An Economic Model of Small Ruminant Production in Small Scale Dryland Farming Systems in West Timor, Indonesia

Maximilian M.J. Kapa[1]
Maria Fay Rola-Rubzen[2]
Martin Bent[2]

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1 PhD Student at Curtin University of Technology
2 Lecturer and Senior Lecturer, respectively, at Curtin University of Technology

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Many farmers in West Timor operate small-scale mixed crop-livestock farms. In most of these farms, productivity of livestock production systems is quite low. There is, however, a potential to improve the contribution of livestock to total household income. Combining breeding and fattening represents an alternative for improving livestock production systems. To examine the feasibility of this production system, a study was conducted in three districts in West Timor. A model of small ruminant production systems was constructed. The production model included economics as well as biological parameters such as age of sexual maturity, age at first mating and age at first kidding. Results of the study indicated that both enterprises would yield positive returns. The financial indicators all showed favourable return from these investments.

Key words: Small ruminant, production systems, and production model

1. Introduction

Small ruminants such as goats and sheep are important sources of meat and cash for farmers in West Timor. Most of the rural households own a few small ruminants, which are kept both for home consumption and for sale. In addition, sheep and goats have been kept as a source of manure. Although goats are traditionally raised as livestock for subsistence in West Timor, the animal is increasingly being marketed. The major population areas of goats are in three districts of West Timor namely, Kupang, Timor Tengah Utara, and Belu.

The contribution of small livestock to family welfare in Indonesia is obvious. Small livestock, such as goats, are popular among small-scale farmers for several reasons. Firstly, goats can meet the immediate needs of the household for meat and milk. Secondly, they survive well in marginal land and thirdly, they are more efficient in converting high quality forage into milk (Devendra 1981).

Although goats play an important role in supplying food (protein) and other products to farmers and their families, goats are considered to be a supplementary farm enterprise. Most of the goats in West Timor are reared by smallholder farmers who lack of capital. According to Mukherjee and Sivaraj (1991) inefficient resource management, low productivity and uncertainty characterise goat-rearing systems at the village level in developing countries.

The status of small livestock as a supplementary commodity in mixed farming systems has resulted in less input (effort) given to the improvement of goat production. Therefore, the productivity of goats has tended to decrease over time.

Various studies have been done in the field of livestock production systems (Sitorus 1982, Kedang *et al* 1987, Amareko 1990, Lazarus 1996, Wie Lawa 1996). However, only a few of them deal with small livestock. Most of the studies are *discipline-oriented* and technologically tested in laboratories. None or very few of the studies (Fuah and Pattie 1992, Fuah 1993) have tried to identify goat production systems currently practiced, level of productivity, weaknesses and opportunities that occur at the field level. Therefore, this study is focused on these areas so that a model appropriate to village conditions could be developed.

2. Objective of the study

The objectives of the study are:

(1) To obtain baseline data dealing with reproduction and production performances of the local goat farming practices in West Timor
(2) To identify problems or obstacles faced by farmers in managing their goats, and
(3) To construct a model of the goat production systems in West Timor.

The advantage of producing this model is to improve goat productivity in the study areas, by which the farm-household income will increase. The model produced is expected to benefit smallholder dryland farmers in West Timor and/or to other areas similar to West Timor.

3. Methodology

3.1 The study area

The locations chosen for the study were three districts in West Timor, Indonesia namely Kupang, Timor Tengah Utara and Belu. These districts were chosen because almost 54.4 per cent of the goat population of NTT is in West Timor. Information for this study was gathered from January to March 1997.

3.2 Sampling Procedure

A multi-stage random sampling procedure was applied in this study. First, a list of the sub-districts from the three districts was obtained from the Bureau of statistics in the Province of East Nusa Tenggara. From the list a total of two sub-districts were selected, and then a list of the villages from the two sub-districts was obtained from the same source. In each of the six subdistricts, the village with the largest goat population was chosen. Therefore, there were 6 villages selected to be the study areas. Finally, 20 farm-households from each village were selected randomly. The total number of respondents interviewed was 120 farm-households.

3.3 Data collection and analysis

A survey method involving interviews with heads of farm-households was used to collect information on farm inputs and outputs, such as farm size, household size, level of education, rearing experience, biological data of the goats, such as reproduction and production performances, goat management regimes, and economic data. All data and information collected were summarized using the statistical software package SPSS. For the economic analysis, gross margin analysis was applied as a proxy for profit. Microsoft excel 1997 spreadsheet was used to build a spreadsheet model of the goat production systems.

4. Results

4.1 Respondent characteristics

Based on the information gathered from 120 farm households, it was found that the average age of the farm-household head was about 43 years (with a range of 18-60 years). The level of formal education of the farmers was low, where 73 per cent only attended primary school, 14 per cent attended secondary school and high school and the remaining 13 per cent were illiterate. Further their non-formal education was also low. For example, 76.95 per cent of the respondents did not participate in any agricultural extension programs. Even though, they have much experience in rearing goats (in average 8 years), the low of level of formal and non-formal education hinders their rate of technology and innovation adoption.

The average family size was four persons (ranging from 1-7 people) per household. The average age of family members was 30.5 years old. This means that each farm household had four productive labourers to operate the farming enterprise.

All respondents in the study area were mainly engaged in agricultural sectors such as food crops, livestock, and perennial crops. In addition most had off-farm activities like trading, fishing, carpentry, work as government official, farm work and other seasonal work.

4.2 Land tenure and farm size

The most common land categories in the study areas were dryland fields, rice fields, home gardens and groves. The average amount of land owned was 4 parcels per household (ranging from 2 to 8 plots). This included 2 parcels of dryland (upland), one parcel of home garden and one parcel of paddy field with an average size of 0.84 ha (ranging from 0 to 15 ha), 0.22 ha (ranging from 0 to 2 ha) and 0.17 ha (ranging from 0 to 3 ha) respectively.

Unlike paddy field farming (lowland areas) where farmers practice mono-cropping viz. rice, in upland (dryland) areas characterised by less fertile soil, lack of water, and limited use of inorganic fertiliser, mixed cropping is practiced. Maize is primarily cultivated in dryland and home gardens during the wet season. Farmers usually combine dryland cultivation of maize, cassava, bean, groundnut and mungbean.

Previously, farmers in the study areas had 4 to 6 plots of arable land. However, due to population pressure, the number of plots has reduced to 2 to 4 plots per farm-household. Respondents who had more than two plots practiced fallow systems. In such cases, one plot was chosen each year to be cultivated while the others were fallowed. The length of fallow depends on the number of plots. For example, a farmer who has 6 plots will have 5 years of fallow period. There were three reasons given why farmers practice fallow systems. Firstly, it is one way to restore soil fertility; secondly, they have a shortage of labour and thirdly, the period of rainy season is short, hence farmers do not have enough time to do land preparation.

4.3 Labour availability

To manage all farming activities, a total of 11 005 hours labour per farm was used each year. Of that, 48 per cent was devoted to food crops, 37.5 per cent to livestock enterprises and 14.5 per cent was used for off-farm activities. The intensity of using labour is determined by the season. The most intensive labour usage was during the rainy season between October and April. October labour is fully utilized for land preparation. To reduce the workload some farmers start land preparation from early August. April labour is mainly utilised for harvest and post-harvest activity. In some areas, harvest time lasts for two months i.e., from April to May.

In relation to goat rearing systems, farmers in the study areas did not provide a specific area for their goat enterprise. During the day in the summer, goats graze around the home, on communal land, as well as on the roadside nearby. In the evening they are then herded home. This practice is common throughout the study areas. In the rainy season when the crops are in the field supervised herding is practiced.

4.4 Management systems

4.4.1 Goat ownership and distribution

The average number of goats owned per respondent was six. Of that, 33.3 per cent were male and 66.7 per cent were female. In addition, the herd size ranged from 1 to 42 heads. All goats were of the local breed (Kacang goats). The distribution of livestock ownership among the households within the three districts was various. Goat rearing experience varied from 1 to 30 years with an average of 8 years. Thus, it can be said that most of the farmers in the study areas are experienced farmers.

Looking at the farm-household's motivation in rearing goats, 100 per cent of the respondents claimed that goats are easy to rear, as they have a short reproductive process (highly fertile animals), are easily sold and feed is abundant at the village level. Further 1 per cent of the respondents said that in addition to the stated advantages rearing goats are also a kind of store of wealth.

4.4.2 Goat management systems

As previously mentioned, farmer respondents in the study areas did not keep goats in a special place. The management practiced is traditional which leads to low

productivity of the goats in the region. There were four types of management systems found in the study areas, namely free grazing (extensive systems), supervised grazing, tethering and penned (Table 1).

Table 1 Percentage of farmers under three types of goat rearing systems by season in West Timor

Season	Free grazing	Supervised grazing	Tethered
Dry season	53.6	6.4	40
Rainy Season	57.8	3.6	38.6

In the dry season, however, during daytime, around 75.4 per cent of respondents let their goats graze freely in the communal land, the owner's field, and other farmers' rice fields and public land. Supervised grazing was normally conducted during the day in the rainy season. At night time, 84.7 per cent of respondents confined their goats and the remainder tethered their goats around their home gardens throughout the year. Fuah (1993) found three further combinations of these systems practiced by farmers in West Timor, namely grazing and penning, grazing and tethering, and tethering and penning. The systems chosen depends on availability of inputs such as labour, land and feed.

Kapa (1994) reported that within extensive regimes, goats usually graze during the day on the communal grounds or dryland adjacent to the village and are then corralled at night. There is no separation of the goats by age or sex. These practices continue throughout the year. There is no doubt that this practice has caused some problems to goat production in West Timor. For instance, extensive grazing systems may lead to (1) uncontrolled breeding management, and (2) high mortalities, which may reach 47 per cent at times.

4.4.3 Goat reproduction and breeding systems

Female goats mostly reached sexual maturity at less than 1 year, whilst male goats reached sexual maturity between 12-24 months. This indicates that most does reach sexual maturity at an optimal age. According to Devendra and McLeroy (1982), the age at first kidding of local goats (kacang goat) is 15-16 months.

The results of this study also revealed that the average age at which female first delivered a kid was 20 months. This result was slightly higher than Fuah's finding in 1993. She found that the average age of does at first kidding was 13.5 months.

About 80.7 per cent of does gave birth for the first time at 1-2 years old and only 19.3 percent after 2 of age. In fact, most does in the study areas reached their reproductive activities at the optimal age. However, lack of bucks in the flock and lack of feed during the dry season lowers their productivity.

Some respondents claimed that they did not have bucks in their flock. They relied on other farmer's bucks under free grazing systems. Free grazing with other farmers' bucks helped their does to mate. Due to uncontrolled mating, kidding occurred the whole year, with most occurring in September, October and April. According to the respondents, 58.6 per cent of does produced kids in September-December, 40 per cent in April-June, and the remainder in January-March.

In relation to the above data, it was found that 46.4 per cent of the does gave birth twice a year, 6.4 per cent three times per two years (1.5 per year) and most of the does (47.1 %) produce kids once per year. These figures show that the productivity of the does was not yet optimum, and there is still a big opportunity to improve productivity. Improving management in terms of feeding, breeding, rearing systems as well as the availability of bucks is urgent since these are the key factors influencing the productivity of goats in the study areas.

Table 2 shows the percentage number of kids per birth under three different birth frequencies. Data from the table indicate that approximately 71 kids are born per year under single-kidding frequency per year, 113 kids under twice-kidding frequency per year and 14 under three kidding frequency per two year (1.5 per year).

Table 2 Relationship between birth frequencies and number of kids per kidding

Birth frequency	Number of kid per kidding (%)			Number of kids born per year
	Single	Twins	Three	
One per year	92.4	7.6	00.0	71
Twice per year	77.9	22.1	00.0	113
Three per two years	76.7	22.2	1.2	14

As shown in Table 2 for the three birth frequency categories, single kidding is the most dominant. This is because for these categories, most does are kidding for the first time. It is also possible that the does are highly prolific, or there could be other genetic factors involved.

Overall the gross kid crop (GKC) of the flock was 73.43 per cent. There was slightly different GKC among the three different age groups. The GKC for less than one-year old does is 84.2 per cent, for 1-2 year old does GKC is 63.4 per cent, and for does older than 2 years, GKC is 86.7. Hence, it seems that GKC was high but Net Kid Crop (NKC) was low (26.5%).

At times the average mortality rate of adult goat was 35.9 per cent. The average kid mortality (KM) was 22.7 per cent. This mortality rate is almost the same as that reported by Fuah (1993) (ie., 21 %). Most of the kids died before weaning, this due to malnutrition, disease and accidents. The most common diseases prevalent in the study areas were ectoparasite infection (dermatitis) and scabby mouth. Other causes of death were vehicular accidents, dog attacks and snake bites.

4.5 Goat marketing systems

Unlike cattle, goat marketing is normally not certain. There is no particular market place for selling goats. The owners bring their goats to the nearest weekly local market whenever they need cash. However, in most cases, trading occurs at the farmer's place. As in other livestock marketing systems, goats are sold in the form of live goats, but are based on a per head price not per kg live weight.

Although farmers sell goats at any time of the year, higher number and frequency of goats are sold during the Moslem festive season (Idul adha and Idulfitri festive). At that time the goats fetch a high price. The price was based on physical appearance, size, age and sex.

4.6 Problems

Among the small-scale farmers in West Timor, goats are viewed as an important element in their farming systems. Goats are known as a multi-purpose animal due to their contribution to the farm household welfare. According to Fletcher (1984) and Rangkuti *et al* (1984) the economic importance of rearing goats to farm families is to provide: (*i*) cash income for immediate needs of the household, (*ii*) meat, milk, hide and fibres, (*iii*) manure for crops and (*iv*) a job for the farmer's family.

Despite the significant role to the economy of farm-households, goat productivity tends to decrease over time. The low productivity of goat production in West Timor is influenced by several factors such as, the agricultural systems practiced, the rearing system of the animal and season. Goat production in West Timor has many problems such as a high mortality rate (but relatively high gross kid crop), lack of nutrients during the dry season and low market extraction rate.

The problems include environmental, biological, management and socio-cultural aspects. Diseases, unavailability of land for grazing, together with insufficient alternative sources of local feedstuff, were identified to be environmental constraints. Problems associated with biological aspects are related to the low genetic potential of local goats in regard to growth rate. Management problems are mostly related to husbandry practices. As previously mentioned the majority of the farmers in the study area practice a free grazing system so that breeding, feeding and disease cannot be controlled. While the social aspects that retard goat production are dog attacks, theft and accident. In addition, problems concerning socio-economic conditions, for instance lack of capital, lack of access to credit facilities and a limited knowledge on how loans work also need to be addressed.

Under the current traditional extensive systems, it is almost impossible to improve the productivity. The effective way to increase goat production is by improving current management practices ie., through better feeding, controlled breeding and disease. Better feeding means that owners should feed the appropriate quantity and quality to their goats. Providing a selected buck is important to avoid an unfavourable mating and keeping goats in the pen is also important to control disease.. However, farmers also have to maintain a finite number of goats based on resources available. Therefore, this study intends to devise a production model that is both profitable and sustainable for small farmer-households.

5. Modeling of goat production systems

5.1 Production systems

The production systems of small livestock commonly run by farmers in West Timor combine goats/sheep, pigs and chickens. This system is important because it provides benefit for farm-households in terms of providing cash through selling animals or increasing protein consumption through meat and eggs.

As the model is directed at small-scale farmers, it starts with a herd size of 5 goats comprising two bucks and three does. Of the two bucks, one is devoted to the breeding program whilst the other is for fattening (store buck). All females are for breeding purposes.

5.2 The model

The primary objective of this study is to produce a spreadsheet production system model for goat producers in West Timor. Numerous biological parameters can be used to formulate the model, however, to keep the model simple, only GKC, NKC and KM are chosen as components of the program. A change in biological components has a potential effect on the economics of goat production. Therefore, the computer model has two separate components. The first component deals with the biological production, while the second deals with the economic analysis and calculations. The economic analysis components of the model computes annual incomes and costs.

The spreadsheet budget development over a 10-year period for a goat production system was developed based on the mentioned parameters. The initial model is designed to reflect the current system implemented. The scenarios run used two different mortality rates depicted in Table 6.

The model was built based on the spreadsheet simulation model with the following assumptions:

1. Input and output prices were set on farm gate prices, which are assumed to be constant during the given period of the project. Goat price at the time of the study is presented in Table 3.

2. Fodder and or forages will be available for the whole year from various sources such as the farmer's property, bare land, communal land and from the forest nearby.

3. The household solely supplies all labour used, so that wage will be neglected in costs of production computation.

Table 3 Average goat price in West Timor**,** 1997

	Culling	**Adult**	**Young**	**Kid**
Male (Rp)	35,000	55,000	35,000	20,000
Female (Rp)	30,000	30,000	30,000	20,000

Note: A$ 1 = Rp 1 850 (as per February 1997)

4. Unrestricted capital (investment) will be obtained from bank credit. The length of the credit loan is five years, with an interest rate of 12 per cent per year and gestation period of 1 year. A credit plan and capital usage is given in Table 4, while a repayment plan is given in Table 5.

Table 4 A credit plan and its usage for goat project in West Timor, 1997

Source of Budget	Amount (Rp)	Activity breakdown	Unit price (Rp)	Total value (Rp)
Bank loan	287 875	• Buying new stock:		
		a. One store buck	35 000	35 000
		b. One breeding buck	55 000	55 000
		c. 3 breeding does	45 000	135 000
		• Building a new pen (10 x 1.25 m^2) per m^2	2 750	34 375
		• Health and disease control in the first year per head	2 000	13 500
		• Planting forage and exotic grass and shrub legumes	N/A	15 000
Total	287 875			287 875

Table 5 Repayment plan of loan

Year	Loan (Rp)	Principal	Interest (12%/year)	Principal + Interest
01	287,875	---	---	---
02	212,875	75,000	34,545	109,545
03	137,875	75,000	25,545	100,545
04	62,875	75,000	16,545	91,545
05	---	62,875	7,545	70,420
06	---	---	---	---
07	---	---	---	---
08	---	---	---	---
09	---	---	---	---
10	---	---	---	---

Note: One-year grace period

(5). This assumption or projection is particularly focused on moderate management projections

(6). Technical coefficients used for the basic system are as follows:

- For the purpose of ownership projection each year, moderate GKC of 125% was used. KM was assumed to be 25 per cent and NKC 100% per year, a sex ratio of 50 per cent (one male and 1 female per birth) was used.
- The first kidding is assumed to be a single kid and subsequent births to be twins.
- Once the project reaches a steady state, then 10 goats will be maintained and the others will be sold.
- Daily weight gain for the fattening system is 0.10 kg and the minimum initial weight of the store buck is 10 kg
- The length of fattening is 5 months (150 days); therefore there will be two fattening periods in a year.

Apart from the base model (moderate scenario), a sensitivity analysis was run for pessimistic and optimistic scenarios using 30 and 10 per cent KM (see Table 6).

Table 6 Scenarios used in the project development model

Scenario	Gross kid crop (%)	Kid mortality (%)	Net kid crop (%)
Average	125	25	100
Pessimistic	125	30	95
Optimistic	125	10	105

These scenarios were chosen to reflect reproductive performances of the goat production systems under village condition in West Timor.

6. Results and implications of the model

6.1 Results of the model

The purpose of the model was to simulate goat production system in West Timor. Therefore, assigning moderate kid mortality at 25 per cent initialised the model. The capital and annual costs of the goat investment are presented in Table 7.

Table 7 Annual income and expenditure cash flow of the model

Year	Total Expense (Rp)	Total Revenue (Rp)	Net Income (Rp)
I	287 875	120 000	-167 875
II	53 000	120 000	67 000
III	24 500	90 000	65 500
IV	85 875	210 000	124 125
V	54 000	300 000	246 000
VI	63 000	642 500	579 000
VII	72 000	1 050 000	978 000
VIII	170 750	1 050 000	879 250
IX	72 000	1 035 000	963 000
X	72 000	1 515 000	1 443 000

Note: A$1= Rp 1 850 (as per February 1997)

As shown in Table 7 the model would generate cash income for the household from the second year. The feasibility of the production model can be seen from the financial analysis components such as the Net Present Value (NPV), Benefit-Cost-Ratio (BCR) and Internal Rate of Return (IRR). The summary of the feasibility analysis is presented in Table 8

Table 8 NPV, BCR and IRR of the production model

Components	Unit	Value		
		12%*	**13%**	**14%**
Moderate				
NPV	Rp	678 443	614 570	556 256
BCR	%	1.88	1.83	1.78
IRR	%	37	37	37
Pessimistic				
NPV	Rp	280 913	244 598	211 608
BCR	%	1.36	1.33	1.29
IRR	%	25	25	25
Optimistic				
NPV	Rp	805 419	732 715	666 288
BCR	%	2.04	1.98	1.93
IRR	%	40	40	40

* The interest rate paid on deposits in 1997

NPV is the horizontal sum of all present values of net cash value at the social discount rate of 12, 13 and 14 per cent respectively. In base model the respective NPV was Rp 678 443, Rp 614 570 and Rp 556 256 for the moderate assumption. These values indicate that the proposed model is economically feasible, as all benefits were above all costs incurred.

The respective BCR was equal to 1.88, 1.83 and 1.78. This indicates that the ratio between benefit and cost is greater than 1, which means that the project is economically feasible. In addition, IRR gives a higher percentage (37 %) than the social discount rate of 12 per cent and 14 per cent. It can, therefore, be said that the proposed production model is a worthwhile project as all social opportunity costs of the investment can be fulfilled with the interest rate over 14 per cent.

Results of the sensitivity analysis using 30 per cent mortality rate of kids showed that the investment remained profitable. As depicted in Table 8, all NPV values of the proposed enterprise were positives namely Rp 280 913, Rp 244 598 and Rp 211 608

respectively. Meanwhile, the respective figures for the BCR were 1.36, 1.33 and 1.29. The IRR rates for this business was 25 per cent for all discount factors applied.

Ten per cent KM with the same interest rates was the second scenario applied in this model. The analysis produced a NPV value of Rp 805 419, Rp 732 715 and Rp 666 288 respectively. The BCR was equal to 2.04, 1.98 and 1.93 respectively, while the IRR was equal to 40 per cent for all interest rate categories. All positive NPV values, and BCR rates greater than one together with 40 per cent IRR rates are an indication of the benefit of doing this project. If the farmer applies for credit, a repayment at this IRR rate would be fully covered and the capital would be properly rewarded.

Based on the three criteria above this project is sound and there is undoubtably much benefit for both investor and farmer to invest in this enterprise. From the social point of view this project is acceptable because goats have become an integral part of the farming systems in the study areas.

6.2 Model implications

The goat production system model can be used to analyse many relationships of biological, economic and management factors. Only few such interrelationships are explored in this paper.

There are three elements that will determine the success of the project: (*i*) motivation and willingness of the farmer-client, (*ii*) support from other institutions, such as government body, private sector and financial institution and (*iii*) the availability of infrastructures.

The production systems modeled in this paper will be of benefit if in implementation it is done within an integrated organisational mechanism in terms of management practiced by farmer and the existence of the enterprise within broad agricultural systems. It should be noted that farmers would be the pivotal element within the system, so that improving knowledge and skills to adopt agricultural technology particularly information pertaining to small ruminant production is essential.

One of the current issues within agricultural development program in region is to distribute animal to farmer-household evenly. The model supports that program to evenly distribute goat ownership among villagers as well as increases the goat population in Indonesia. However, the ultimate goal is to increase farm family cash income for smallholders.

7. Conclusion

Goat farming is increasingly seen as an attractive option for smallholder farmers in the dryland areas of West Timor in recent years. The result of the study showed that the investment in goat enterprise for smallholder farmers in west Timor is financially feasible and socially acceptable over the optimistic, moderate and pessimistic scenarios at three different social discount rates. The positive NPV for three scenarios and BCR values greater than one are an indication of the profitability of the project. According to the IRR results the maximum interest which farmers could pay to operate their business and not lose any money was 37 per cent for the base model and 40 and 25 per cent for the optimistic and pessimistic models respectively. Despite farmers experiencing no profit during the initial year, with good support, coordination and partnership between farmers, government bodies, private sectors and financial institutions this condition can be easily borne. However, in order for the project to be operated profitably, the current orientation of production has to be changed; that is from the extensive traditional systems to agribusiness-oriented intensive systems.

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