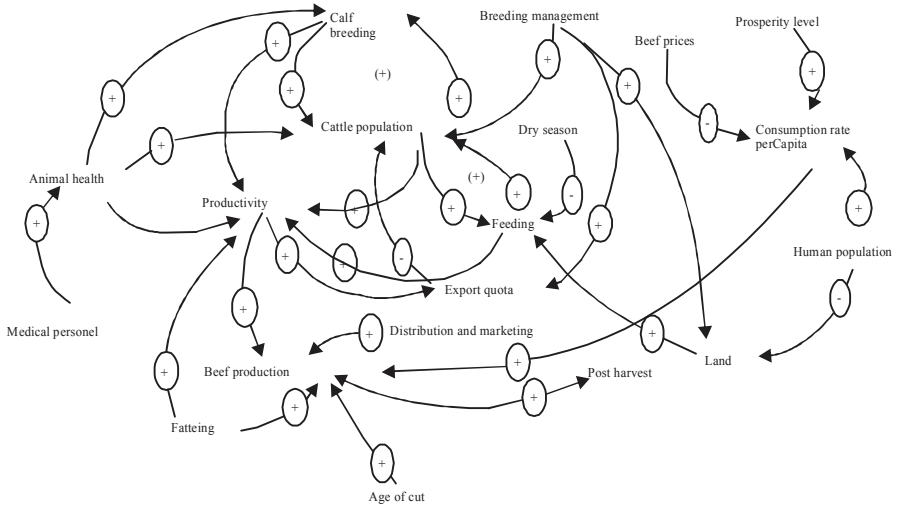


Fig. 1: Stuctured model of beef cattle population

length of cattle weaning, and age of production. The existence of the death fraction in each structure of female cattle population is very significant to the decrease in beef cattle population. The population of male cattle as the main commodity of cattle exports is influenced by the calf population of male cattle that grow and develop into a steer, adult and culling. Factors affecting the rate of birth, death and productive age of males. The birth of male cattle is very much influenced by the population of females giving birth so that there is an increase in the male population. An increase in male population in the population structure is significant to an increase in the availability of beef cattle in the agroecosystem. Increasing or decreasing beef cattle population in agroecosystems greatly affects the ability of agroecosystems to supply cattle export quotas to produce a policy of beef cattle export quota allocation from NTT. The problems described are very complex will continue to change and develop over time, so that, the correct problem solving is to use a dynamic system approach with Powersim[9].

**System identification and problem finishing:** System identification is the process of design to produce a picture of the relationship between elements (entities) and the relationship of input and output from the operation of a system[9]. The problem of the analysis of the development of beef cattle population in Timor Island forest agroecosystem is highly dependent on the population of female cattle that give birth to female calves for replacement stock and male calf population as preparation for the main commodity of export cattle. Female population with good reproductive ability influences the increase in beef cattle population supported by the availability of superior males. Male cattle that grow and develop into young cattle are used as steers into an adult to be prepared as beef cattle. Female and male cattle that have been culled are very supportive of increasing beef cattle population as beef production in fulfilling domestic and regional beef needs. Information and data in the analysis of beef cattle population development in the Timor Island forest agroecosystem can be seen in Table 1.

Table 1: Condition of existing beef cattle population in 2019

| | Gender of livestock | |
|---|---|---|
| Data of population model | Female | Male |
| **Beef cattle population (head)** | | |
| Calf | 109 | 123 |
| Young | 284 | 268 |
| Adult | 342 | 312 |
| Culled | 47 | 53 |
| Total | 782 | 756 |
| **The state of broodstock reproduction (%)** | | |
| Pregnant broodstock | 10 | - |
| Partum broodstock | 29 | - |
| Lactation broodstock | 66 | - |
| **Fraction of influence factor (%)** | | |
| Calf birth ratio | 65,4 | 34,6 |
| Mortality | | |
| Calf | 29,7 | 20,9 |
| Young | 11,1 | 15,3 |
| Adult | 10,2 | 3,9 |
| Conception rate | 56,0 | - |
| **Cattle come out agroecosystem** | | |
| Female culled | 44,2 | - |
| Male culled | - | 44,5 |
| Steer | - | 52,9 |
| Male adult | - | 57,3 |
| **Production time fraction (month)** | | |
| Calf age | 6 | 6 |
| Young age | 19 | 20 |
| Adult age | 62 | 65 |
| Age culled | 89 | 96 |
| Calving interval | 12 | - |
| Pregnant age | 9,2 | - |

Primary and secondary processed data (2019)

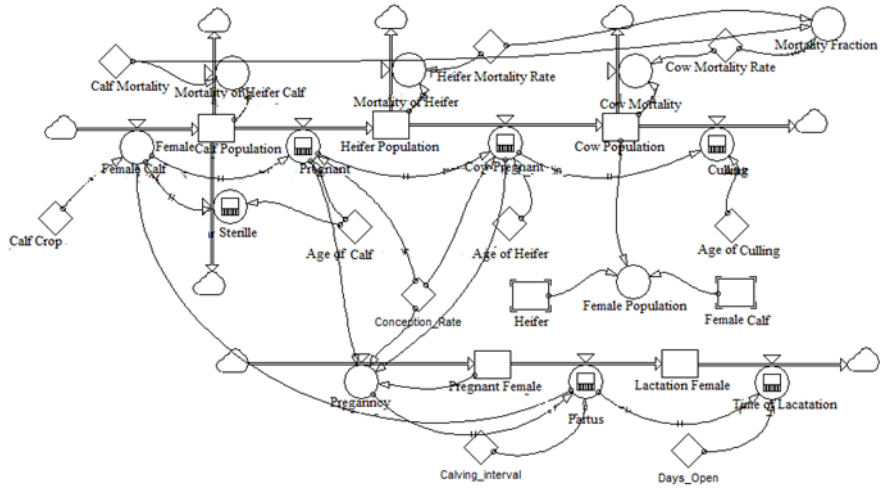


Fig. 2: Submodel of female cattle population

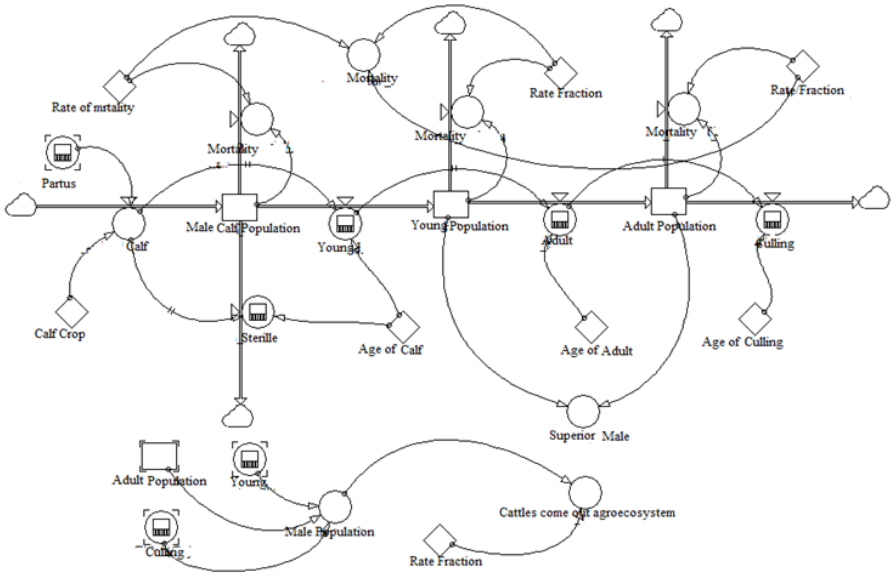


Fig. 3: Submodel of male cattle population

**Model flow chart (model structure):** The structure of the model will give shape to the system and at the same time give characteristics that influence the behavior of the system. The behavior is formed by a combination of feedback loop behavior (causal loops) which make up the structure of the model. All model behavior, however the complexity can be simplified into a basic structure, namely the mechanism of input, process, output and feedback (Fig. 1). Figure 1 explains that in the structure of the main model of beef cattle population in Timor Island forest agroecosystem the main focus is beef cattle population and productivity which has a causal loop with various factors. The structure of the main model is actually derived from the submodel aggregation consisting of 2 sub-models, namely the male population sub-model and the female population submodel (Fig. 2 and 3).

Figure 2 explains that the development of female cattle population is very influenced by the birth ratio of female cattle that will grow and develop into calf females continue to develop into young females, adult females until the cattle are culled. The growth status of female cattle population is influenced by pregnant heifer and pregnant adult females when they reach production age. Growth and development of cattle population is strongly influenced by pregnant cattle and partum and weaning

Bali calf (lactation). Pregnancy of a female cattle depends on the value of the conception rate, female childbirth (parturition) is influenced by gestational age and lactation females are influenced by lenght of breast feeding factors. The lactation female returns to being pregnant when she has weaned her offspring. The factor of livestock mortality in every age structure of the population influences the decrease in cattle population. In general, the factors that influence the development of female cattle population consist of livestock births, livestock mortality, age of livestock production and reproductive status of female cattle.

Figure 3 explains that the growth and development of male cattle population is strongly influenced by the ratio of births of male cattle, then grow into young bulls, mature bulls and culled bulls. Growth and development of male cattle population is strongly influenced by livestock mortality factors. High cattle mortality in every population structure accelerates the decrease in cattle population. The lower livestock mortality, the rate of decrease in cattle population can be slow and resistenced. The decrease in the population rate of male cattle is also affected by young cattle and adult cattle which are sold as beef producers for the needs of beef consumers. The sale of cattle which does not consider the ability of the region has accelerated the rate of degradation of the cattle population. Utilization of cattle as a fulfillment of meat protein needs is strongly influenced by the age of livestock production from cattle born to calves that grow to become young cattle (steer), become adult cattle and be culled (slaughtered). Increasing the population of male cattle is influenced by the reproductive status of female cattle to give birth to male calves. In general, the factors that influence the growth and development of male cattle population are the birth of bulls, the death of bulls in each population structure, the rate of cattle sales toward regional capacity and the reproductive status of bulls. The better the reproductive status of female cows influences the increasing number of the male cattle population.

## RESULTS AND DISCUSSION

**Female beef cattle population:** The results of dynamic system simulation using Powersim in female population submodels show that if farmers and stakeholders continue to engage in cattle activities such as existing conditions, it is estimated that within 30 years there will be decrease of the cattle population until used up in forest agroecosystem (Fig. 4). The results of the simulation of existing condition data show a decline in calf population in each agroecosystem which also impacts on the decline in young and adult cattle population. The constraints of developing cattle agroecosystem based cattle on Timor Island are: mortality of female populations in each age structure of the population is quite high, especially, calves

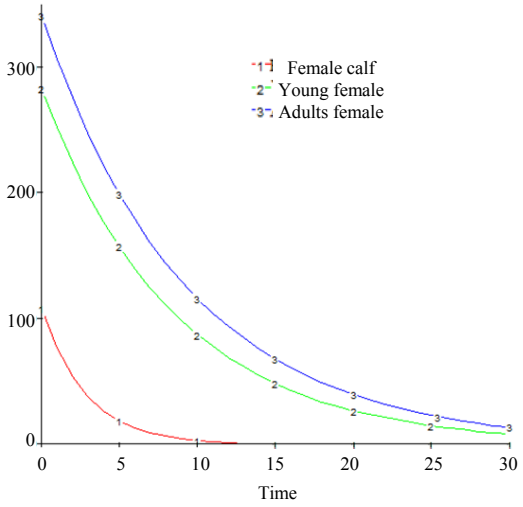


Fig. 4: Simulation results of female cattle population

(>27.3%) although, the broodstock conception rate is quite high for dryland areas such as Timor Island NTT, which is >34.6% and broodstock females have relatively long of calving intervals and days open. The condition of the female reproductive status of cattle in each agroecosystem that seems low like this is a major obstacle in increasing the population of cattle on Timor Island.

Drouillard[10] stated that the low value of natural increase affects the replacement stock and cattle cultivation in an area. The magnitude of the natural increase value is determined by the livestock mortality rate in the population where the higher the livestock mortality rate decreases the natural increase value and vice versa if the mortality rate is lower improving natural increase value[11]. In addition, the natural increase is also influenced by the number of days open and service per conception. Goto *et al*.[12] states that if there is a long calving interval value due to the long day's open value. The calf is not weaned, so, the first postpartum lust becomes long, the breeder breeds the cattle for a long time, so that, the days are long open, high service per conception and the age of the female is first mated late.

Dynamic system simulation results show that the conditions of existing farms based on agroecosystems on Timor Island need to be improved at the level of the livestock system in the real world. The strategy that can be done is to shorten the days open and calving intervals and reduce the mortality of female cattle. Priyanto *et al*.[13] Tadesse and Tegegne[14] explained that the improvement in the quality and quantity of productivity of beef cattle can be done by shortening the value of calving interval and days open, saving productive females, delaying cattle slaughtering time and applying artificial insemination (IB)/controlled mating to increase the value of conception rate.

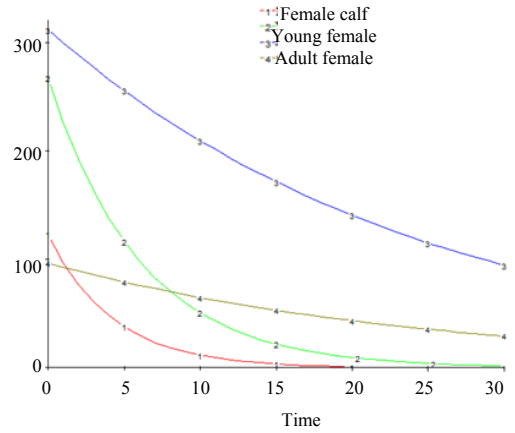


Fig. 5: Simulation results of male cattle population

**Male beef cattle population:** The results of dynamic system simulation on the submodel of cattle cultivation in forest agroecosystems show a decrease in the population of bulls over the next 30 years. Decreasing male cattle population affects the cultivation of male cattle farming to be excluded from agroecosystems as beef cattle (Fig. 5). The decrease in the male cattle population is due to the high mortality of male calf in the agroecosystem on Timor Island which reaches >25% per year. This situation is in accordance with the research results of several researchers who reported that the value of a natural increase in cattle population in Timor Island is still low due to high calf mortality (35-40%) and high broodstock mortality (>20%) in the cattle population[6, 15, 16].

The degradation of male cattle population in forest agroecosystems is also influenced by the expenditure of male cattle from agroecosystems that are not controlled and do not consider agroecosystem capabilities. Conditions like this will accelerate the decrease in the value of natural increase in cattle population. Some researchers state that the size of the livestock population is very closely related to the total population (male and female), birth and death of livestock and uncontrolled livestock expenditure[1, 5, 6, 10, 12]. Livestock birth and death in one agroecosystem affects the value of natural increase where if the value of natural increase is high, it shows that the agroecosystem has a number of productive female livestock with good management and handling. Conversely, if the mortality rate is high it will reduce the value of natural increase and further deplete the population if the female reproductive status is low. Likewise, livestock expenditure from an agroecosystem that does not consider agroecosystem capabilities will further accelerate the rate of population disappearance.

## CONCLUSION

The role of the island of Timor as an area of cattle production centers in supporting government policies to fulfill the needs of national meat needs to be considered in the aspect of spending beef cattle from the province of East Nusa Tenggara because it will have problems in aspects of beef cattle population on the island of Timor. This is influenced by factors of calf mortality and broodstock mortality that are still high, low reproductive status of livestock and expenditure of beef cattle that have not considered the ability of the region. Based on the results of dynamic system analysis shows that the government needs to reduce livestock quota according to the ability of agroecosystems to prevent the decrease in cattle population.

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