PN-ABS-051

# Small Ruminant - CRSP

SUB-BALAI PENELITIAN TERNAK, SUNGAI PUTIH

BALAI PENELITIAN TERNAK

PUSAT PENELITIAN DAN PENGEMBANGAN PETERNAKAN

PN-ABS-051

# CALCULATION OF THE PERFORMANCE OF SHEEP IN INDONESIA AND FACTORS AFFECTING IT

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## ABSTRACT

In this paper an attempt is made to calculate the overall performance of sheep in Indonesia. For the calculation model the spreadsheet program LOTUS was used. Information to construct the model was obtained from literature. The formulae used are partly based on literature and partly based on assumptions. The spreadsheet is divided into three sections: the input (management and prices), breed information and the output (technical and economical).
In the sensitivity analysis the influence of changes in the basic input on economic results was investigated. The hairsheep crosses show the best economic results. With increasing culling rate the economic returns increase. The optimum selling age depends strongly on the post-weaning mortality, if the mortality is high, the optimum selling age is lower. A shorter lambing interval results in higher economic returns. Concentrate is beneficial only when the price is around Rp 160/kg (depending on farming system and management). The use of anthelmintics seemed beneficial even if the price is above Rp 1000 per dose.
For constructing this model some assumptions were made. To make this model more valid, these assumptions have to be verified.

## INTRODUCTION

A lot of research has been conducted on performance of sheep in Indonesia. Production factors like litter size, growth, mortality are often the subject of research. Differences due to breed, location, nutrition and management have been found frequently. Also diseases play an important role in the economic returns of the farmers. Decisions of farmers about the treatment of animals will often be based on economic calculations. The economic returns due to treatment always have to be higher than the money spent on these treatments.

However it is always difficult to translate partial results of research into results that give an indication of total performance of sheep under experimental conditions as well as under village conditions.

This paper makes an attempt to calculate the total economic performance of sheep taking some major production factors and their influencing factors into account. This paper does not pretend to give a complete simulation of a sheep flock, but it can be very useful to make a rough calculation and to see how economic returns change when adjustments are made on the input side of the calculation model. In this way some management decisions can be evaluated very quickly.

The first part gives a review of production factors and influencing factors which are known from other research. After this review the construction of the calculation model will be explained. The third part contains a sensitivity analysis which shows the influence of changes of the input.

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## PRODUCTION FACTORS

Factors that influence the economic returns of a sheep farmer can be separated into two mayor sections: genetic factors and management factors. All of these factors together determine the results of a farmer. Of course there is some interaction among these sections as well. The choice of a breed can be considered a management factor, and if a certain breed is present this may influence some management factors.

### Breed characteristics

Under similar environmental circumstances different breeds will perform differently. So the influence of the breed cannot be ignored. Information about different breeds are obtained from literature. The initial breeds used for this model are: the Javanese sheep breeds (Java Thin-tail (JTT) and East Java Fat-tail (JFT)), Sumatra Thin-tail (STT) or Sumatra Local and crosses with Virgin Island hairsheep (H). In this paper the Java Thin-tail and the East Java Fat-tail are put together because results from the Cicadas experimental station in Bogor show there is not much difference in production factors of the two breeds (Subandriyo, 1986). The Virgin Island/ St.Croix hairsheep do not originate from Indonesia, but were imported in the year 1984 by the SR-CRSP. The hairsheep crossbreeds are Virgin Island /St.Croix hairsheep crossed with Sumatra Local sheep.

#### Litter size

Litter size is one of the major production traits determining the economic returns on a smallholder farm. These returns depend mostly on the selling of slaughter lambs, and the number of lambs born at the farm depends on litter size and lambing frequency (Subandriyo, 1984).

A possible disadvantage of bigger litters is the poor performance of lambs born in larger litters. To make use of the high reproductive potential of ewes, the sheep have to be fed at a higher level of supplementary feeding (Romjali and Gatenby, 1991). This higher plane of nutrition means additional costs for the farmer.

In Table 1 the litter size distributions of the three sheep breeds under experimental conditions are presented.

*Table 1.: Litter size distribution under experimental conditions*

| Breeds | Litter size distribution (% of litters) 1 | 2 | 3 | 4 | Literature source |
|---|---|---|---|---|---|
| Java Fat-tail | 54% | 36% | 9% | 1% | Sutama, 1991 |
| Sumatra Local | 65% | 32% | 3% | 0% | Romjali and Gatenby, 1991 |
| Hairsheep crosses | 69% | 28% | 2% | 1% | Romjali and Gatenby, 1991 |

#### Birth weight

Birth weight differs among the different breeds and there is a big influence of litter size on birth weight. Lambs born in multiple litters have lower birth weights than single lambs (See Table 2).

*Table 2.: Birth weight of lambs (kg) under experimental conditions for different litter sizes.*

| Breeds | Birth weight of lambs in kilogram according to litter size at birth 1 | 2 | 3 | 4 | Literature source |
|---|---|---|---|---|---|
| Javanese sheep | 2.5 | 1.7 | 1.2 | 1.2 | Tiesnamurti et al, 1985 |
| Sumatra Local | 2.2 | 1.7 | 1.4 | --- | Romjali and Gatenby, 1991 |
| Hairsheep crosses | 2.9 | 2.3 | 2.0 | 1.1 | Romjali and Gatenby, 1991 |

Lamb survival

Lamb survival has a major effect on economic revenues of sheep farmers. Due to a decreased survival rate, the total weight of lamb meat is reduced, but also the selection intensity is reduced because fewer replacements animals are available (Subandriyo, 1986). A distinction can be made between pre-weaning and post-weaning lamb survival.

*Pre-weaning lamb survival*
Survival rates are highly influenced by litter size at birth (See Table 3). In the first few days the lower birth weight of lambs born from multiple litters is an important factor which influences lamb survival. Especially later in the rearing period the amount of milk produced by the ewe is of great importance to the rate of survival of the lambs. Often ewes with big litters are not able to produce enough milk to support all the lambs.

*Table 3.: Pre-weaning lamb survival under experimental conditions according to litter size.*

| Breeds | Survival rate of lambs according to litter size at birth (%) 1 | 2 | 3 | 4 | Literature source |
|---|---|---|---|---|---|
| Javanese sheep | 75% | 61% | 54% | 42% | Subandriyo, 1986a |
| Sumatra Local | 90% | 84% | 66% | --- | Romjali and Gatenby, 1991 |
| Hairsheep crosses | 89% | 94% | 67% | 50% | Romjali and Gatenby, 1991 |

*Post-weaning lamb survival*
Not much information is known on survival of weaned animals. In some experiments control groups were used, which didn't receive certain treatments. Out of these trails, a monthly survival rate can be calculated (See Table 4).

*Table 4.: Post-weaning lamb survival.*

| age of the lambs | duration of the experiment | monthly mortality | literature source |
|---|---|---|---|
| 1½-8 months | 112 days | 4.6% | Beriajaya and Stevenson, 1986 |
| 1½-8 months | 168 days | 2.1% | Beriajaya and Stevenson, 1986 |
| 1½-8 months | 150 days | 1.2% | Beriajaya and Stevenson, 1986 |

Average daily weight gain from birth until weaning

The growth from birth until adult weight is in theory described by a S-curve. However, the growth of lambs under practical circumstances is often described by a linear function from birth until weaning and from weaning until adult age another growth rate is found.

Average daily weight gain of the lambs is influenced by litter size. First of all the ewe has got a limited capacity of milk production. Lambs reared in multiple litters receive per animal less milk than single lambs, resulting in a lower growth rate. The average daily weight gain of lambs according to litter size from different breeds is given in table 5.

*Table 5.: Daily weight gain (g/day) of lambs according to litter size.*

| Breeds | Daily weight gain of lambs according to litter size in g/day 1 | 2 | 3 | 4 | Literature source |
|---|---|---|---|---|---|
| Java Thin-tail | 82 | 58 | 68 | 68 | Tiesnamurti et al, 1985 |
| Sumatra Local | 98 | 59 | 68 | — | Romjali and Gatenby, 1991 |
| Hairsheep crosses | 124 | 76 | 70 | 84 | Romjali and Gatenby, 1991 |

Average daily weight gain after weaning

After weaning generally growth of the lambs will continue on a lower level. Not much information is known about growth after weaning. In some experiments control groups are used, which can give a indication of growth after weaning. Beriajaya and Stevenson (1986) found an average daily weight gain of lambs in the control groups of 35 g/day and Chianago et al (1984) found an average daily weight gain of 30 g/day. The growth rate will be zero after reaching the adult weight.

**Management**

Culling rate

If a higher culling rate is used, the percentage of younger ewes on a farm will increase. Because younger ewes are not yet able to produce large litters, a decrease in average age will also mean a decrease in number of lambs born each year. the influence of parity on litter size is shown in Table 7.

*Table 7.: Increase of litter size per parity under experimental conditions (Sutama, 1991).*

| Parity | No. of litters | Litter size (% of litters) 1 | 2 | 3 | 4 | Mean Litter size |
|---|---|---|---|---|---|---|
| 1 | 73 | 65.8 | 30.0 | 4.1 | - | 1.38 ± 0.1 |
| 2 | 77 | 53.2 | 36.4 | 10.4 | - | 1.57 ± 0.1 |
| 3 | 77 | 44.1 | 40.3 | 11.7 | 3.9 | 1.75 ± 0.1 |
| Mean | | 54.4 | 35.6 | 8.7 | 1.3 | 1.57 ± 0.1 |

Also other authors mentioned differences in litter size due to parity. Some results are presented in Table 8.

*Table 8.: Litter size according to parity.*

| Parity | Subandriyo, 1986b litter size | Sutama, 1991 litter size | Sitorus et al, 1985 litter size | |
|---|---|---|---|---|
| 1 | 1.47 | 1.38 | 1.6 | 1.5 |
| 2 | 1.83 | 1.57 | 1.9 | 1.9 |
| 3 | 1.96 | 1.75 | 2.2 | 2.3 |
| ≥ 4 | 1.99 | | | |
| Breed | JTT | JFT | JTT | JFT |

Subandriyo used ages of the ewes in years in his publication, not parities.

Subandriyo (1986b) found a linear relation between age of the ewe and litter size:

$$\text{Litter size} = 1.8 + 0.18 * (\text{Age of the ewe} - 2.5)$$

Lambing interval

The lambing interval is the period between subsequent lambings. The length of this period has a very strong influence on the number of lambs born per year. A longer lambing interval means fewer lambings per year, which implies lower economic returns. On the other hand, very short lambing intervals can have a negative effect on litter size (Sutama, 1991). The average lambing interval for JFT and JTT investigated in several studies varies from 7 to 9 months (Sitorus et al, 1985; Sutama, 1991; Aziz, 1991). Romjali et al (1991) reported a lambing interval of about 7 months for the STT and H1. Similar results were found by Verwilghen et al (1992) for Sumatra Local and Hairsheep crosses under village conditions in North Sumatra.

Sanchez et al (1990) found that supplementation of ewes from 6 weeks before lambing through 3 months of lactation can shorten the lambing interval from 219 to 194 days.

During lactation the ovarian function is depressed by prolactin. Thus earlier weaning can be used as a tool shortening the lambing interval. Weaning at 40 days post partum (pp) resulted in first detected oestrus at an average of 53 days pp. Weaning at 55 days pp. resulted in first detected oestrus at an average of 64 days pp. Though this difference is not really significant, it seems that early weaning of lambs results in an shorter lambing interval (Nuryadi et al, 1986).

Feed supplements

Feed supplements to ewe can have four major positive effects:
- lower pre-weaning lamb mortality
- higher pre-weaning growth
- higher birth weight
- bigger litter size

Handayani et al (1986), experimented with different supplementation levels. On medium supplement, 1% of body weight on a dry matter basis, an increase of birth weight of 21.4%, an increase of daily weight gain of 40% and a decrease of mortality of 89% was measured and litter size was 32% higher than the control group. However, Chaniago et al (1984) didn't find a significant effect on birth weight.

Anthelmintics

Helminth infections cause a reduction in farmers' income, because of a decrease of growth and an increase of mortality among animals. One way to reduce the worm burden is to make use of anthelmintics.

Anthelmintic treatment in a cut-and-carry system has shown no significant effect on growth, probably because the nematode worm burden is too low in permanent housed sheep to have a marked effect (Beriajaya, 1986). In this experiment different broad-spectrum anthelmintics were used, under village-conditions. The animals used were aged 1½ - 8 months. In treated groups in a grazing system an average daily gain of 48 g/day was found, which means an increase of 36% compared to the untreated groups (35 g/day).

Not only an increase in weight gain, also a reduction in mortality rate in treated animals was noted. In groups treated with different kinds of broad-spectrum anthelmintics the average death rate was 4.4%, while in untreated groups 11.1% of the animals died during the trial which lasted 5 months (Beriajaya, 1986).

Chaniago et al (1984) reported an improvement of daily weight gain from birth to weaning of approximately 80%, if anthelmintic treatment and a special diet were given. The type of supplement was not mentioned.

The effect of anthelmintics on growth found by Handayani and Gatenby (1986) was even greater than reported by Beriajaya (1986). In an experiment in Sei Putih, North Sumatra with Sumatra Local sheep, a live weight gain of 2 g/day without anthelmintic treatment and a live weight gain of 29 d/day with anthelmintic treatment was reported.

Labor use

A distinction has to be made between the cut-and-carry system and the grazing system that are used in Indonesia. In a cut-and-carry system the sheep don't go out for grazing and all the feed has to be brought to the barn. In a grazing system the sheep are often fed in the barn with fresh cut grass in the morning and go out grazing in the afternoon. The labour used in the two farm systems was researched by Amir et al. (1985). Some results are presented in Table 9.

*Table 9.: Average daily labour used for sheep farming by type of labor (minutes/day) (Amir et al,1985).*

| Activity | Farm system Cut-and-carry | Grazing |
|---|---|---|
| Cutting grass | 166 | 88 |
| Transporting grass | 61 | 21 |
| Preparing feed | 16 | 13 |
| Providing water | 5 | 10 |
| Herding | 6 | 158 |
| Total | 257 | 290 |

The time spent cutting grass for a flock increases with the flock size. In the report of Amir et al (1985), the flock sizes at the investigated farms were not mentioned. The time for herding remains the same for all flock size, with a upper limit of about 250 animals, which is the maximum flock size for shepherds working for SR-CRSP in Sei Putih (Gatenby, personal communication).

The cutting of the grass is mostly performed by the men, while the herding is often performed by women and children.

A normal price to pay for fresh cut fodder is Rp 20 per kg. An adult animal in a grazing system consumes about 5 kg fresh cut fodder per day.

**THE MODEL STRUCTURE**

The calculation model has a simple structure, because the main objective is not to simulate a sheep farm, but to see the rough impact of changes in input on the economic returns of a farmer. The model is deterministic, so no variation in variables is taken into account. The model is also static, so no development over the years can be calculated.

For the model the spreadsheet program LOTUS 1-2-3 is used (LOTUS, 1983). Cells which contain input are not protected, the cells with formulae and text are protected to avoid mistakes of the user. In this part the input of the model, the calculations and the output, the economic results will be described.

The spreadsheet is divided in tree sections: The input, the output and the breed information. The spread sheet is presented in Appendix 1. The cell formulae are presented in Appendix 2.

Input variables

The input can be separated into three sections, the breeding input, the management input and price information. So the results of the farmer are determined by the natural resources, his own input in the farm and external factors. These three sections are strongly interrelated. For instance price information will determine some management decisions.

*Breeding input.*

The breed information is supposed to contain the parameters on a basic level, so without the use of technologies like anthelmintics and feed supplements.

Breed factors included are:

* litter size distribution at first and third parity.
* birth weight of the lambs according to litter size
* growth of the lambs according to litter size
* survival rate of the lambs according to litter size
* growth rate of the lambs after weaning
* mature body weights of male and female animals
* mortality rate after weaning

In the model breed information is available on the following breeds: Sumatra Thin-tail, Javanese sheep and Virgin Island crosses. There is also the possibility to use own input.

*Management input.*

The management input consists of factors that can be controlled or influenced by the farmer.

Management factors included are:

* farming system (grazing or cut-and-carry)
* the breed used (sl, js, hairsheep, own input)
* number of mature ewes
* number of mature rams (>1 per 30 ewes)
* lambing interval (> 4½ months)
* culling rate (> 10% and < 60%)
* weaning age (> 60 days)
* selling age (> weaning age)
* use of concentrates (yes or no)
* use of anthelmintics (yes or no)

Some factors of the management input have certain logical or physiological boundaries (values written between brackets). Some factors are limited because if a value outside this interval is used, the results will be affected by other factors, which are not in this model included. If the user exceeds these boundaries, the model will react with a comment. If the input is within the boundaries, the model will react with the comment "O.K.".

*Price information.*

The prices included are:

* prices of rams, ewes and lambs per kg live weight
* barn price (calculated)
* interest percentage
* price of feed supplements
* price of fodder
* price of anthelmintic
* price of labor (distinction between adult male and female/children)

Calculation formulae

The formulae used for the calculations are all presented in Appendix 2 in LOTUS cell notations. To rebuild the program this information can be used. For a normal understanding of the used formulae are translated in written text, if possible.

There is no distinction made between sexes. The distribution at birth is supposed to be 50%-50% and some influence can be expected from the culling rate, but because of little differences between male and female animals the sex influence is neglected.

*Litter size distribution:*
Litter size increases until the third litter. So if the culling rate is high, a large percentage of the ewes have not yet reached this third parity.

In the input the litter size distribution (l.s.d.) of the first litter and the third litter are given. Ewes in their second parity will be regarded as the average of the first and the third parity distribution and all animals above the second litter have an equal distribution as the third litter.

Suppose the culling rate is 30% per year. The culling rate per parity with a lambing interval of 8 months will then be 0.30 * 8/12 = 20%. With a regular distribution of ewes at different parities, the distribution will be:

| parity | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| percentage of ewes | 20% | 20% | 20% | 20% | 20% |

So in this example the average litter size distribution will be calculated as (20 + ½ * 20)% of the first l.s.d. and (½ * 20 + 20 + 20 + 20)% of the third l.s.d.

A general formula to be used for any given culling rate can be constructed.

$$\text{Culling rate per parity} = \text{culling rate per year} * \frac{\text{Lambing interval}}{12}$$

$$1\tfrac{1}{2} * \text{culling rate per parity} * \% \text{ of each litter size in the 1st l.s.d.}$$

$$(1 - 1\tfrac{1}{2} * \text{culling rate per parity}) * \% \text{ of each litter size in the 3rd l.s.d}$$

Per litter size the new calculated percentages have to be summed, which will result in a new average litter size distribution.

For the example mentioned above this means that the l.s.d. of the first parity will be weighted for 1½ * 20% = 30% and the l.s.d. of the third parity will be weighted for (100% - 1½ * 20%) = 70%.

For the example the following litter size distributions are used:

| litter size | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| first parity | 75% | 20% | 5% | 0% |
| third parity | 60% | 30% | 8% | 2% |
| average distr. | 0.3 * 75 + 0.7 * 60 | 0.3 * 20 + 0.7 * 30 | 0.3 * 5 + 0.7 * 8 | 0.3 * 0 + 0.7 * 2 |
| 20% culling/par. | 64.5% | 27% | 7.1% | 1.4% |

*The number of lambs born:*
The number of lambs born is the number of litters per ewe per year, times the number of lambs born with each litter, according to the litter size distribution of the ewes, times the number of present ewes.

*The number of lambs weaned:*
The number of lambs weaned is the number of lambs born times the survival rates from birth until weaning, according to litter size.

*Average weaning weight:*
The average weaning weight is the birth weight, plus the growth rate from birth until weaning times the weaning age, according to litter size.

*Mortality rate:*
The mortality rate is the number of lambs weaned divided by the number of lambs born.

*Weight at selling:*
The weight at selling is the weaning weight, plus the growth rate after weaning, times the number of days from weaning until selling, with a maximum weight of the average of female and male animals.

*Number of surviving lambs:*
The number of surviving lambs is the number of weaned lambs times the period from weaning until selling times the survival in that period.

*Number of sold lambs:*
The number of sold lambs is the number of lambs that survived minus the number of ewes that have to be replaced per year.

*Number of sold ewes:*
The number of sold ewes is the number of ewes present times the culling rate per year.

*The influence of anthelmintics and feed supplements:*
The use of anthelmintics and feed supplements have their main influence on mortality and growth. So if used, the growth rates and mortality rates in all parts of the calculation are corrected with a correction factor. The correction factors for the grazing system are different from the correction factors for the cut-and-carry system. This because the effect of the use of anthelmintics is much smaller for the cut-and-carry system. This factor is calculated from information obtained from other research and in some cases some assumptions have been made. The factors used for the grazing system are presented in Table 10 and the factors for the cut-and-carry system in Table 11.

*Table 10.: Correction factors for mortality and growth with different management treatments in a grazing system.*

| Treatment used | correction factor mortality rate | growth |
|---|---|---|
| no treatment | 1.0 | 1.0 |
| anthelmintics | 0.4 | 1.4 |
| feed supplements | 0.9 | 1.4 |
| anthelmintics and feed supplements | 0.4 | 1.8 |

*Table 11.: Correction factors for mortality and growth with different management treatments in a cut-and-carry system.*

| Treatment used | correction factor mortality rate | growth |
|---|---|---|
| no treatment | 0.7 | 1.2 |
| anthelmintics | 0.4 | 1.4 |
| feed supplements | 0.5 | 1.7 |
| anthelmintics and feed supplements | 0.4 | 1.8 |

In the breed information the growth rate of lambs and the mortality rate are given for a grazing system without using anthelmintic and concentrate. The correction factors in this model are based on this situation.

Economic results

The main objective for sheep farming is to gain some economic profit. So the technical results of a sheep farm have to be translated in economic parameters. The objective of farmers doesn't have to be to maximize the returns in general, but a farmer wants to maximize his returns under the circumstances he prefers.

In this part the gross returns of sheep farming will be described. After this the costs associated with sheep farming will be described, separated in barn costs, labor costs, costs for concentrate and costs for anthelmintics.

At the time this report was written the exchange rate of the Rupiah was 1 US$ ≈ Rp. 2000.

*Gross returns*

The gross returns are the number of lambs sold times the average selling weight times the price per kg. The returns from the ewes is the number of ewes culled times the adult ewe weight times the price per kg live weight. The returns from rams are not included in this model. It is assumed that whenever a ram is sold, the farmer has to buy a new one for the same price. So selling adult rams has no influence on the gross returns.

*Costs*

Barn costs:
For the calculation of the barn cost the annuity method is used. This means that costs are equal every year and until the barn is devaluated to zero. This method is described by the formula:

$$a = B * \frac{(r^n * i)}{(r^n - 1)}$$

a = annuity
B = barn costs (total)
r = i + 1
i = interest rate * 0.01
n = life span of the barn

The total barn costs depend on the average number of animals present, because each animal needs a certain space allowance.

The number of adult ewes and rams are part of the input, but the number of lambs present will fluctuate within the year due to lambings and selling of animals. To calculate the average barn space occupation a number of assumptions were made:

* the lambings are spread out over the year;
* a lamb reaches its adult size at an age of 12 months;
* the growth of the lamb is linear.

Using these assumptions this means that a lamb at the age of 5 months will occupy 5/12 times the space of a adult animal.
Factors that will influence the number of lambs present are:

* number of adult ewes and rams present;
* average litter size;
* lambing interval;
* age of selling.

If the input is a lambing interval of 6 months and the selling age of 8 months it is possible to calculate that the average occupation by lambs is 0.5 times an adult animal. This is only true for a single litter. In case of multiple litters this barn occupation factor number has to be multiplied with the litter size.

This factor can also be calculated for other lambing intervals and selling ages. The formula which has to be used for this calculation is:

$$(\tfrac{1}{2} * \text{Selling age} + \tfrac{1}{2} * \text{Selling age}^2)/144 * (12/\text{Lambing interval})$$

$$= \frac{\text{Selling age} + \text{Selling age}^2}{24 * \text{Lambing interval}}$$

This formula has one restriction: The selling age has to be below one year, because a lamb of 13 months will not take the space of 13/12 of an adult animal. In that case for each litter 1/12 has to be deducted from the correction factor.

The formula for this extra correction is:

$$\text{Corr.} = \frac{(\text{Selling age} - 12) + (\text{Selling age} - 12)^2}{24 * \text{Lambing interval}}$$

The complete formula used for barn occupation is as follows:

$$BO = E + R + E * L * ((S + S^2)/(24 * I) - \text{corr.})$$

| | | |
|---|---|---|
| BO | = | total Barn Occupation |
| E | = | number of adult Ewes |
| R | = | number of adult Rams |
| L | = | average Litter size |
| S | = | Selling age |
| I | = | lambing Interval |
| corr. | = | extra correction for selling age > 12 months |

The total barn costs is the Barn Occupation multiplied by the barn costs per present animal. In our calculations the barn costs per present animal used is Rp 15 000.

Labor costs:
The costs for labor are divided in two parts. In the first part are the costs of labor due to cutting fodder and the second part the costs of labor due to herding sheep.

The costs of labor due to cutting fodder depend on the management system. In the system where the animals go out for grazing, the adult sheep receive 5 kg of fodder each day. In the cut-and-carry system it is assumed that the animals get 1.8 times 5 is 9 kg of fodder per day. The amount of fodder for lambs is assumed to be half the amount of adult animals in both systems. The costs of cutting fodder are calculated as the total amount of fodder per month times the price of fodder which is given in the input.

For calculating the costs of grazing it is assumed that the animals go out for grazing 4 hours per day, 365 days per year. The costs for hiring a shepherd are estimated at Rp 500 per hour. The limit for one shepherd is 50 adult sheep.

Concentrate:
The costs for concentrate depend on the number of animals present, the amount of concentrate per animal per year and the price of concentrate per kg. The amount of concentrate depends on the weight of the animals. In the model the amount of concentrate per day is calculated as 1% of the body weight of the animal. The ewes receive concentrate during 134 days per lambing, starting 6 weeks before lambing through three months

of lactation. For lambs the calculation is more complicated. Lambs receive concentrate after weaning. The weight of the lambs is calculated as the average weight from weaning to selling. The amount of concentrate for lambs is 1% of this average weight per day. The number of lambs present between the time of weaning and selling is calculated as the average of the number of lambs present at weaning and the number of lambs present at selling. The total costs for concentrate are calculated as the costs for concentrate of the ewes per lambing times the lambing frequency and the costs for concentrate of the lambs. The rams receive no concentrate at all.

Anthelmintics:
The costs for anthelmintic is the price times the number of adult animals present (ewes and rams) times 4 (treatment every three months). The lambs are given anthelmintic every three months.

*Net profit and the returns to labor and management*

The net profit is calculated as the gross returns minus the total costs. The returns to labor and management are calculated as the gross returns minus the barn costs, costs of concentrate and the costs of anthelmintic.

**SENSITIVITY ANALYSIS**

The described model is based on information obtained from different literature sources and some assumptions. To investigate the influence of changes in the basic input and to investigate some different management strategies, a sensitivity analysis is conducted.

In the sensitivity analysis for each calculation only one or two input variables were changed to investigate their influence. The results of the calculations were compared with the results of the basic farm. In this part only the economic results are discussed, because economic results are a good indicator for the general farm results.

Three output variables are presented after each calculation. The Gross Returns (GR), the returns to Labor and Management (LM) and the Net Profits (NP). The Gross Returns are defined as the total income from sold animals. The returns to Labor and Management are defined as the Gross Returns minus all the costs associated with the sheep farm except the labor costs. This variable gives an indication about the income of the farmer, because in most cases all work is carried out by family labor. The Net Profit is defined as the returns to Labor and Management minus all the costs calculated for labor. This variable gives an indication about the economic profitability of the enterprise if non family labor is used.

The basic farm input is as follows:

| | |
|---|---|
| farming system: | grazing |
| breed: | Javanese sheep |
| number of ewes: | 10 |
| number of rams: | 1 |
| culling rate: | 20% |
| lambing interval: | 7 months |
| weaning age: | 90 days |
| selling age: | 10 months |
| interest rate: | 20% |
| use of anthelmintics: | no |
| use of concentrate: | no |
| meat price: | 2500 Rupiah |

The economic results of this farm are as follows:

| | | | |
|---|---|---|---|
| Gross income: | | | Rp 555914 |
| Barn costs: | | Rp 63561 | |
| Costs for concentrate: | | Rp 0 | |
| Costs for anthelmintics: | | Rp 0 | |
| Returns to labor and management: | | | Rp 492353 |
| Labor costs: | fodder: | Rp 574466 | |
| | grazing: | Rp 730000 | |
| Net Profit | | | Rp -812113 |

More information about the farm results is presented in Appendix 1.

**Breeds**

In the model a choice can be made out of three breed (plus own input if wanted). For the basic farm the Javanese sheep is chosen, because the most information was known about this breed so this breed information is the most reliable of the three breeds.
In Table 12 the economic results of the three different breeds are presented.

*Table 12: Economic results of different sheep breeds in Rupiahs (thousands) per year.*

| Breed | GR | LM | NP |
|---|---|---|---|
| Javanese sheep | 556 | 492 | -812 |
| Sumatra local | 657 | 590 | -738 |
| Hairsheep crosses | 805 | 739 | -589 |

**Culling rate**

If the culling rate decreases the average parity of the ewes will go up. This means the total number of lambs born on the farm will increase. So higher economic returns are expected. However, this model show a linear decrease of economic returns due to a decrease of the culling rate (see Table 13). The explanation for this phenomenon is that the increased number of lambs produced per year cannot compensate the negative effect of a higher litter size on growth and mortality.

*Table 13: Economic results of different culling rates in Rupiahs (thousands) per year.*

| Culling rate | GR | LM | NP |
|---|---|---|---|
| 15 % | 547 | 484 | -821 |
| 20 % | 556 | 492 | -812 |
| 25 % | 564 | 501 | -803 |

**Interest percentage**

The interest percentage on invested money influences economic returns, because the barn costs per year will increase. An interest percentage of 15% results in a LM of 503 thousand Rupiah, an interest percentage of 20% results in a LM of 492 thousand Rupiah and an interest percentage of 25% results in a LM of 481 thousand Rupiah.

## Selling age

The selling age is of major importance for economic returns for farmers. If the farmer sells his animals when they are too young, the selling weight will be low, but if he keeps his lambs too long, mortality can have a negative influence and besides this, the lamb will not grow anymore if the mature weight is reached and will only cost money because of occupation of barn space and intake of food. The mature weight under extensive conditions is only reached at an age of 24 months. This confirms with Verwilghen et al (1992), who concluded that a ewe under village conditions reaches its mature weight at the third parity, which is an age of two years.
In figure 1 the influence of selling age and post-weaning mortality rates on LM are displayed.

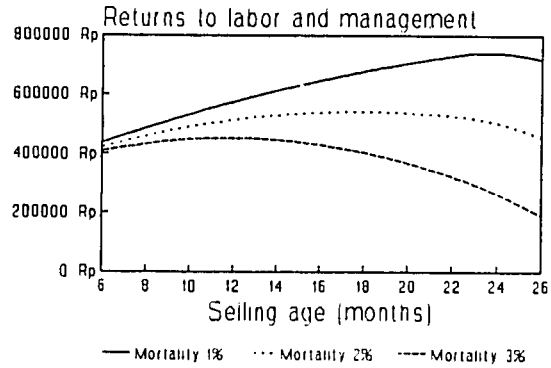


**Figure 1** Influence of selling age and post weaning mortality on LM

The optimum selling age looking at the returns to labor and management doesn't have to be at the same selling age looking at the gross returns. For example the optimum selling age with a post weaning mortality of 2% is 18 months looking at returns to labor and management, but 21 months looking at gross returns. The losses due to mortality in the time from 18 to 21 months still less than the gain in weight of the surviving lambs, but because of a higher barn occupation rate a selling age of 20 months is to be preferred.

## Lambing interval

If the lambing interval can be shortened more litters per year are born, resulting in more lambs sold. The effect of shorter lambing intervals on gross returns and returns to labor and management is presented in Figure 2.

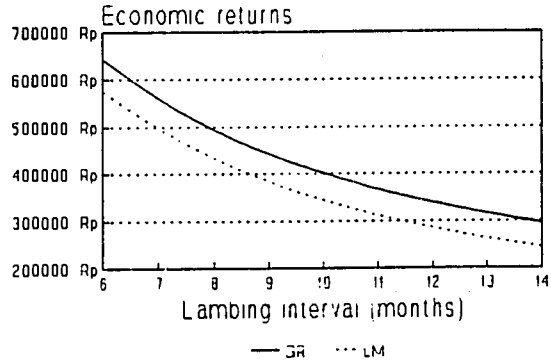


**Figure 2** Influence of lambing interval on economic returns

This figure shows that the lambing interval has to be as short as possible, because the economic returns increase with a short lambing interval. Besides this the economic gain due to a change from 7 months to 6 months is bigger than the economic gain due to a change from 11 months to 10 months.

In research conducted by Sanchez (1990) a correlation between the use of concentrate and lambing interval was found. If concentrate was used the lambing interval was shorter: 6.5 months with using concentrate and 7.3 months without using concentrate. Karo Karo and Scholz (1991) found an extra profit when concentrate was used. The lambing interval was changed from 7.3 months to 6.5 months due to the use of concentrate. The price of concentrate was set on Rp 184 per kg and the price of meat was set on Rp 2400 per kg live weight. A calculation with the above mentioned figures in the model resulted in a extra profit of Rp 5923/ewe/year. In the model the infuence of concentrate on lambing interval is not taken into account. Without adjusting the lambing interval manually no extra profit is calculated when using concentrate.

Use of concentrate

If concentrate is used the model will adjust growth and mortality in such a way that the growth rates are higher and the mortality is lower. However, using concentrates also implies higher feeding costs. To investigate when to use concentrate, 4 different systems were taken into account:

1. concentrate and anthelmintic
2. concentrate and no anthelmintic
3. no concentrate and anthelmintic
4. no concentrate and no anthelmintic

The price of anthelmintics is kept constant at Rp 250 per dose.

In Figure 3 the returns to labor and management for the 4 different systems at different prices of concentrate in a grazing system are illustrated. If the price of concentrate is below Rp 153/kg (A) and anthelmintics are used, it is economically beneficial to use concentrate. If no anthelmintics are given, the price of concentrate can go up to Rp 169/kg (B) before the extra returns due to the use of concentrate are zero.

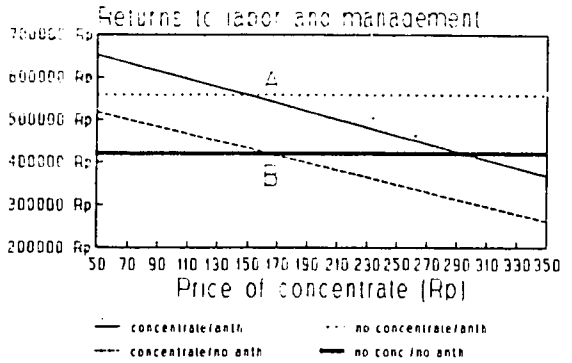


**Figure 3** Influence of the price per kg of concentrate on the LM

In a cut-and-carry system the benefits of using concentrate are higher. If anthelmintics are used the price of concentrate can go up to Rp 153 per kg before the benefits due to concentrate are zero. If no anthelmintics are used, the price can go up to Rp 212 per kg.

**Use of anthelmintics**

The same as for using concentrate, the model will adjust the growth rate and the mortality rate if anthelmintics are used. Using anthelmintics also implies costs for anthelmintic treatment. To get an impression to what extend anthelmintics are economically beneficial the four above mentioned systems were taken into account.

In the grazing system the use of anthelmintics is very beneficial. For the calculations the price of concentrate was Rp 250. When using concentrate the price of anthelmintics can go up to Rp 2000 per doses, which is eight times the price normally used for anthelmintics. If no concentrate is used the price of anthelmintics can go up to Rp 2300 per dose before the use of it is not beneficial any more.

In Figure 4 the returns to labor and management for the 4 different systems at different prices of concentrate in a cut-and-carry system are illustrated. The price of concentrate was Rp 250.

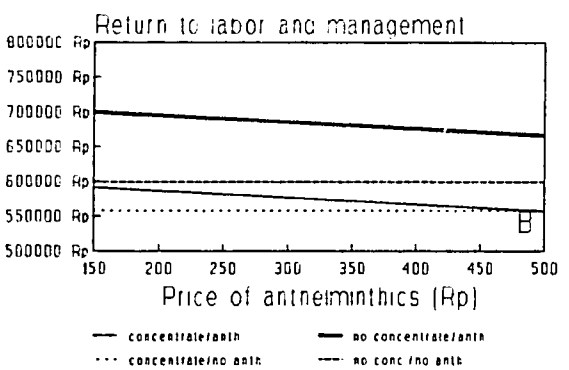


**Figure 4** Influence of the price of anthelminthics on the LM (price of concentrate Rp 250)

If concentrate is used. the use of anthelmintics is no longer economically beneficial at the price of Rp 492 (B) per dose. If no concentrate is used this price is Rp 1190 (A).

In the cut-and-carry system the impact of the use of anthelmintics is less than in the grazing system. This because the worm burden is much lower in the cut-and-carry system. This is the reason that in the cut-and-carry system the break even point for the use of anthelmintics is reached at a lower price-level.

Not only the price of anthelmintics determines whether the use of it is beneficial, but also the price of concentrate. If the price of concentrate is low, the price of anthelmintics can go up more before the use of it is no longer economically beneficial.

In figure 5 again the returns to labor and management for the 4 different systems are presented. The only difference is that the price of concentrate is Rp 100 per kg. If no concentrate is used the situation is the same. At a price of Rp 1190 (B) per doses it is no longer beneficial to use anthelmintics. If concentrate is used however, the price at which the use of anthelmintics is no longer economically beneficial goes up to Rp 546 (A) per doses.

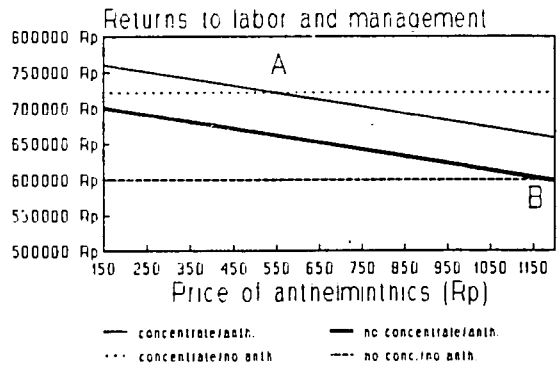


**Figure 5** Influence of the price of anthelminthics on the LM (price of concentrate Rp 100/kg)

## DISCUSSION AND CONCLUSION

In this working paper a calculation model for sheep farming in Indonesia is described.
Calculations showed that sheep farming can be beneficial for farmers if family labor is used. However, if the labor has to be paid for all combinations show negative economic results.
Barn costs seemed to have only little effect on the economic results (only 13% of the Gross income).
In a breed comparison by this model the hairsheep crosses appeared to show the best economic results, followed by the Sumatra Local and the Javanese sheep.

In the sensitivity analysis some variables were changed to investigate the influence of these variables on the economic results.
If culling rate increases, the economic returns increase as well. This contradicts an expected decrease of economic returns, because if the culling rate is lower the average litter size will be bigger and

therefore the level of production will be higher. Apparently this increase in lambs born do not make up the loss due to higher mortality rate and decrease in growth. It is possible that not only litter size increases with parity, but also growth rate of the lambs increases and mortality decreases because a more mature ewe is able to produce more milk and has more experience with raising young animals. This is not yet included in this model.
Because the barn costs are of little influence on the total economic results, also the interest rate, used to calculate the yearly barn costs is of little influence on the total economic results.
The economical optimum selling age of the lambs depends strongly on mortality rate after weaning. A change from 2% mortality per month to 3% per month results in a change of the optimum selling age from 20 months to 14 months. Not much is known about post-weaning mortality, so the chosen 2% on the standard farm may be not realistic.
Lambing interval has a big influence on economic returns on a sheep farm. The shorter the lambing interval, the more lambs are born each year. The marginal profit of a change in lambing interval in bigger when the interval is short. However, literature showed that if the lambing interval is too short, some negative effects may occur. So the economic gain of very short lambing intervals may decrease because of these effects. This possibility is not included in this calculation model. When using concentrate the lambing interval is shorter, which results in an extra profit. The adjustment of the lambing interval when using concentrate is not included in this model. The reason that lambing interval is not linked to the use of concentrate is that using concentrate is not the only factor determining lambing interval.
The use of concentrate is only to be recommended if the price per kg is very low and the concentrate is used strategically.
The use of anthelmintics seemed beneficial even if this has to be bought for a very high price. In a grazing system the differences between using and not using are higher, because the worm burden is assumed to be higher in a grazing system.

The described model is of course not perfect. A lot of assumptions were made to calculate the influences of some variables on economic returns. Still a lot of information is missing to be able to construct a valid model. This model has to be regarded as a first attempt to simulate a sheep farm. Hopefully some constraints of this model will be eliminated and corrections will be made where necessary in the future.

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## APPENDIX 1

LOTUS spreadsheet of the calculation model (Cells A1..F73)

CALCULATION MODEL FOR SHEEP FARMING IN INDONESIA

| FARM INFORMATION | | | | ADDITIONAL COMMENTS |
|---|---|---|---|---|
| farming system: | grazing | | | O.K. |
| breed used: | jtt | | | O.K. For information about the current breed press TAB |
| number of mature ewes: | | 10 | | O.K. |
| number of mature rams: | | 1 | | O.K. |
| lambing interval: | | 7 | months | O.K. |
| culling rate: | | 20 | %/year | O.K. |
| weaning age: | | 90 | days | O.K. |
| selling age: | | 10 | months | O.K. |
| use of concentrate: | no | | | O.K. |
| use of anthelmintics: | no | | | O.K. |
| correction for growth | | 1 | | |
| correction for mortality | | 1 | | |

| PRICE INFORMATION | | | | |
|---|---|---|---|---|
| prices (Rp): | ram | 2500 | Rp/kg | O.K. |
| | ewe | 2500 | Rp/kg | O.K. |
| | lamb | 2500 | Rp/kg | O.K. |
| price of the barn: | | 266480 | Rp | |
| lifetime of the barn: | | 10 | years | O.K. |
| interest percentage: | | 20 | %/year | O.K. |
| price of concentrate: | | 250 | Rp/kg | O.K. |
| price of fodder: | | 20 | Rp/kg | O.K. |
| price of anthelmintics: | | 250 | Rp/sheep | O.K. |

FARM RESULTS

| | | | | |
|---|---|---|---|---|
| littersize distribution | 1 | 2 | 3 | 4 |
| | 47.9% | 38.5% | 10.4% | 3.2% |

| | | |
|---|---|---|
| number of lambs born: | 29 | per year |
| average litter size: | 1.69 | |
| average birth weight: | 1.85 | kg |
| number of lambs weaned: | 18 | per year |
| average weaning weight: | 7.18 | kg |
| pre weaning mortality: | 38.81 | % |
| pre weaning growth: | 59 | g/day |
| weight at selling: | 13.48 | kg |
| post weaning mortality: | 14 | % |
| post weaning growth: | 30 | g/day |
| # surviving lambs: | 15 | per year |
| # sold lambs: | 13 | per year |
| # sold ewes: | 2 | per year |

ECONOMIC RESULTS

| | | | |
|---|---|---|---|
| TOTAL FLOCK PER YEAR | | | |
| Gross income: | | 555914 | Rp |
| Costs: | | | |
| - barn costs: | | 63561 | Rp |
| - labor: * cut fodder: | 574466 Rp | | |
| * grazing: | 730000 Rp | | |
| Total: | | 1304466 | Rp |
| - concentrate: | | 0 | Rp |
| - anthelmintics: | | 0 | Rp |
| Tot. costs: | | 1368027 | Rp |
| Net profit: | | -812113 | Rp per year |
| Net profit: | | -67676 | Rp per month |
| Return to labor and management: | | 492353 | Rp per year |
| Return to labor and management: | | 41029 | Rp per month |
| Return to labor and management: | | 49235 | Rp per adult ewe |

---

## Breed information of the LOTUS spreadsheet (Cells I3..M20)

Current breed: Javanese Thin Tail

| | | |
|---|---|---|
| mature ewe body weight | 22 | kg |
| mature ram body weight | 30 | kg |

| litter size | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| distribution (%) | | | | |
| first parity | 65.8 | 30 | 4.1 | 0 |
| third parity | 44.1 | 40.3 | 11.7 | 3.9 |
| from birth until weaning | | | | |
| survival rate (%) | 87 | 60 | 29 | 50 |
| growth (gram/day) | 69 | 46 | 36 | 65 |
| birth weight (kg) | 2 | 1.5 | 1 | 1 |

| | | |
|---|---|---|
| daily w.gain after weaning | 30 | gram/day |
| mortality rate after weaning | 2 | % per month |

To go back to the input press SHIFT and TAB simultaniously

## Information about other breeds used in the spreadsheet (Cell X15..AC40).

| | | | | |
|---|---|---|---|---|
| breed | Sumatra Local | | | |
| abw | 22 | | | |
| rbw | 30 | | | |
| l.size | 1 | 2 | 3 | 4 |
| distr.1 | 72 | 27 | 1 | 0 |
| distr.3 | 64 | 33 | 3 | 0 |
| surv.rate | 90 | 84 | 66 | 0 |
| d.w.g. | 70 | 42 | 49 | 0 |
| b.weight | 2.2 | 1.7 | 1.4 | 0 |
| d.w.g.>w | 30 | | | |
| mort.>w | 2 | | | |

| | | | | |
|---|---|---|---|---|
| breed | Hairsheep | | | |
| abw | 28 | | | |
| rbw | 35 | | | |
| l.size | 1 | 2 | 3 | 4 |
| distr.1 | 75 | 24 | 1 | 0 |
| distr.3 | 68 | 29 | 2 | 1 |
| surv.rate | 93 | 83 | 66 | 75 |
| d.w.g. | 83 | 50 | 51 | 55 |
| b.weight | 2.8 | 2 | 2 | 1.4 |
| d.w.g.>w | 40 | | | |
| mort.>w | 2 | | | |

APPENDIX 2

# Cell formulae of the LOTUS calculation model

```
A1: [W3] 'CALCULATION MODEL FOR SHEEP FARMING IN INDONESIA
A3: [W3] 'FARM INFORMATION
E3: 'ADDITIONAL COMMENTS
I3: [W20] 'Current breed:
J3: @IF(C6="javanese thin tail"#OR#C6="jtt"#OR#C6="j.t.t",Z3,@IF(C6="sumatra local"#OR#C6="s.l."#OR#C6="sl",Z15,
    @IF(C6="hairsheep"#OR#C6="st. croix",Z27,@IF(C6="else",R3,"Breed information not known"))))
Q3: [W20] 'Input:
R3: U 'own breed
Y3: 'breed
Z3: U 'Javanese Thin Tail
B4: [W23] 'farming system:
C4: U [W11] 'grazing
E4: @IF(C4="","Type: cut-and-carry",@IF(C4="cut-and-carry"#OR#C4="grazing","O.K.","Type: cut-and-carry"))
Y4: 'ebw
Z4: U 22
C5: (H) [W11] @IF(C4="grazing",1,1.8)
E5: @IF(C4="","  or: grazing",@IF(C4="cut-and-carry"#OR#C4="grazing"," ","  or: grazing"))
I5: [W20] 'mature ewe body weight
K5: [W5]@IF($J$3="Javanese Thin Tail",Z4,@IF($J$3="sumatra local",Z16,@IF($J$3="hairsheep",Z28,@IF($J$3="Own breed",S5,
    "N.K."))))
L5: [W5] 'kg
Q5: [W20] 'mature ewe body weight
S5: U [W5] 50
T5: [W5] 'kg
Y5: 'rbw
Z5: U 30
B6: [W23] 'breed used:
C6: U [W11] 'jtt
E6: @IF(C6="","ENTER BREED",@IF($C$6="javanese thin tail"#OR#$C$6="jtt"#OR#$C$6="j.t.t."#OR#$C$6="sumatra local"
    #OR#$C$6="s.l."#OR#$C$6="sl"#OR#$C$6="hairsheep"#OR#$C$6="st. croix"#OR#$C$6="else","O.K.  For information","Breed not
    known"
I6: [W20] 'mature ram body weight
K6: [W5]@IF($J$3="Javanese Thin Tail",Z5,@IF($J$3="sumatra local",Z17,@IF($J$3="hairsheep",Z29,@IF($J$3="own breed",S6,
    "N.K."))))
L6: [W5] 'kg
Q6: [W20] 'mature ram body weight
S6: U [W5] 90
T6: [W5] 'kg
Y6: 'l.size
Z6: U 1
AA6: U 2
AB6: U 3
AC6: U 4
E7: @IF(C6="","(jtt,sl,hairsheep",@IF($C$6="javanese thin tail"#OR#$C$6="jtt"#OR#$C$6="j.t.t."#OR#$C$6="sumatra local"
    #OR#$C$6="s.l."#OR#$C$6="sl"#OR#$C$6="hairsheep"#OR#$C$6="st. croix"#OR#$C$6="else","about the current breed",""))
Y7: 'distr.1
Z7: U 65.8
AA7: U 30
AB7: U 4.1
AC7: U 0
E8: @IF(C6="","or else for own input)",@IF($C$6="javanese thin tail"#OR#$C$6="jtt"#OR#$C$6="j.t.t."#OR#$C$6="sumatra local"
    #OR#$C$6="s.l."#OR#$C$6="sl"#OR#$C$6="hairsheep"#OR#$C$6="st. croix"#OR#$C$6="else","press TAB",""))
I8: [W20] 'litter size
J8: 1
K8: [W5] 2
L8: [W5] 3
M8: [W5] 4
Q8: [W20] 'littersize
R8: 1
S8: [W5] 2
T8: [W5] 3
U8: [W5] 4
Y8: 'distr.3
Z8: U 44.1
AA8: U 40.3
AB8: U 11.7
AC8: U 3.9
B9: [W23] 'number of mature ewes:
C9: U [W11] 10
E9: @IF(C9<=0,"Your not a farmer yet","O.K.")
I9: [W20] ' distribution (%)
Q9: [W20] 'distribution
Y9: 'surv.rate
Z9: U 87
AA9: U 60
AB9: U 29
AC9: U 50
B10: [W23] 'number of mature rams:
C10: U [W11] 1
E10: @IF(C9/C10>30,"You need more rams","O.K.")
I10: [W20] 'first parity
J10: @IF($J$3="Javanese Thin Tail",Z7,@IF($J$3="sumatra local",Z19,@IF($J$3="hairsheep",Z31,@IF($J$3="own breed",
    R10,"N.K."))))
K10: [W5]@IF($J$3="JavaneseThinTail",AA7,@IF($J$3="sumatra local",AA19,@IF($J$3="hairsheep",AA31,@IF($J$3="own breed",
    S10,"N.K."))))
L10: [W5]@IF($J$3="JavaneseThinTail",AB7,@IF($J$3="sumatralocal",AB19,@IF($J$3="hairsheep",AB31,@IF($J$3="own breed",
    T10,"N.K."))))
M10: [W5]@IF($J$3="JavaneseThinTail",AC7,@IF($J$3="sumatralocal",AC19,@IF($J$3="hairsheep",AC31,@IF($J$3="own breed",
    U10,"N.K."))))
Q10: [W20] 'first litter
R10: U 70
S10: U [W5] 20
T10: U [W5] 10
U10: U [W5] 0
Y10: 'd.w.g.
Z10: U 69
AA10: U 46
AB10: U 36
AC10: U 65
B11: [W23] 'lambing interval:
C11: U [W11] 7
D11: 'months
E11: @IF(C11<5.5,"This is too short","O.K.")
I11: [W20] 'third parity
J11: @IF($J$3="Javanese Thin Tail",Z8,@IF($J$3="sumatra local",Z20,@IF($J$3="hairsheep",Z32,@IF($J$3="own breed",
    R11,"N.K."))))
K11: [W5]@IF($J$3="JavaneseThinTail",AA8,@IF($J$3="sumatralocal",AA20,@IF($J$3="hairsheep",AA32,@IF($J$3="own breed",
    S11,"N.K."))))
L11: [W5]@IF($J$3="JavaneseThinTail",AB8,@IF($J$3="sumatralocal",AB20,@IF($J$3="hairsheep",AB32,@IF($J$3="own breed",
    T11,"N.K."))))
M11: [W5]@IF($J$3="JavaneseThinTail",AC8,@IF($J$3="sumatralocal",AC20,@IF($J$3="hairsheep",AC32,@IF($J$3="own breed",
    U11,"N.K."))))
Q11: [W20] 'third litter
R11: U 60
S11: U [W5] 25
T11: U [W5] 15
U11: U [W5] 0
Y11: 'b.weight
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Z11: U 2
AA11: U 1.5
AB11: U 1
AC11: U 1
B12: [W23] 'culling rate:
C12: U [W11] 20
D12: '%/year
E12: @IF(C12>65,"Culling rate is too high",@IF(C12<=10,"Cullingrate is too low","O.K."))
I12: [W20] 'from birth until weaning
Q12: [W20] 'from birth until weaning
Y12: 'd.w.g.>w
Z12: U 30
I13: [W20] 'survival rate (%)
J13: @IF($J$3="Javanese Thin Tail",Z9,@IF($J$3="sumatra local",Z21,@IF($J$3="hairsheep",Z33,@IF($J$3="own breed",
     R13,"N.K."))))
K13:[W5]@IF($J$3="JavaneseThinTail",AA9,@IF($J$3="sumatralocal",AA21,@IF($J$3="hairsheep",AA33,@IF($J$3="ownbreed",
     S13,"N.K."))))
L13:[W5]@IF($J$3="JavaneseThinTail",AB9,@IF($J$3="sumatralocal",AB21,@IF($J$3="hairsheep",AB33,@IF($J$3="ownbreed",
     T13,"N.K."))))
M13:(W5]@IF($J$3="JavaneseThinTail",AC9,@IF($J$3="sumatralocal",AC21,@IF($J$3="hairsheep",AC33,@IF($J$3="ownbreed",
     U13,"N.K."))))
Q13: [W20] 'survival rate (%)
R13: U 95
S13: U [W5] 90
T13: U [W5] 85
Y13: 'mort.>w
Z13: U 2
B14: [W23] 'weaning age:
C14: U [W11] 90
D14: 'days
E14: @IF(C14<=60,"Too short",@IF(C14>120,"Too long","O.K."))
I14: [W20] 'growth (gram/day)
J14: @IF($J$3="Javanese Thin Tail",Z10,@IF($J$3="sumatra local",Z22,@IF($J$3="hairsheep",Z34,@IF($J$3="own breed",
     R14,"N.K."))))
K14: [W5] @IF($J$3="Javanese Thin Tail",AA10,@IF($J$3="sumatra local",AA22,@IF($J$3="hairsheep",AA34,@IF($J$3="own breed",
     S14,"N.K."))))
L14: [W5] @IF($J$3="Javanese Thin Tail",AB10,@IF($J$3="sumatra local",AB22,@IF($J$3="hairsheep",AB34,@IF($J$3="own breed",
     T14,"N.K."))))
M14: [W5] @IF($J$3="Javanese Thin Tail",AC10,@IF($J$3="sumatra local",AC22,@IF($J$3="hairsheep",AC34,@IF($J$3="own breed",
     U14,"N.K."))))
Q14: [W20] 'growth (gram/day)
R14: U 300
S14: U [W5] 275
T14: U [W5] 250
B15: [W23] 'selling age:
C15: U [W11] 10
D15: 'months
E15: @IF(C15<=0,"Give age in months",@IF((C15*30)<C14,"Selling after weaning!!","O.K."))
I15: [W20] 'birth weight (kg)
J15: @IF($J$3="Javanese Thin Tail",Z11,@IF($J$3="sumatra local",Z23,@IF($J$3="hairsheep",Z35,@IF($J$3="own breed",
     R15,"N.K."))))
K15: [W5] @IF($J$3="Javanese Thin Tail",AA11,@IF($J$3="sumatra local",AA23,@IF($J$3="hairsheep",AA35,@IF($J$3="own breed",
     S15,"N.K."))))
L15: [W5] @IF($J$3="Javanese Thin Tail",AB11,@IF($J$3="sumatra local",AB23,@IF($J$3="hairsheep",AB35,@IF($J$3="own breed",
     T15,"N.K."))))
M15: [W5] @IF($J$3="Javanese Thin Tail",AC11,@IF($J$3="sumatra local",AC23,@IF($J$3="hairsheep",AC35,@IF($J$3="own breed",
     U15,"N.K."))))
Q15: [W20] 'birthweight (kg)
R15: U 4
S15: U [W5] 3.5
T15: U [W5] 3
Y15: 'breed
Z15: U 'Sumatra Local
Y16: 'abw
Z16: U 22
I17: [W20] 'daily w.gain after weaning
L17: [W5] @IF($J$3="Javanese Thin Tail",Z12,@IF($J$3="sumatra local",Z24,@IF($J$3="hairsheep",Z36,@IF($J$3="own breed",T17,
     "N.K."))))
M17: [W5] 'gram/day
Q17: [W20] 'daily w.gain after weaning
T17: U [W5] 100
U17: [W5] 'gram/day
Y17: 'rbw
Z17: U 30
B18: [W23] 'use of concentrate:
C18: U [W11] 'no
E18: @IF(C18="","Type yes or no",@IF(C18="yes"#OR#C18="no","O.K.","Type yes or no"))
I18: [W20] 'mortality rate after weaning
L18: [W5] @IF($J$3="Javanese Thin Tail",Z13,@IF($J$3="sumatra local",Z25,@IF($J$3="hairsheep",Z37,@IF($J$3="own breed",T18,
     "N.K."))))
M18: [W5] '% per month
Q18: [W20] 'mortality rate after weaning
T18: U [W5] 1
U18: [W5] '% per month
Y18: 'l.size
Z18: U 1
AA18: U 2
AB18: U 3
AC18: U 4
B19: [W23] 'use of anthelmintics:
C19: U [W11] 'no
E19: @IF(C19="","Type yes or no",@IF(C19="yes"#OR#C19="no","O.K.","Type yes or no"))
Y19: 'distr.1
Z19: U 72
AA19: U 27
AB19: U 1
AC19: U 0
B20: [W23] 'correction for growth
C20: [W11] @IF(C4="grazing",D21,D22)
D20: (H) U @IF(C18="yes"#AND#C19="yes",1.8,@IF(C18="yes"#AND#C19="no",1.4,@IF(C18="no"#AND#C19="yes",1.4,1)))
I20: [W20] 'To go back to the input press SHIFT and TAB simultaniously
Q20: [W20] 'To go back to the input press SHIFT and TAB simultaniously
Y20: 'distr.3
Z20: U 64
AA20: U 33
AB20: U 3
AC20: U 0
B21: [W23] 'correction for mortality
C21: [W11] @IF(C4="grazing",D21,D23)
D21: (H) U @IF(C18="yes"#AND#C19="yes",0.4,@IF(C18="yes"#AND#C19="no",0.9,@IF(C18="no"#AND#C19="yes",0.4,1)))
Y21: 'surv.rate
Z21: U 90
AA21: U 84
AB21: U 66
AC21: U 0
D22: (H) U @IF(C18="yes"#AND#C19="yes",1.8,@IF(C18="yes"#AND#C19="no",1.7,@IF(C18="no"#AND#C19="yes",1.4,1.2)))
Y22: 'd.w.g.
Z22: U 70
AA22: U 42
AB22: U 49
AC22: U 0
D23: (H) U @IF(C18="yes"#AND#C19="yes",0.4,@IF(C18="yes"#AND#C19="no",0.5,@IF(C18="no"#AND#C19="yes",0.4,0.7)))
Y23: 'b.weight
Z23: U 2.2
AA23: U 1.7
AB23: U 1.4
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AC23: U 0
X24: [W3] 'PRICE INFORMATION
Y24: 'd.w.g.>w
Z24: U 30
B25: [W23] 'prices (Rp):  ram
C25: U [W11] 2500
D25: 'Rp/kg
E25: @IF(C25="","Enter price information","O.K.")
F25: ←D71
Y25:  mort.>w
Z25: U 2
B26: [W23] '                    ewe
C26: U [W11] 2500
D26: 'Rp/kg
E26: @IF(C26="","Enter price information","O.K.")
B27: [W23] '                    lamb
C27: U [W11] 2500
D27: 'Rp/kg
E27: @IF(C27="","Enter price information","O.K.")
Y27: 'breed
Z27: U 'Hairsheep
B28: [W23] 'price of the barn:
C28:(F0)[W11]@IF(C15>12,15000*(C9+C10+C9*(C42/C9*C11/12)*((0.5*C15+0.5*C15^2)-0.5*(C15-12)-0.5*(C15-12)^2)/(12*C11)),
     15000*(C9+C10+C9*(C42/C9*C11/12)*((0.5*C15+0.5*C15^2)/(12*C11))))
D28: 'Rp
Y28: 'ebw
Z28: U 28
B29: [W23] 'lifetime of the barn:
C29: U [W11] 10
D29: 'years
E29: @IF(C29="","Enter a number of years","O.K.")
Y29: 'rbw
Z29: U 35
B30: [W23] 'interest percentage:
C30: U [W11] 20
D30: '%/year
E30: @IF(C30="","Enter your interest rate","O.K.")
Y30: 'l.size
Z30: U 1
AA30: U 2
AB30: U 3
AC30: U 4
B31: [W23] 'price of concentrate:
C31: U [W11] 100
D31: 'Rp/kg
E31: @IF(C31=""#AND#C18="yes","Enter price information","O.K.")
Y31: 'distr.1
Z31: U 75
AA31: U 24
AB31: U 1
AC31: U 0
B32: [W23] 'price of fodder:
C32: U [W11] 20
D32: 'Rp/kg
E32: @IF(C32="","Enter price information","O.K.")
Y32: 'distr.3
Z32: U 68
AA32: U 29
AB32: U 2
AC32: U 1
B33: [W23] 'price of anthelmintics:
C33: U [W11] 1200
D33: 'Rp/sheep
E33: @IF(C33=""#AND#C19="yes","Enter price information","O.K.")
Y33: 'surv.rate
Z33: U 93
AA33: U 83
AB33: U 66
AC33: U 75
Y34: 'd.w.g.
Z34: U 83
AA34: U 50
AB34: U 51
AC34: U 55
A35: [W3] 'FARM RESULTS
Y35: 'b.weight
Z35: U 2.8
AA35: U 2
AB35: U 2
AC35: U 1.4
B36: [W23] 'littersize distribution
C36: [W11] 1
D36: 2
E36: 3
F36: 4
Y36: 'd.w.g.>w
Z36: U 40
C37: (P1) [W11] (+J10*(1.5*SCS11/12*SCS12/100)+J11*(1-1.5*SCS11/12*SCS12/100))/100
D37: (P1) (+K10*(1.5*SCS11/12*SCS12/100)+K11*(1-1.5*SCS11/12*SCS12/100))/100
E37: (P1) (+L10*(1.5*SCS11/12*SCS12/100)+L11*(1-1.5*SCS11/12*SCS12/100))/100
F37: (P1) (+M10*(1.5*SCS11/12*SCS12/100)+M11*(1-1.5*SCS11/12*SCS12/100))/100
Y37: 'mort.>w
Z37: U 2
B38: [W23] 'number of lambs born:
C38: (F0) [W11] +C9*12/C11*C39
D38: 'per year
B39: [W23] 'average litter size:
C39: (F2) [W11] (C37+2*D37+3*E37+4*F37)
B40: [W23] 'average birth weight:
C40: (F2) [W11] (C37*J15+2*D37*K15+3*E37*L15+4*F37*M15)/(J10+2*K10+3*L10+4*M10)*100
D40: 'kg
B42: [W23] 'number of lambs weaned:
C42: (F0) [W11] +C9*12/C11*(C37*J13+2*D37*K13+3*E37*L13+4*F37*M13)/100
D42: 'per year
B43: [W23] 'average weaning weight:
C43: (F2) [W11] (1*C37*J13*((C20*J14)/1000*C14+J15)+2*D37*K13*((K14*C20)/1000*C14+K15)+3*E37*L13*((L14*C20)/1000*C14+L15)+
     4*F37*M13*((M14*C20)/1000*C14+M15))/(C37*J13+2*D37*J14+3*E37*J15+4*F37*J16)
D43: 'kg
B44: [W23] 'pre weaning mortality:
C44: (F2) [W11] (100-(C42/C38*100))*C21
D44: '%
B45: [W23] 'pre weaning growth:
C45: (F0) [W11] (C43-C40)/C14*1000
D45: 'g/day
B47: [W23] 'weight at selling:
C47: (F2) [W11] @IF((+C43+((C20*L17)/1000)*(30*C15-C14))>(K5+K6)/2,(K5+K6)/2,(C43+((C20*L17)/1000)*(30*C15-C14)))
D47: 'kg
B48: [W23] 'post weaning mortality:
C48: [W11] (1-C50/C42)*100
D48: '%
B49: [W23] 'post weaning growth:
C49: (F0) [W11] ((C47-C43)/(C15*30-C14))*1000
D49: 'g/day
B50: [W23] '# surviving lambs:
C50: (F0) [W11] +C42*(100-(L18*C21)*(C15-C14/30))/100
D50: 'per year
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B51: [W23] '# sold lambs:
C51: (F0) [W11] +C50-C52
D51: 'per year
B52: [W23] '# sold ewes:
C52: (F0) [W11] +C12/100*C9
D52: 'per year
A54: [W3] 'ECONOMIC RESULTS
B56: [W23] 'TOTAL FLOCK PER YEAR
B57: [W23] 'Gross income:
D57: (F0) +C27*C47*C51+C26*C52*K5
E57: 'Rp
B59: [W23] 'Costs:
B60: [W23] '- barn costs:
D60: (F0) +C28*((C30*0.01+1)^C29*(C30*0.01))/((C30*0.01+1)^C29-1)
E60: 'Rp
B61: [W23] '- labor: * cut fodder:
C61: (F0) [W11] (((C42+C50)/2)*((C15*30)-C14)*5*C5/2+(C9+C10)*5*C5*365)*C32
D61: 'Rp
B62: [W23] '              * grazing:
C62:  [W11]  @IF(C4="grazing"#AND#(C9+C10)<=50,365*4*500,@IF(C4="grazing"#AND#(C9+C10)>50,@INT((C9+C10)/50+1)*365*4*500,0))
D62: 'Rp
C63: [W11] 'Total:
D63: (F0) +C61+C62
E63: 'Rp
B64: [W23] '- concentrate:
D64: (F0) @IF(C18="yes",((C9*(K5*0.01)^(12/C11*L34)+(((C43+C47)/2)*0.01*(C15*30-C14))*((C50+C42)/2))*C31),0)
E64: 'Rp
B65: [W23] '- anthelmintics:
D65: (F0) @IF(C19="yes",((C9+C10)*4+C42*@INT(C15/3))*C33,0)
E65: 'Rp
C66: [W11] 'Tot. costs:
D66: (F0) +D60+D63+D64+D65
E66: 'Rp
B68: [W23] 'Net profit:
D68: (F0) +D57-D66
E68: 'Rp per year
B69: [W23] 'Net profit:
D69: (F0) +D68/12
E69: 'Rp per month
B71: [W23] 'Return to labor and management:
D71: (F0) +D57-D60-D64-D65
E71: 'Rp per year
B72: [W23] 'Return to labor and management:
D72: (F0) +D71/12
E72: 'Rp per month
B73: [W23] 'Return to labor and management:
D73: (F0) +D71/C9
E73: 'Rp per adult ewe
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