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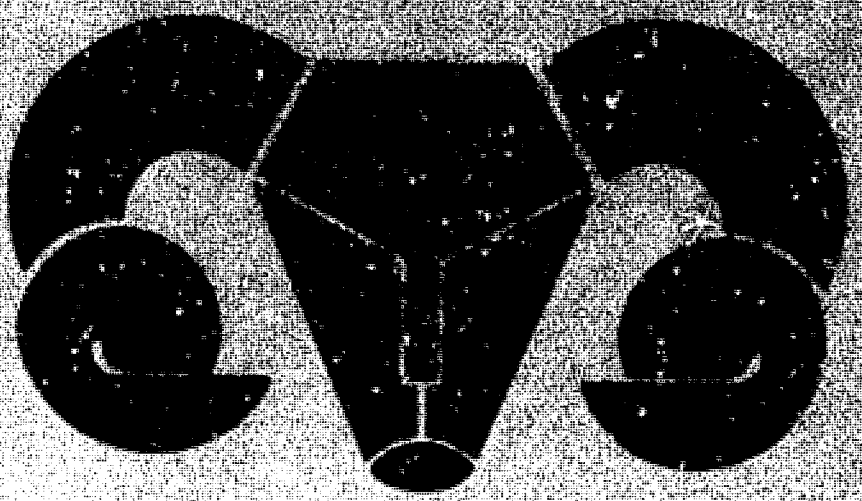
New Technologies for Small Ruminant Production in Indonesia



A publication of the
Small Ruminant-Collaborative Research Support Program
and
Research Institute for Animal Production
Central Research Institute for Animal Science
Agency for Agricultural Research and Development
Indonesian Ministry of Agriculture

Winrock International
Institute for Agricultural Development
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Winrock International Institute for Agricultural Development
September 1992

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Foreword

For more than 10 years the Research Institute for Animal Production, the Central Research Institute for Animal Science and the Agency for Agricultural Research and Development in Indonesia have conducted research with scientists of the Small Ruminant Collaborative Research Support Program, a USAID funded project. Both biological and social aspects of small ruminant production were investigated.

Indonesian scientists worked closely with researchers from the University of California at Davis to study breeding and genetics of tropical sheep and goats. Animal nutrition scientists collaborated with researchers at North Carolina State University at Raleigh. The University of Missouri at Columbia joined Indonesian sociologists and Winrock International in research relating to economics.

The goal of the project was to learn more about small ruminant production in the tropics. Since the inception of the program in 1978, a tremendous amount of useful information has been generated; much of it has been published in scientific journals within Indonesia and in international journals.

This publication presents a summary of the most important findings of research on small ruminants in the tropics and hopefully provides a valuable source of information to other researchers as well as agribusiness enterprises.

The first section describes the general setting of small ruminant production in Indonesia. Using a farming-systems approach, livestock production is described in terms of household participation and contribution to household income. This is followed by two articles presenting basic information on tropical small ruminant production.

The second section gives detailed accounts of feeding techniques. The most important nutrition trials conducted on-station are presented. Tables of estimates of daily energy and protein requirements for tropical sheep, as well as nutritional contents of various feedstuffs are important sources of information for other researchers, and, hopefully also, for agribusiness enterprises. The commercial value of research in feeding techniques is immense and already has proved critical to large scale sheep production enterprises in Java and North Sumatra.

The third section presents research in breeding techniques. Methods for reducing preweaning mortality rates are described which will greatly improve a flock's productivity. An important finding is that the high prolificacy in Javanese sheep is probably controlled by a single gene. Managing prolificacy is important to maximize output for given resources. A breeding program with a nucleus flock is described which has potentially high commercial value.

The fourth and final section describes research findings in socioeconomics. Facto affecting prices are analyzed. Marketing agents and channels of small ruminants described and found to work well. Two articles discuss formats of technology transfer and systems of information dissemination. These insights can provide policymakers with methods of designing extension packages with a high degree adoption.

I would like to take this opportunity to thank all those who contributed to the program during the last decade. In particular I would like to thank the Indonesia institutions and scientists for making the commitment to research of small rumin in the tropics: Dr. M. Sabrani, Dr. A. Djajanegara, Dr. T. D. Soedjana, Dr. Suband Dr. M. Rangkuti; their American counterparts, Dr. G. E. Bradford, Dr. K. Pond, D F. Nolan, Dr. H. C. Knipscheer as well as the resident scientists, Dr. L. C. Iniguez, R. Gatenby and Dr. P. Ludgate who together with Dr. S. Scholz edited the papers finally, thanks to Cami Sims who edited the text for grammar and language. A v special thanks to Barbara Scott and Winrock International for their dedication to publication.

– Dr. P. Sitorus
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May 1992

The General Setting

Social Structure of Small-ruminant Farm Families and Production Techniques in Java

Sri Wayhuni, Agus Suparyanto,
I. W. Mathius and Dwi Priyanto

Abstract

An analysis of small-ruminant production systems in Indonesia revealed that all family members participate in maintenance, management, and breeding activities. Based on these findings technology changes must accommodate the family structure if adoption rates are to remain high. Practices for raising small ruminants in Java are described. To increase productivity management of zero-grazing techniques needs to be improved. Animal barns and feeding practices are evaluated and recommendations are presented.

Introduction

Several research studies have pointed out that small-ruminant production enterprises are suitable for densely populated areas where landholdings are declining. The animals are easy to care for and eat forage collected from marginal land (Knipscheer, DeBoer, and Soedjana, 1983; Sajogyo, 1984; Vink, 1984). Furthermore, sheep and goat husbandry is a low risk investment compared to that of buffalo or cattle. In West Java about 20% of the 550,910 households maintain sheep and goats.

Raising small ruminants in Indonesian villages serves several objectives in the farming system. Therefore, changes in one production component affect others, and the introduction of new technologies must take this interaction into account. Smallholders prefer small ruminants because they have short reproduction intervals, are prolific, require low investment, and have a ready market. Sheep and goats can convert agricultural by-products and forages from marginal land into valuable meat. Meat is an important source of protein for the Indonesian population. To keep up with the population expansion, sheep production should increase 3% annually. An increase in sheep production can be gained from improved management techniques described in this paper and throughout the book.

Summary of Research Findings

Family participation and woman's role

In Java all members of the family are involved in livestock production activities. Almost half (46%) of such activities are undertaken by women (Sabrani, Mawi, Soedjana, and Knipscheer, 1982). Sons contribute 41% and daughters 12%.

The extent of women's role in small ruminant production is still debated. There is a significant difference in perception between men and women regarding participation and decision making in small-ruminant production. The women's participation in decision making, as reported by men, is markedly lower than the women's participation as reported by women. Husband and wife were in total disagreement for most of the questions asked (Wahyuni, Knipscheer and Gaylord, 1985). Interestingly, this study found that in a Spearman correlation test, the correlation between the ranking by wives and husbands was significant. This indicates that in spite of the large difference in perception between husbands and wives, if a wife rated her role in decision making highly relative to the other wives, then her husband was likely to rate her participation in decision making highly relative to other husbands.

Women's role in small-ruminant production activities is determined by her socioeconomic status. In poorer households the woman is more involved in managing livestock. Poorer women worked for up to 2.5 hours per day collecting forage. Women from better-off households collect no forage and are less likely to participate in animal breeding activities. Poorer women also take greater care in instructing their children in various animal production processes (Wahyuni and Gatenby, 1985).

Information exchange

The most important source of information for livestock raising activities comes from relatives of the family (Wahyuni and Gatenby, 1985). Issues in breeding, disease, feed and maintenance are discussed. Village leaders, thought to be knowledgeable in general, are frequently used as a source of information in livestock raising activities.

In Java, several extension agencies exist: Livestock Extension Agents (KCD), Agricultural Extension Services (PPL), Rural Credit Project (RCP) and the Small Ruminant-Collaborative Research Support Program (SR-CRSP). These agencies have worked together in providing information on sheep production.

Animal management and ownership

Most sheep are raised in barns under a cut-and-carry or zero-grazing system. The sheep are fed two or three times a day and are rarely tethered in the yard (Mulyadi, Knipscheer, and Mathius, 1984).

Ownership of animals depends on the socioeconomic status of the farmer. Wealthier farmers tend to own all the animals in the barn; farmers with fewer resources share animals in a single barn (the *gaduhan* system or the *Sumba contract* system). Sabrani, Sitorus, Rangkuti, Subandriyo, Mathius, Soedjana, and Semali (1982) reported that 60% of the sheep studied had a single owner and 40% were shared.

Animal barns and environment

Providing a shelter for the animals is one of the most important components in livestock production. The shelter protects the animals from predators, heat, wind, and rain. Keeping animals in a barn also prevents their destroying crops and other plants, helps control disease, and helps manage mating and parturition (Gatenby, Martawidjaja, Handayani, and Waldron, 1985).

Because of climatic conditions, topography and production objectives of the farmers, barn designs and construction vary from location to location. In Garut and throughout most of West Java, animal barns are of the raised-floor type. In a recent study from Wanaraja (a subdistrict of Garut), Suparyanto and Mathius (1990) reported that they found 98% of the barns in good condition. Animal density in barns was 1.5 head/m^2 which translates into .66 m^2/animal thus conforming to suggestions made by Gatenby (1985).

The climate in West Java is considered favorable for hair sheep production (Martawidjaja, Gatenby, and Handayani, 1985). The average temperature in the Garut area is 22.2° C with a humidity level of 80%. In the dry season, between June and September, the temperature averages 0.5° C higner. Garut has an annual rainfall of 2,160 mm. During the dry season, monthly rainfall averages 60 mm.

Feeding practice

Feed resources are the major constraint in increasing sheep production in Java. Because feed is collected on the farm, feed availability is determined by farm size (Sabrani et al., 1982). About 30% of feed came from off-farm sources, usually bartered with products or services.

In general, the main forages are native grasses (Van Eys, Mathius, Rangkuti, and Johnson, 1983; Mathius, 1989). Nutritional value and composition of native grasses vary. Some of the major species of grasses suitable for sheep feed are *Cynodon dactylon, Ischaemum limorense, Equisetum debile, Synderella rodiflora,* and *Portulaca oleracea.*

In addition to grasses, farmers also provide tree leaves and agricultural by-products as feed supplements. The most popular tree leaves are bananas and mangos but *kembang sepatu* and jack fruit are also suitable. Agricultural by-products include rice and bean straw, cassava leaves, and corn leaves. The sheep diet in Garut consists of 81% native grasses, 8% leaves, 9% agricultural by-products, and 2% shrubs.

One way to measure adequate amounts of feed is to weigh forage that is dried and calculate the ratio of dry matter to animal body weight. For instance if dry matter weighs 1 kg and the animal 20 kg, the ratio is 0.05 or 5%. In Indonesia the average amount of feed offered is 5.7% of the animal's body weight. This amount is much higher than the 3% recommended by the American National Research Council (NRC). Offering more feed than the animal needs results in wasted feed. On the other hand, if forage is of low quality, larger than recommended amounts need to be offered. In Java, much of the forage is low-quality because it contains large stems, which the animals do not eat. Because large stems develop when the forage matures, cutting forage at a younger stage would result in fewer stems. Consequently, the animals could eat all parts of the feed offered.

To summarize, smaller amounts of feed are necessary when offering higher-quality feed. To get a high-quality feed, farmers should cut grassy forage every 3 weeks rather than the conventional 4 to 5 weeks. Feeding smaller amounts of high-quality forage would result in better fed animals and overall increased productivity.

Production and reproduction performance

Animal productivity is determined by genetic and environmental factors. Twin births and triplets are common in the Javanese Thin-tailed (JTT) sheep. A single gene in the JTT sheep is believed to be responsible for the number of ova shed. The average litter size is 1.7 lambs per parturition. However, mortality rate is high, especially among triplets and quadruplets (Subandriyo, 1985).

A ewe's annual productivity is measured by both the number of lambs born and the total weight of lambs weaned. On average, the lambs studied weigh 2.7 kg at birth, 5.7 kg at 30 days, and 8.7 kg at 60 days. At weaning (usually at 90 days), average weight was 11.3 kg. With 1.5 litters per year and 1.7 lambs per parturition the average weight of lambs weaned for JTT is 28.8 kg.

Conclusion

In Java, the whole family participates in traditional livestock production. Perception of the role of women in livestock production differs between men and women. Nonetheless, there is some agreement of relative importance of contribution of women in livestock production. A difference of women's role according to socioeconomic status has been found. Poorer women spend more time in livestock raising and are more involved in teaching their children about crops and livestock. Related family members are the most important source of information of raising animals.

To increase sheep productivity in the Javanese villages, feed resources should be improved by cutting forage at an earlier stage of growth. Providing high-quality

forages to pregnant and lactating ewes will increase the weight of lambs and reduce their mortality rate. This practice will increase overall output in terms of total kilograms of meat produced annually.

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Reproductive Development and Performance of Small Ruminants in Indonesia

I-Ketut Sutama

Abstract

Surveys on small ruminant flock composition showed that sex ratios are sufficient for highly productive flocks. Puberty of sheep and goats is reached at 6 to 8 months and 7 to 10 months respectively. Lambing intervals can be shortened to increase overall productivity.

Introduction

Most of the sheep and goats in Indonesia are raised on the most populated island of Java, where grazing is limited and animals are usually kept under a total-confinement management system (cut-and-carry or zero-grazing). A wide variation in reproductive efficiency exists among farms with similar resources. This variation is because of differences in management.

In Indonesia, small ruminant production takes place primarily on small farms, where sheep and goats are managed in a traditional system. The productivity of these animals is generally low. Chaniago, Obst, and Boyes (1982) reported growth rates ranging from 20 g/day to 40 g/day, and Bell, Inounu, Tiesnamurti, and Subandriyo (1983) reported that one lamb per ewe is weaned each year on farms. Improved nutrition through supplementary feeding with concentrates can increase growth rates (Sutama, Fletcher, and Edey, 1985).

Indonesian sheep and goats are prolific, but the mortality rate of preweaned lambs and kids can be as high as 40% to 50% (Bell et al., 1983; Obst, Boyes, and Chaniago, 1982). The high mortality rate indicates the existence of nongenetic factors that influence the productivity of these animals.

Summary of Findings

Flock size and gender ratio

A survey of the sheep population in several villages in West Java (Bell et al., 1983) showed that on average there is one ram per seven ewes, many more than commonly found in western countries. In Java, an average farm raises two to ten animals. In North Sumatra the averages are 4.7 sheep and 5.0 goats. The distribution per farm of goats and sheep by age and gender in both Java and Sumatra is provided in table 1.

Table 1. Distribution per farm of goats and sheep by age and gender in Java and North Sumatra.

	Java		Sumatra	
Age and gender	Goats	Sheep	Goats	Sheep
Mature males	0.5	0.7	0.5	0.9
Mature females	1.3	2.2	2.0	2.1
Young weaned	1.3	0.6	1.3	0.8
Suckling		0.5	1.2	1.1
Total	3.1	4.0	5.0	4.7

Sources: Soedjana and Knipscheer, 1983; Pulungan, Reese, Van Eys, and Johnson, 1985.

Because the average flock size is small, keeping a ram on every farm is not efficient. But if farmers do not own their own rams, they must rely on their ability to detect estrus and arrange to borrow a ram for mating. Farmers can detect estrus more easily when rams are within sight, smell, and sound of ewes. To attain maximum productivity of small flocks, farmers need access to a ram at the right time. Farmers can have one ram on each farm or share a ram among two or three neighboring farmers. The same recommendations apply to goats.

Puberty

Puberty is defined as the time when reproduction first becomes possible. In the male, puberty occurs when spermatozoa are first produced, the male exhibits sexual behavior, and the development of the penis allows intromission and ejaculation. In the female, puberty is reached when estrus and ovulation occur concurrently and the young female is able to sustain a pregnancy.

Puberty in both goats and sheep is influenced by breed, nutritional status, and season of birth (for temperate areas). In Indonesia, puberty is reached at 6 to 8 months for sheep and 7 to 10 months for goats. Body weight can also be an indicator. For male Javanese Thin-tailed (JTT) sheep, puberty is reached at a body weight of 14.5 kg to 18.9 kg. For female JTT sheep, puberty occurs at a body weight of 16.8 kg to 24 kg. Type of birth, regardless of weight, does not seem to influence the onset of puberty in JTT sheep. But because ewe lambs born as singles have higher birth weights, they reach puberty earlier than twins (Sutama, 1990). Estimates of the percentage of mature body weight required for the onset of puberty vary. For example, weight at puberty of JTT sheep ranges from 38% to 60% of the mature body weight (Sutama, Edey, Fletcher, 1988). No data is available for goats.

Puberty is also influenced by growth rate. Slow growth rates during rearing (caused by limited or poor-quality feed) delay the onset of puberty, and accelerated growth rates advance the onset of puberty (Sutama et al., 1985 and 1988). In temperate zones,

sheep born in the spring reach puberty earlier than those born during summer or autumn (Mallampati, Pope, and Casida, 1971; Foster, 1981); however, no difference exists in the tropics where breeding occurs throughout the year.

For females, the introduction of a male following a period of total isolation can, in some cases, accelerate the onset of puberty (the ram effect). The ram effect induces puberty only if females are already close to normal pubertal weight.

Sexual behavior

Sexual behavior determines productivity somewhat. For example, the ewe's response contributes to the ram's level of sexual arousal necessary for successful mating.

Sexual behavior begins before puberty and is expressed by mounting. This behavior is called *play activity* and is more pronounced in males than in females. The young female does not usually initiate contact but may accept services if a male makes sexual advances (Dyrmundsson, 1973), whereas many mature ewes and does approach males directly.

Sexual behavior of ewes includes tail-fanning and turning of her head toward the ram as he approaches, sometimes leading to circling as the ewe moves around in an attempt to nuzzle the ram. Reports of sexual behavior of sheep in temperate zones showed that 14% of ewe lambs did not show tail-fanning and 40% did not turn their heads toward the ram when the latter made sexual approaches (Edey, Kilgour, and Bremner, 1978).

Rearing management also influences the sexual development of young animals. For example, raising ram lambs in a monosexual group adversely affects their sexual development. Ram lambs reared individually for as long as 150 days exhibit earlier courtship, mounting, and service behavior than those reared as a group.

Lambing/kidding performance

Important aspects of sheep productivity are lambing intervals, ovulation, litter size, and birth and weaning weights.

Lambing. Biologically, three lambings in 2 years is considered good for hair sheep, which implies a lambing interval of 240 days. In Indonesia, longer lambing intervals are common. Ewes with previous multiple births have longer lambing intervals than those which previously had a single lamb. The longer interval is associated with post-partum body condition, but supplementary feeding of ewes during pre- and post-partum can shorten the interval between parturition and subsequent conception.

Ovulation rate and litter size. The average ovulation rate of JTT sheep is 2.05, which is higher than that of Javanese Fat-tailed (JFT) sheep (1.92). Sitorus, Subandriyo, and Inounu (1985) reported that the average litter size at first lambing of JTT is 1.6, and 1.9

and 2.2 in the second and third lambings. Repeatability of litter size is relatively high (0.35), indicating that genetic improvement for litter size in Indonesian sheep is possible (Bradford, Quirke, Sitorus, Inounu, Tiesnamurti, Bell, Fletcher, and Torell, 1986). Additionally, improved feeding before mating can increase litter size slightly (Chaniago et al., 1982).

Indonesian sheep and goats are prolific even though they have small bodies. The incidence of multiple births is high. For sheep, twins occur in 27% to 46% of all lambings and triplets in 3.2% to 14% (see table 2). The Priangan sheep appear more prolific than the JTT and JFT breeds. However, the figures are not as high as those for prolific temperate breeds such as the Finnish Landrace and Booroola. In another study, Mason (1980) reported that the number of lambs born per ewe per year was approximately 1.89, 2.27, and 2.34 for JTT, JFT, and Priangan respectively with 7- to 8-month lambing intervals.

For goats, Subandriyo, Setiodi, and Sitorus (1986) reported that Kacang goats have an ovulation rate of 1.68 compared to 1.50 for Ettawah crosses with average litter sizes of 1.56 kids and 1.43 kids, respectively. Setiadi and Sitorus (1986) found twins in 52.5% of Kacang lambings and 31% of the Ettawah crosses.

Table 2. Prolificacy of goats and sheep in Indonesia.

Breed	Birth type (%)				Average litter size
	Single	Twin	Triplet	Quad	
Goats					
Kacang	43.5	52.5	4.0		1.64
Ettawah crosses	62.9	31.1	6.0		1.60
Sheep					
Javanese Thin-tail	68.9	27.7	3.2	0.2	1.33
Javanese Fat-tail	54.4	35.6	8.7	1.3	1.57
Priangan	37.4	46.0	14.3	2.3	1.82

Sources: Bradford et al., 1986; Chaniago et al., 1982.

Birth and weaning weights. At an Indonesian research station, birth weight ranged from 1.5 kg to 2.1 kg for sheep and 1.3 kg to 3.1 kg for goats. Weaning weight ranged from 5.9 kg to 9.7 kg for sheep and 4 kg to 10.2 kg for goats. Preweaning growth rates averaged 86 g/day for sheep and 80 g/day for goats (see table 3).

Table 3. Average birth and weaning weights and pre-weaning growth rates of sheep and goats on an Indonesian research station.

	Birth weight (kg)	Weaning weight (kg)	Preweaning growth rates (g/day)
Sheep			
Javanese Thin-tail	1.8	7.8	85
Javanese Fat-tail	1.7	8.3	87
Priangan	1.8	7.8	
Goats			
Kacang	1.6	6.5	80
Ettawah cross	2.6	7.3	81

Source: Sutama et al., 1985.

The birth weight of lambs increases as the ewe gets older. Nutritional status of ewes, particularly during the last term of pregnancy, also influences birth weight (Sutama et al., 1985).

Productivity can be improved by keeping perinatal mortality as low as possible. In JTT sheep, preweaning mortality ranged between 4% and 55% and more than half of the deaths occurred during the first 3 days of life (Obst et al., 1982; Soedjana and Knipscheer, 1982; Sutama et al., 1988). Low birth weight, which resulted in the lambs' inability to suckle during the critical first day of life, was the main cause of death.

Lifetime ewe performance

Lifetime ewe performance is another factor of productivity. Productivity of does and ewes increases with age up to a certain point. The increase in productivity is associated with an increase in body weight (table 4). Nutrient requirements increase as the animals become heavier.

Table 4. Effect of age and weight on litter size.

Age (year)	Mating weight (kg)	Litter size (avg. no. of lambs)
1	19.3	1.3
2	21.7	1.4
3	23.8	1.5
4	25.3	1.6

Source: Subandriyo, 1985.

In Javanese villages, productivity of sheep is around 27%, which is less than their potential of 110% (see table 5). The table shows the differences between actual and potential productive and reproductive performances of the discussed criteria for productivity. The use of proper selection programs and improved general management practices would enhance overall productivity.

Table 5. Actual and potential level of productive and reproductive performance of sheep in Indonesia.

	Actual[a]	Potential[b]	Ratio
Litter size	1.4	1.8	0.78
Lambing interval (days)	520	240	0.46
Age first lambing (days)	500	420	0.84
Survival to 90 days (%)	74	85	0.87
Preweaning growth (g/day)	67	100	0.67
Weaning weight (kg)	8.3	12.0	0.69
Weaning rate per year	0.73	2.32	0.31
Productivity per year (%)	27	110	0.25

Source: Gatenby et al., 1988.
[a] information from villages.
[b] from data obtained on research stations.

Conclusion

Several management areas can be addressed to improve productivity of sheep and goats in Indonesia. Flock size determines, at least to some extent, the availability of a ram. Although the presence of a ram in each flock is not necessary for high productivity, in the absence of good skills to detect estrus, a ram in each flock is best. An earlier onset of puberty, resulting from better nutrition of lambs, can also improve productivity. Sexual behavior by both male and female animals assures successful mating. Lambing performance is perhaps the most obvious sign of productivity. Better management can reduce lambing interval and preweaning mortality rates.

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Barn Design for Small-ruminant Production

Muchji Martawidjaja

Abstract

A well designed, constructed, and maintained barn contributes to small-ruminant productivity in the tropics. Separating animals in the barn by physiological status allows for differing feeding management, which improves productivity.

Introduction

In West Java, sheep and goats are kept in small, raised barns. The main reason for the cut-and-carry practice is land pressure prevalent in Java, which has a population density of almost 600 persons per square kilometer. Raising small ruminants in zero-grazing sheds protects animals from weather, provides security from theft, and reduces health problems.

Research in barn design has focused on building cool and dry areas that are easily kept clean, minimize draft, and allow farmers to separate animals (Gatenby, 1985).

Summary of Findings

Barn types

There are two types of barn constructions: those with walkways in the center and those without. Barns without walkways make moving animals more difficult.

The barn should have several movable divisions. This lets farmers separate animals according to physiological status (such as age and estrous cycle). Separation allows different feeding schedules for pregnant ewes, lactating ewes, and lambs. Pregnant ewes can give birth and take care of their lambs under less stressful conditions. Isolating sick animals is desirable and is possible in barns with movable interior walls.

Movable walls are ideal to accommodate the flock's needs at different stages. Interior walls should be 70 cm to 80 cm high.

Separating animals by physiological status

The amount of space needed for each animal varies. Adults require more space than young animals. Lactating females and their young require more space than single adults (see table 1).

Table 1. Recommended barn area sizes for animals.

	Age (months)	Barn area (m^2)
Adult male	12	1.20
Adult female	12	1.00
Lactating female		1.00[a]
Weaned male/female	3-7	.50
Young male/female	7-12	.75

[a] Add .05 m for each lamb/kid.

If the barn area is limited, separating adult males individually, young males in groups of two or three, and pregnant females in groups of two or three is recommended.

Regulating social dominance among small ruminants is important and separating groups most affected by aggression is necessary. Separation is especially important for young rams/bucks, adult rams/bucks, and pregnant ewes/does.

Furthermore, lack of separation causes inbreeding, which leads to reduced productive performance and genetic defects in the next generation.

Barn construction considerations

Location. Trees and buildings near the barn affect air movement around and through the barn. When choosing a location, make sure some air movement exists in the area. Tall trees that shade the roof help to keep the barn cool and short vegetation surrounding the barn is cooler than concrete. The orientation of the barn (north, south, east, or west) has little effect on the temperature inside the barn. The barn should be on a well-drained site that slopes away on all sides.

Roof. The roof protects the animals from direct sunlight and rain. The roof should be well insulated so that the undersurface remains cool. For example, a barn with a tin roof can be made cooler if a layer of insulation (thatch) is put beneath the tin. Thatch and tile roofs allow air movement, which keeps the barn cool. An open apex roof also allows air movement, but does not provide enough protection from heavy rain in the wet tropics. A high roof is cooler than a low roof, but is more likely to be damaged by strong winds. Similarly, a long overhang protects against the sun and rain, but can be damaged easily. The steeper the roof, the more stable it is in the wind and the less

likely it is to leak. The roof is probably the most important part of a barn in hot countries. Protecting animals from rain reduces body heat loss and thus prevents cold stress.

Walls. Most barns in the tropics have open walls to allow air movement. Ventilation removes heat, water vapor, and pollutants. In open-sided buildings, some form of wall (such as wire netting, bamboo slats, or wooden rails) is necessary to confine the animals and maintain security. In many open-sided barns in Indonesia, one or more walls are closed with plastic sacking to keep the animals dry during heavy rains and protect them from drafts.

Floors. Unless the floor is raised substantially (half a meter) and slatted, it has little effect on the thermal environment. Slats encourage air movement, and, therefore, have an effect similar to the open walls. The design of the floor is important to prevent disease. Floors must allow easy exit of feces and urine because a moist floor allows pathogenic microorganisms to spread. Drainage away from the barn is essential because the amount of manure produced is considerable. The separation of floor slats of 15 mm to 25 mm is recommended. Slats farther apart can cause foot injury, especially to kids and lambs.

Feed trough. The roof should protect the feeding trough from rain and sun. The trough must be low enough to let young animals feed but not so low to let the animals walk on the feed and contaminate it. The entire feed trough should be cleaned out every day. Uneaten food should not build up on the bottom of the feed trough where it will decompose. Clean troughs are essential to prevent many diseases.

Manure pit. A pit under the barn collects feces, urine, and feed refusals that fall through the floor. Usually, uneaten grasses are thrown into the manure pit temporarily and moved later to a special compost area or spread directly on the crops. The pit is slightly smaller than the floor area of the barn. The pit should be approximately 35 cm to 50 cm deep with an earth ridge around the top to prevent rain water from filling the pit.

Economics. A barn built of traditional material, such as bamboo and thatch, can be as good as one built from expensive materials such as concrete, even in the long run. Furthermore, a barn built from traditional material can easily be expanded or disassembled to accomodate the size of the flock, which might fluctuate according to farmer's need, forage availability and seasonal demand.

Maintaining a healthy environment

Poor sanitation leads to death of animals and reduced productivity. Maintaining a clean barn is therefore essential to a healthy flock. Barns should be cleaned twice a week, including the removal of manure from under the barn and the removal of feces from inside the barn. Clean water and fresh forage every day is essential to proper maintenance.

Conclusion

Barns are an important component in sheep and goat production in Java. A well designed and properly maintained barn facilitates good management and contributes to productivity.

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Feeding Techniques

Energy and Protein Requirements for Small Ruminants in the Humid Tropics

Budi Haryanto and Andi Djajanegara

Abstract

Nutrient requirements are established for temperate breeds of sheep and goats, but little research has been conducted under tropical conditions to determine requirements for tropical sheep and goats. In this paper, results for sheep and goats from several studies in Indonesia using local feeds and feeding conditions are reported. Data was compiled to estimate energy and protein requirements for Indonesian sheep and goats. Results demonstrate that tropical sheep and goats have higher requirements than temperate animals.

Introduction

Several experiments have been conducted at the Research Institute for Animal Production (RIAP) in collaboration with the USAID Small Ruminant Collaborative Research Support Program (SR-CRSP) since 1981. This paper reviews the results of those nutrition experiments and synthesizes the information about energy and protein requirements for sheep and goats under local conditions. In addition, requirements for calcium and phosphorus and requirements for gestating and lactating animals are presented.

Summary of Findings

Data description

The data was derived from 13 experiments involving 74 treatment combinations.[1] Data from intake and digestibility studies for dry matter, neutral detergent fiber (NDF), crude protein (N x 6.25), and daily weight gain were used to calculate energy and protein requirements.

The sheep ranged in weight from 10 kg to 22 kg (average = 17 kg), and goats were 10 kg to 21 kg (average = 14 kg). Sheep ate an average of 608 g/day while goats consumed 460 g/day.

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[1] Haryanto and Johnson, 1988; Mathius and Van Eys, 1983; Mathius, Van Eys, Pulungan, and Rangkuti, 1985; Mathius, Van Eys, and Pulungan, 1985; Prabowo, Van Eys, Mathius, Rangkuti, and Johnson, 1984; Pulungan, Van Eys, and Rangkuti, 1985; Rangkuti, Pulungan, and Van Eys, 1985; Sitorus, 1985; Sitorus, Van Eys, and Pulungan, 1985; Sitorus, Pongsapan, Van Eys, Manurung, and Gatenby, 1986.

The metabolizable energy (ME) content of the feed was estimated as a function of fiber content using the Moir (1974) equation:

$$ME = 4.718 - (0.033 \times NDF) \quad (1)$$

Intake of digestible energy (DE) was calculated using the equation:

$$ME = 0.82\ DE \quad (2)$$

A regression analysis was conducted between weight gain (g/day) and intake of either ME or protein to estimate the energy and protein requirements for maintenance.

Energy requirements

Not all energy in feeds is available to the animal to meet its requirements. Some of the energy ends up in the feces and urine, and some energy is lost as heat and gas during the digestion process. Digestible energy (DE) is energy that is not lost in the feces (and is presumed to be digested). Metabolizable energy (ME) is an estimate of feed energy that would be available for metabolism; it is a smaller value than DE because it accounts for losses in feces, urine, and gas.

Animals need energy to maintain basic activities such as breathing, walking, chewing, and swallowing. Energy necessary to support these processes is termed *maintenance energy*, and requirements for it must be met before an animal can grow or produce milk. Energy the animal consumes above the maintenance requirement is used for growth (production of meat), milk secretion, or fetal development. Energy requirements are affected by age, body size, growth rate, pregnancy, and lactation. Environmental conditions such as temperature, humidity, and wind velocity may also affect energy requirements.

The calorie is the most common unit used to measure and express energy values. Because animal energy requirements are high, energy is discussed in terms of kcals (thousands of calories) or mcals (1 mcal = 1,000 kcal).

The following multiple regression equations were derived to determine the energy requirements for Indonesian small ruminants:

$$ME = 0.1603 + 0.0663\ BW + 0.00797\ G \quad (3)$$

for sheep, and

$$ME = -0.6934 + 0.1311\ BW + 0.00158\ G \quad (4)$$

for goats, where BW is body weight (kg), and G is weight gain (g/day). Using these equations, requirements for sheep and goats at various daily gains were calculated (see tables 1 and 2).

Table 1. Estimates of daily energy and protein requirements for tropical sheep.

Body weight (kg)	Daily weight gain (g/day) 0	10	20	30	40	50	60	70	80	90	100
Digestible energy requirement (mcal/day)											
8	0.84	0.94	1.04	1.13	1.23	1.33	1.43	1.52	1.62	1.72	1.81
10	1.00	1.10	1.20	1.30	1.39	1.49	1.59	1.68	1.78	1.88	1.98
12	1.17	1.26	1.36	1.46	1.55	1.65	1.75	1.85	1.94	2.04	2.14
14	1.33	1.42	1.52	1.62	1.72	1.81	1.91	2.01	2.10	2.20	2.30
16	1.49	1.59	1.68	1.78	1.88	1.97	2.07	2.17	2.27	2.36	2.46
18	1.65	1.75	1.84	1.94	2.04	2.14	2.23	2.33	2.43	2.52	2.62
20	1.81	1.91	2.01	2.10	2.20	2.30	2.39	2.49	2.59	2.69	2.78
Metabolizable energy requirement (mcal/day)											
8	0.69	0.77	0.85	0.93	1.01	1.09	1.17	1.25	1.33	1.41	1.49
10	0.82	0.90	0.98	1.06	1.14	1.22	1.30	1.38	1.46	1.54	1.62
12	0.96	1.04	1.12	1.20	1.27	1.35	1.43	1.51	1.59	1.67	1.75
14	1.09	1.17	1.25	1.33	1.41	1.49	1.57	1.65	1.73	1.81	1.89
16	1.22	1.30	1.38	1.46	1.54	1.62	1.70	1.78	1.86	1.94	2.02
18	1.35	1.43	1.51	1.59	1.67	1.75	1.83	1.91	1.99	2.07	2.15
20	1.49	1.57	1.65	1.73	1.81	1.88	1.96	2.04	2.12	2.20	2.28
Crude protein requirement (g/day)											
8	38.05	43.86	49.66	55.46	61.27	67.07	72.88	78.68	84.48	90.29	96.09
10	44.57	50.48	56.28	62.08	67.89	73.69	79.50	85.30	91.10	96.91	102.71
12	51.29	57.09	62.90	68.70	74.51	80.31	86.11	91.92	97.72	103.53	109.33
14	57.91	63.71	69.52	75.32	81.12	86.93	92.73	98.54	104.34	110.15	115.95
16	64.53	70.33	76.14	81.94	87.75	93.55	99.35	105.16	110.96	116.77	122.57
18	71.15	76.95	82.76	88.56	94.37	100.17	105.97	111.78	117.58	123.39	129.19
20	77.77	83.57	89.38	95.18	100.99	106.79	112.59	118.40	124.20	130.01	135.81
Digestible protein requirement (g/day)											
8	8.12	11.87	15.61	19.36	23.11	26.85	30.60	34.34	38.09	41.84	45.58
10	16.49	20.24	23.98	27.73	31.48	35.22	38.97	42.71	46.46	50.21	53.95
12	24.86	28.61	32.35	36.10	39.85	43.59	47.34	51.08	54.83	58.58	62.32
14	33.23	36.98	40.73	44.47	48.22	51.96	55.71	59.46	63.20	66.95	70.69
16	41.60	45.35	49.10	52.84	56.59	60.33	64.08	67.83	71.57	75.32	79.06
18	49.97	53.72	57.47	61.21	64.96	68.70	72.45	76.20	79.94	83.69	87.43
20	58.35	62.09	65.84	69.58	73.33	77.07	80.82	84.57	88.31	92.06	95.80

Table 2. Estimates of daily energy and protein requirements for tropical goats.

Body weight (kg)	Daily weight gain (g/day) 0	10	20	30	40	50	60	70	80	90	100
Digestible energy requirement (mcal/day)											
8	0.43	0.45	0.47	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63
10	0 75	0.77	0.79	0.81	0.83	0.85	0.87	0.89	0.91	0.93	0.95
12	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27
14	1.39	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.55	1.57	1.59
16	1.71	1.73	1.75	1.77	1.79	1.81	1.83	1.85	1.87	1.89	1.91
18	2.03	2.05	2.07	2.09	2.11	2.13	2.15	2.17	2.19	2.21	2.23
20	2.35	2.37	2.39	2.41	2.43	2.45	2.47	2.49	2.51	2.53	2.55
Metabolizable energy requirement (mcal/day)											
8	0.36	0.37	0.39	0.40	0.42	0.43	0.45	0.47	0.48	0.50	0.51
10	0.62	0.63	0.65	0.66	0.68	0.70	0.71	0.73	0.74	0.76	0.78
12	0.88	0.90	0.91	0.93	0.94	0.96	0.97	0.99	1.01	1.02	1.04
14	1.14	1.16	1.17	1.19	1.21	1.22	1.24	1.25	1.27	1.28	1.30
16	1.40	1.42	1.44	1.45	1.47	1.48	1.50	1.51	1.53	1.55	1.56
18	1.67	1.68	1.70	1.71	1.73	1.75	1.76	1.78	1.79	1.81	1.82
20	1.93	1.94	1.96	1.98	1.99	2.01	2.02	2.04	2.05	2.07	2.09
Crude protein requirement (g/day)											
8	46.25	53.96	61.68	69.39	77.10	84.82	92.53	100.24	107.96	115.67	123.38
10	49.67	57.38	65.10	72.81	80.52	88.24	95.95	103.66	111.37	119.09	126.80
12	53.09	60.80	68.51	76.23	83.94	91.65	99.37	107.08	114.79	122.51	130.22
14	56.51	64.22	71.93	79.65	87.36	95.07	102.78	110.50	118.21	125.92	133.64
16	59.93	67.64	75.35	83.06	90.78	98.49	106.20	113.92	121.63	129.34	137.06
18	63.34	71.06	78.77	86.48	94.20	101.91	109.62	117.33	125.05	132.76	140.47
20	66.76	74.48	82.19	89.90	97.61	105.33	113.04	120.75	128.47	136.18	143.89
Digestible protein requirement (g/day)											
8	32.37	38.81	45.25	51.69	58.12	64.56	71.00	77.43	83.87	90.31	96.74
10	34.22	40.66	47.10	53.53	59.97	66.41	72.85	79.28	85.72	92.16	98.59
12	36.07	42.51	48.95	55.38	61.82	68.26	74.70	81.13	87.57	94.01	100.44
14	37.92	44.36	50.80	57.23	63.67	70.11	76.55	82.98	89.42	95.86	102.29
16	39.77	46.21	52.65	59.08	65.52	71.96	78.40	84.83	91.27	97.71	104.14
18	41.62	48.06	54.50	60.93	67.37	73.81	80.25	86.68	93.12	99.56	105.99
20	43.47	49.91	56.35	62.78	69.22	75.66	82.09	88.53	94.97	101.41	107.84

Protein requirements

Protein is necessary for maintenance, but it is especially important for growing, lactating, and pregnant animals. Protein is found in every tissue of the body and is a structural component of meat and milk. Protein cannot be measured directly, but it contains about 16% nitrogen. Since nitrogen is found almost exclusively in protein, we can measure nitrogen and multiply by 6.25 to estimate the protein content of the feed. As with energy, digestible protein is calculated by measuring the difference between the amount of protein fed and the amount of protein excreted.

The following multiple regression equations were derived to determine the protein requirements for Indonesian small ruminants:

$$CP = 11.5720 + 3.3099\ BW + 0.5804\ G \quad (5)$$

for sheep and

$$CP = 32.5781 + 1.7092\ BW + 0.7713\ G \quad (6)$$

for goats, where CP is intake of crude protein (g/day), BW is body weight (kg), and G is weight gain (g/day). Using these equations, requirements for sheep and goats at various daily gains are presented in tables 1 and 2.

Conclusion

The tables presented here should give more precise estimates of energy and protein requirements for sheep and goats raised in Indonesia. Because only a limited number of animals were used to derive the equations presented in this paper, additional studies should be conducted.

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Composition of Small-ruminant Feeds and Rations in Indonesia

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Abstract

The amount of energy, protein, and minerals found in commonly used feed is presented. The daily requirements of sheep and goats are presented along with sample diets for lactating and growing animals.

Introduction

Satisfying the nutrient requirements to meet a production goal requires knowledge of nutrient composition of feedstuffs. A feed composition table shows the value of the most important nutrients (energy, protein, calcium, and phosphorus). These values represent averages obtained from various experiments conducted in Indonesia. A complete database of feed compositions is maintained by the Indonesian Small Ruminant Network, Bogor, Indonesia.

Summary of Findings

Dry matter and as-fed amounts

The feed compositions listed in table 1 are reported from dry matter because there is a large variation in the water content. The percentage of dry matter (DM) in a feed is 100% minus the percentage of moisture in the feed, which is determined by drying the feedstuffs. To determine the amount of feed needed, producers must convert the data in the feed composition tables to an as-fed amount. To convert amounts of feed from a DM to an as-fed amount, divide the weight of feed by the DM content. For example, 277 g of rice bran DM would be 315 g of as-fed rice bran (277/.88). (Caution: This formula is for converting amounts only and will not work for percentages.)

Because palatability is not a factor that was considered when constructing feed composition tables, some experimentation with available feedstuffs may be necessary. If the animals are unable or unwilling to eat all the feed, they will gain less than predicted. On the other hand, if the animals eat more feed, they should gain more than anticipated. Values presented in this table are intended to be used as guidelines.

Table 1. Composition of feedstuffs for sheep and goats in Indonesia.

Name (description)	Dry matter (%)	Energy DE mcal/kg	ME mcal/kg	Protein CP (%)	DP (%)	Minerals Ca (%)	P (%)
Albazia falcata (Paraserianthes Falcataria)		-	-	18.7	13.6	1.56	0.03
Andropogon tinorensis (bluestem grass)	56	2.14	1.75	3.2	0.0	0.40	0.11
Arachis hypogaea (peanut leaves)		2.82	2.31	19.2	14.1	0.45	0.52
Arachis hypogaea (peanut seed hulls)	88	0.70	0.54	10.2	5.8	0.19	0.06
Arachis hypogaea (peanut stem)		2.20	1.80	7.1	3.0	0.88	0.28
Artocarpus integra, leaves		-	-	15.2	10.5	-	-
Brachiaria decumbeas (signal grass)	20	2.35	1.93	10.2	5.9	0.49	0.16
Caliandra callothyrsus, red leaves		2.74	2.25	27.8	22.0	1.49	0.77
Caliandra callothyrsus, red stems		2.47	2.02	19.4	14.3	1.62	0.33
Calopogonium spp		-	-	13.8	9.2	2.21	0.21
Calopogenium mucunoides		2.53	2.07	18.7	13.7	1.40	0.24
Calopogonium caerelium		2.50	2.05	18.1	13.1	1.68	0.28
Cocos nucifera (coconut oil cake)	91	3.48	2.86	21.2	16.0	0.20	0.40
Coffea spac (coffee seedhulls)	90	2.36	1.94	11.5	7.1	0.33	0.02
Daucus carota, leaves		2.16	1.77	20.0	14.9	0.06	0.65
Desmodium spp		2.41	1.98	11.6	7.1	0.65	0.13
Digitaria decumbens (pangola grass)	25	2.98	2.44	8.9	4.7	0.61	0.12
Elaeis guineensis (palm kernel cake)		2.64	2.17	18.2	13.2	1.36	0.55
Elaeis guineensis (palm oil cake)		2.95	2.42	22.5	17.1	0.31	0.65
Erythriue variegata		3.11	2.55	29.6	23.6	0.97	0.34
Gliricidia		2.80	2.29	23.6	18.2	2.35	0.35
Gliricidia sepium, stems		2.23	1.83	10.2	5.8	0.97	0.31
Glycine max (soybean meal, expeller)	90	4.14	3.39	46.4	39.5	0.30	0.65
Gypura procumleus		-	-	15.2	10.5	3.74	0.26
Hordeum vulgare (barley beer waste)		3.25	2.67	23.5	18.0	0.32	0.45
Imperata cylindrica		2.30	1.89	7.7	3.6	0.55	0.14
Leucaena leucocephala	31	2.63	2.18		13.7	2.50	0.30
Macademian nut cake		1.99	1.63	31.0	24.9	0.52	1.05
Manihot esculenta (cassava leaves)	25	3.22	2.64	26.3	20.6	1.73	0.42
Manihot esculenta (cassava root peelings)		2.59	2.12	12.0	7.5	0.64	0.36
Marquissa skin		2.31	1.90	8.0	3.9	0.20	0.14
Musa paradisiaca (banana leaves)		2.55	2.09	15.2	10.5	1.30	0.35
Musa paradisiaca (banana peelings)		2.98	2.44	6.5	2.4	0.21	0.42
Musa paradisiaca (banana petiole)		2.24	1.84	7.1	3.0	1.26	0.10
Musa paradisiaca (banana stems)		2.14	1.76	3.5	0.0	-	-
Native grasses	20	-	-	9.8	5.6	0.75	0.25

Table 1. Composition of feedstuffs for sheep and goats in Indonesia (continued).

Name (description)	Dry matter (%)	Energy DE mcal/kg	ME mcal/kg	Protein CP (%)	DP (%)	Minerals Ca (%)	P (%)
Oryza sativa (broken rice)	89	3.65	2.99	12.5	7.9	0.15	0.07
Oryza sativa (rice bran, first grade)	88	3.64	2.99	14.6	9.9	0.10	1.20
Oryza sativa (rice bran, second grade)		3.15	2.58	14.5	9.8	0.51	0.98
Panicum maximum (guinea grass)	22	2.30	1.89	9.4	5.2	0.99	0.23
Paspalum dilatatum		2.42	1.99	12.9	8.4	1.00	0.31
Pennisetum purpureum (napier grass)	20	2.40	1.97	10.8	6.4	0.69	0.26
Phaseolus radiatus		3.49	2.86	28.3	22.4	0.20	0.35
Phaseolus vulgaris, seed hulls		2.32	1.90	5.3	1.3	0.47	0.05
Psophocarpus tetragonolobus		4.60	3.77	39.0	32.2	-	0.56
Pueraria javanica (kudzu)	28	2.90	2.38	19.5	14.2	0.94	0.16
Raphanus sativus, leaves		2.79	2.28	16.2	11.3	5.67	0.57
Red bean hulls		-	-	18.1	13.1	1.11	0.39
Saccharum officinarum (sugarcane bagasse)	55	1.72	1.41	2.0	0.0	0.35	0.27
Saccharum officinarum (sugarcane)	70	3.35	2.75	2.4	0.0	1.15	0.19
Saccharum officinarum (sugarcane tops)		2.20	1.80	3.5	0.0	0.41	0.12
Sesamum orientale, seed hulls		-	-	50.7	42.9	0.40	0.64
Sesbania grandiflora, leaves		2.12	1.74	26.0	20.3	2.34	0.27
Setaria karangula	25	2.40	1.97	12.0	7.5	0.70	0.33
Setaria sphacelata	25	2.37	1.94	12.5	7.9	0.60	0.34
Solanum tuberosum, leaves		2.90	2.38	16.7	11.8	3.85	0.60
Sorghum bicolor, leaves		2.29	1.88	11.7	7.2	0.61	0.27
Sorghum bicolor, stems		2.23	1.83	7.6	3.5	0.63	0.26
Theobroma cacao, meat part of fruit		2.08	1.70	14.6	9.9	0.37	0.40
Triticum aestivum, wheat bran	89	3.30	2.71	18.7	13.6	0.13	1.38
Triticum aestivum, wheat sprouts		4.58	3.76	32.9	26.7	0.21	1.05
Zea mays, grain	88	3.72	3.05	11.1	6.6	0.02	0.35
Zea mays, leaves		2.56	2.10	15.8	11.0	0.89	0.33
Zea mays, stems		2.34	1.92	6.6	2.5	0.35	0.16

Source: Compiled from research at CRIAS and BPT, Bogor, Indonesia.
Similar research was conducted at Gadjah Mada University in Yogyakarta in 1980.

Potential diets for sheep and goats

Potential diets for sheep and goats reared in Indonesia are listed in table 2. Locally available feedstuffs, including by-products, can be used as supplements. Using the animal requirements and feed composition tables, one can formulate supplements to meet the specific needs of a producer.

Table 2. Sample diets for sheep and goats in Indonesia.

	Native grass	Broken rice	Cassava leaves	Total feed offered
Lactating 25 kg ewe or doe	630 (3150)	415 (466)	155 (620)	1200 (4236)
Lamb, 10 kg gaining 50 g/day	265 (1325)	222 (249)	13 (52)	500 (1626)
Lamb, 15 kg gaining 50 g/day	210 (1050)	300 (337)	90 (360)	600 (1747)
Kid, 10 kg gaining 50 g/day	428 (2140)	32 (36)	0 (0)	460 (2176)
Kid, 15 kg gaining 50 g/day	530 (2650)	30 (34)	0 (0)	560 (2684)

Note: Values are per day, with dry matter grams as the top value and as-fed g/day in parentheses.

Daily requirements for sheep and goats

On an average, lactating ewes and goats need 4 g/day calcium (Ca) and 3 g/day phosphorus (P); lambs and kids require half that amount (see table 3). Calcium and phosphorus are usually high enough in the diet to meet animal requirements, but the phosphorus level must not be too high relative to that of calcium. Some by-product feedstuffs are high in phosphorus and low in calcium. If phosphorus in the diet is equal to or higher than calcium, animals (especially males) may develop urolithiasis (urinary calculi, calculosis, or water belly), which is a blockage of urinary output by the formation of stones in the urethra. The calcium to phosphorus ratio should be kept between 1.5:1.0 and 3.5:1.0.

Animals on low-quality diets may not be able to consume the amounts of feed listed. High-energy supplements (such as rice bran) are digested more readily in the rumen than more fibrous feedstuffs. Therefore, high-energy feedstuffs are less likely to limit intake from rumen distension.

Table 3. Daily requirements for sheep and goats in Indonesia.

	DMI (g)	DE (mcal)	DP (g)	Ca (g)	P (g)
Lactating 25 kg ewe or doe	1200	3.54	100	4.0	3.0
Lamb, 10 kg gaining 50 g/day	500	1.49	35	4.0	2.0
Lamb, 10 kg gaining 100 g/day	550	1.98	56	4.5	2.0
Lamb, 15 kg gaining 50 g/day	600	1.89	54	4.0	2.0
Lamb, 15 kg gaining 100 g/day	650	2.38	75	4.5	2.5
Kid, 10 kg gaining 50 g/day	460	1.14	25	2.0	1.5
Kid, 10 kg gaining 100 g/day	640	1.58	35	2.0	1.5
Kid, 15 kg gaining 50 g/day	560	1.38	31	2.0	1.5
Kid, 15 kg gaining 100 g/day	740	1.82	41	2.5	1.5

Conclusion

Knowing the amount of energy, protein, and minerals found in commonly used feed allows farmers to better meet the nutritional needs of small ruminants. Farmers can use the daily requirements table to determine the nutritional needs at each stage of an animal's life.

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Rice Bran as a Supplement for Small Ruminants

Kuswandi

Abstract

Rice bran, a by-product of rice processing, is readily available and can be used as a feed supplement for small ruminants. Although rice bran used as a single supplement can maintain or improve animal performance, the use of the bran with other concentrate feeds or with basal mixed-forages appears to provide superior results. Basal mixed-forages supplemented with rice bran can be recommended as an inexpensive feeding practice for post-weaning ruminants, while rice bran-based supplements is more appropriate for preweaning, pregnant, and lactating small ruminants.

Introduction

In tropical developing countries, rice is often the main staple. Rice bran has good potential as a supplement for small ruminant diets because it is inexpensive and readily available in the villages. Rice bran is predominantly used in monogastric animal feed diets (such as chickens and ducks), and its use as a ruminant animal supplement has been limited. Rice bran production is expected to further increase in the coming decade, making its dietary use for small ruminants more attractive.

Summary of Research Findings

Types of rice bran

Rice bran, obtained from rice processing, contains the hull, aleuron, and endosperm layers of rice. Differences in the dehulling process result in variations of nutrient content. Lubis (1958) classified rice by-products into three categories: coarse rice bran, fine rice bran (lunteh), and rice polish (bekatul).

Coarse rice bran, along with the hull, is obtained from the first pounding or milling process. This bran is mostly indigestible and the nutritive value is low.

Fine rice bran is obtained in the second and third poundings in villages (lunteh kampung) or the first and second rice millings in the factory (lunteh pabrik). This bran consists mainly of the aleuron and endosperm layers, broken rice, and a little fine hull. Fine rice bran is of high quality and a good feed supplement for livestock. Consequently, the term *rice bran*, as discussed in this paper, refers to fine rice bran.

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Rice polish, obtained during the final processing, consists of endosperm without any hull, and is highly digestible.

The nutrient content of rice bran as a percentage of dry matter was determined (see table 1).

Table 1. Nutrient content of rice bran (% dry matter).

Items	Coarse rice bran	----Fine rice bran---- villages	factory	Rice polish
Crude protein	6.8	11.4	15.3	12.5
Fat	2.6	5.6	9.2	3.3
Crude fiber	29.9	17.3	9.0	5.6
Nitrogen-free extract	43.4	54.5	57.0	70.1
Ash	17.3	11.2	9.5	8.5
Digestible crude protein by sheep	1.4	7.2	9.7	7.9
Digestible organic matter	25.2	72.2	73.6	87.3
Estimated metabolisable energy (Mcal/kg)*	0.896	2.434	2.690	2.894

Source: Lubis, 1958.

*Assumed that digestible energy (DE) = 0.04409 x corrected total digestible nutrients, and metabolizable energy = 0.82 x DE.

Rice bran experiment

A rice bran combined with grass which was fed to buffalo resulted in higher microbial crude protein (Hendratno, Abidin, Suharyono, and Bahauddin; 1983, 1986), indicating that rice bran provided energy for rumen microbial growth and, therefore, animal maintenance.

When sheep (weighing 18 kg) were supplemented with 90 g of rice bran, coconut meal or corn meal, the weight gain was lowest for rice bran (16 g/day for rice bran, 21 g/day for coconut meal, and 28 g/day for corn meal). However, the cost of rice bran is much lower, making its use viable and preferable to coconut meal and corn meal.

Evidence from growth studies

A maximum of 38% rice bran feed for growing lambs is recommended (see table 2). With a basal diet of mature napier grass, rice bran offered at 200 g/day (or 23.5% total DM intake) was more economical than the other rations. Supplementation at higher than 400 g (as fed) may waste approximately 17% of the rice bran.

Approximately 201 g of the 300 g rice bran offered was eaten, (Chaniago and Obst, 1981) resulting in a similar average daily gains (65 g) for sheep of similar weights fed native grasses with 349 g rice polishings (Soedarsong, Sudharmaji, and Tristiarti, 1979). Also, supplementation with rice polishings might result in lower total DM (657 g) than supplementation with rice bran (864 g), indicating more efficient use of the rice polishing nutrients despite the higher cost.

A basal diet consisting of a mixture of several forages supplemented with rice bran yields better animal performance than a basal diet with single forage supplemented with rice bran (see table 2).

Table 2. Intake of rice bran mixed with different grasses and forages.

	---------Napier grass----------				---NG-CL-----		Forages
Rice bran level (g/day)	0	100	200	400	100	300	150
Sheep							
Intake (g/day):							
DM: Rice bran	0	90.0	180	297	-	174.0	130
Forage	608	620.5	582	476	-	690.0	659
Total	608	710.5	762	773	515	864.0	789
Digestible OM	-	320.0	385	364	309	-	-
Digestible CP	-	29.0	31	51	-	-	-
ADG (g)	-	15.5	38	42	59	65.5	52
FCR (total DM/ADG)	-	46.0	20	18	9	13.0	15
Goats							
Intake (g/day):							
DM	-	-	-	-	410	-	-
Digestible OM	-	-	-	-	226	-	-
Digestible CP	-	-	-	-	39	-	-
ADG (g)	-	-	-	-	37	-	-
FCR (total DM/ADG)	-	-	-	-	11	-	-

Source: Chaniago and Obst, 1981; Mathius et al., 1981a; Mathius et al., 1981b.
Note: Intakes of dry matter (DM), organic matter (OM), crude protein (CP), average daily gain (ADG), and feed conversion ratios (FCR) of growing sheep or goats fed rice bran at 0 g, 100 g, 150 g, 200 g, 300 g, or 400 g with napier grass, fresh napier grass and dried cassava leaves (NG-CL), or village forages.

Earlier studies with growing sheep indicated that increasing the level of concentrates in a diet by limiting the amount of basal fresh napier grass (see table 3) could increase animal growth (Mathius, Batubara, Rangkuti, and Djajanegara, 1981; Umboh, Batubara, Sitorus, and Kaligis, 1981).

Table 3. Intake of various levels of concentrate.

	------Levels of supplement (g/head/day)--------			
	200	300	400	*ad libitum*
Initial live weight (kg)	13	13	13	13
Intake (g/day):				
DM: Concentrate	183	275	367	547
Total	373	465	557	737
Digestible OM	184	245	289	374
Digestible CP	22	29	37	55
ADG (g)	47	50	85	143
FCR	8	9	7	5

Source: Mathius, et al., 1981a.
Note: Intakes of dry matter (DM), organic matter (OM), and crude protein (CP), average daily gain (ADG), and feed conversion ratios (FCR) of sheep fed 1 kg fresh napier grass and 200 g, 300 g, 400 g, and *ad libitum* of concentrate (35 parts rice bran, 35 parts coconut meal, 29 parts corn meal, 1 part Rajamix).

There is a positive relationship between average daily gain and dry matter intake. This study included rice bran as high as 17% to 26% of the total DM intake. Similarly, feeding fresh napier grass with concentrate *ad libitum* increases live weight gain (see table 4).

The rice bran constituted half of the concentrates (36.5% to 39% of total dry matter intake). The remaining halves were coconut cake, soybean oil cake, groundnut cake, tapioca waste (onggok), and a small portion of minerals, with different compositions providing a crude protein content of 10% to 18% dry matter. The concentrate represented 73% to 78% of total dry matter intake and this yielded daily weight gains from 99 g to 144 g.

Lactating and preweaning Thin-tail sheep fed basal diets containing cultivated grasses with napier grass, which was then replaced with rice-bran-based concentrate (40% rice bran, 33% corn meal, 25% coconut oil cake, 2% minerals) maintained normal body condition and growth (see table 5).

Lactating and preweaned Ettawah crossbred goats demonstrated improved performance when their diets were supplemented with a concentrate containing rice bran (Triwulaningsin, Setiadi, and Sitorus, 1984).

Table 4. Levels of rice bran concentrates.

	CP (%) of rice-bran-based concentrates				
	10	12	14	16	18
Intake (g/day):					
DM: Concentrate	433.0	556	528.0	514	538
total	594.5	717	689.0	675	699
Digestible CP	38.0	54	61.0	67	78
ADG (g)	99.0	141	127.5	127	144
FCR	6.0	5	5.0	5	5

Source: Umboh, Batubara, Sitorus, and Kaligis, 1981.
Note: Intake of dry matter (DM) and digestible crude protein (CP), average daily gain (ADG), and feed conversion ratio (FCR) in sheep fed 700 g fresh napier grass with different CP contents of concentrates given *ad libitum*.

Table 5. Liveweight of preweaned thin-tailed sheep on forages fed with a rice bran-based concentrate.

	Lambing type					
	Single			Twin		
	Male	Female	Average	Male	Female	Average
Birth weight (kg)	3.2	3.1	3.2	2.4	1.9	2.2
Weight (kg)						
30 days	8.8	8.9	8.8	6.3	5.8	6.2
60 days	12.9	13.0	12.9	9.4	9.5	9.4
90 days	17.7	16.4	16.9	11.6	12.7	11.9

Source: Triwulaningsih, Setiadi, and Sitorus, 1984.

Conclusion

Rice bran, which is always available following the harvesting and processing of rice and can be stored safely between rice harvests, can be an alternative energy feed for semicommercial and commercial production systems when cereal grain meals or oil cakes are expensive or not readily available.

As a single supplement, approximately 200 g/day of rice bran is sufficient to improve daily gains of growing small ruminants at a medium production level, while 100 g/day of rice bran for survival is sufficient when the availability of rice bran is limited.

Although rice bran can represent more than 40% of the total dry matter intake, optimum levels should be determined to achieve an efficient feeding program. With

the exception of crisis feeding for survival, rice bran as a single supplement should represent less than 40% of the total dry matter intake.

Efficient supplementary feeding is achieved when either basal mixed forages are used with a single rice bran supplement or a single forage is used with rice-bran-based concentrates. The options available depend on the availability and the cost of feedstuffs and the physiological status of the small ruminants. Pregnant, lactating, and preweaning animals may be supplemented with rice bran based concentrates to meet their need for high-quality feed.

Care must be taken in selecting and using rice bran because its quality is often determined by the length of storage. Rice bran usually cannot be stored longer than 50 to 60 days after processing. Practical treatments (such as drying, steam-depressing, cooling, or defatting) before storage can inhibit adverse enzyme activity.

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Cotton By-products as a Feed for Small Ruminants

Budi Haryanto

Abstract

Cotton by-products are palatable to small ruminants and, under certain price conditions, the use of cotton by-products is economical.

Introduction

The development of cotton plantations in Indonesia has not been rapid. Small-scale cotton farmers increased the cotton production area to 63,000 hectares in 1986. Cotton is generally planted in arid or semiarid regions. These areas are also appropriate for raising small ruminants. The grass availability in these areas is marginal. However, there is a potential of cotton by-products as a source of feed for ruminants. By-products of cotton include whole seeds, seed hulls, and lint or seed oil cake. Cottonseed is a source of protein, but the fat content of whole cottonseed limits the amount that can be fed to ruminants. Seed hulls and lint can be fed if mixed with other ingredients to make a nutritionally balanced ration.

Summary of Findings

Haryanto, Yulistiani, Rangkuti, and Pond (1990) found that feeding whole cottonseed to sheep required a long adjustment period (4 weeks) and resulted in weight gain of 44 g/day if fed in combination with napier grass.

Indonesian cottonseed has an average of 5.3% ash, 32.5% fat, and 36.6% crude protein (Saroso, 1987). Protein digestibility (in vitro) was 80%. The average protein solubility in 0.1N NaOH was no less than 85%. The protein, fat, and free gossipol contents of cottonseed oil cake processed by four different methods are shown in table 1.

The amino acid profiles of cottonseed meal and soybean meal are presented in table 2. Although chemical composition appears to be favorable, the high fat content of the seeds may limit their use as a ruminant feed. A diet consisting of 71.2% cotton seed hulls and lint, 10% soybean meal, 16% molasses, 0.75% urea, and 1.85% minerals resulted in a weight gain of 106 g/day (Haryanto et al., 1990). Cottonseed meal and molasses fed at a high intake to dairy goats increased milk production and milk lactose, but milk fat was not affected significantly (Sarwiyono, Holmes, and McIlroy, 1988).

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Table 1. Protein, fat, and free gossipol content of cotton seed oil cake, extracted using different solvents.

Solvent	Protein (%)	Fat (%)	Free gossipol (ppm)
Hexan	49.5	16.1	6900
Hexan:alcohol (82:18)	58.3	5.3	1800
Alcohol	39.2	23.8	1600
Hexan, followed by alcohol	52.9	11.2	3500

Source: Winarto, 1988.

Table 2. Amino acid concentrations of cottonseed and soybean meal.

Amino acids	Cottonseed meal (mg/g)	Soybean meal (mg/g)
Isoleucine	95	216
Leucine	425	487
Lysine	351	483
S-amino acids	110	80
Aromatic amino acids	219	279
Valine	279	310

Source: Winarto, 1988.

Conclusion

Feeding cotton by-products to small ruminants is feasible if the animals are near the cotton production areas. A mixture of cotton by-products, molasses, and foliage is advisable.

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Gliricidia as a Source of Forage for Small Ruminants

I-Wayan Mathius

Abstract

The high protein content of *Gliricidia* leaves makes them an excellent source of fodder for ruminant livestock. The leaves' high-nutrient content plus the tree's high yield makes it a good single feed or supplemental feed source.

Introduction

Feed availability for small ruminants raised under intensive production systems in West Java depends on the ability of the farmer to collect forages from the surrounding area. The quality and the quantity of feed vary considerably. The shortage of forage in general is one of the main constraints in increasing small ruminant production. Intensive cultivation and production strategies of several varieties of forage trees should be considered, taking into account prevalent land use patterns.

One particularly promising forage supply is the legume tree *Gliricidia*. In addition to providing a forage, *Gliricidia* provides shade, acts as a fence, serves as a source of green fertilizer, and improves the quality of the soil due to its nitrogen-fixing ability. To promote the cultivation of *Gliricidia*, research on its potential as a fodder source was necessary.

Summary of Research Findings

Potential and quality of *Gliricidia*

Gliricidia (Gliricidia sepium) is a legume tree which grows 8 m to 15 m high and has a life span of 17 to 32 years. The tree is found in almost all regions of the Indonesian archipelago that have sufficient rainfall. *Gliricidia* propagates through seeds or vegetatively. Seeds are recommended because the tree develops a deeper and stronger root system, which enables it to produce forage longer.

Gliricidia serves many functions: firewood, building material, shading for cacao, fences, support trees (for vanilla and pepper), weed eradicator, pulp and high-quality forage for ruminants.

Annual forage production from *Gliricidia* per hectare depends on the tree's primary function. Chadhokar (1982) and Smith and Van Houter (1987) determined that, with a distance between trees of 3.0 m x 0.43 m, the forage production was 43 metric tons/ha

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annually of fresh forage which equals 8 metric tons/ha to 11 metric tons/ha of dry matter and 2 metric tons/ha of crude protein. Based on nutrient content, *Gliricidia* leaves are as good as *Leucaena* leaves. The reported variation in the nutritional content of *Gliricidia* leaves probably resulted from differences in variety, age at harvest, soil type, climate, and the part of the plant tested (Chadhokar, 1982; Smith and Van Houter, 1987; Van Eys, Mathius, Pongsapan, and Johnson, 1986). Mineral content also varied, although it was slightly above the minimum requirements for a green fodder (Chadhokar, 1982). Amino acid content of *Gliricidia* is higher than those of alfalfa and *Leucaena* (except for lysine and isoleucine). *Gliricidia* contains the antinutrient substances cumarin and o-cumarin (Smith and Van Houter, 1987). Wilting reduces the effect of these substances and increases the palatability of this forage (Mathius, Rangkuti, Djajanegara, 1981).

Gliricidia as a feed

The high-fiber content of *Gliricidia* limits its use as a nonruminant feed, but both sheep and goats consume *Gliricidia* readily. Some farmers report that sheep and goats refuse to consume *Gliricidia* because of its characteristic smell. To reduce the smell, *Gliricidia* can be sun-dried for several hours or wilted overnight in a shaded area. A gradual increase in the amount offered often encourages small ruminants to consume *Gliricidia*.

The rate of rumen degradation of *Gliricidia* is higher than that of *Leucaena* (Van Eys et al., 1986). Digestibility of dry matter, crude protein, and crude fiber of *Gliricidia* for goats is 58.5%, 71.5%, and 17.9%, respectively (Anitawati, 1981). Digestibility of dry matter, crude protein, and crude fiber for sheep is 57%, 55%, and 52%, respectively (Mathius et al., 1981). *Gliricidia* promotes the growth rate of small ruminants, and, as a sole feed, resulted in improved weight gains (88 g/day to 111 g/day) compared with that of a native grass diet (Mathius et al., 1981).

Combining *Gliricidia* with other feed also achieves good results. Carbohydrate supplements given 5 hours after consuming a basal diet (a combination of elephant grass and *Gliricidia* [60:40]) were found to increase body weight gains more than when administered after 2 hours. The addition of *Gliricidia* at 500 g/day and tapioca waste at 150 g/day resulted in 56 g/day body weight gain for sheep (Rangkuti and Martawidjaja, 1989). The inclusion of *Gliricidia* in various amounts did not affect the digestibility of feed nutrients.

The effect of *Gliricidia* on livestock reproduction is also favorable. *Gliricidia*-based rations (25% to 75%) given to sheep for one gestation period produced higher lambing rates than in the control group. The addition of *Gliricidia* (75%) to *Brachiaria miliformis* resulted in higher birth weight. Kantharaju and Chadhokar (1981) conducted similar research on different types of sheep and found comparable results.

Conclusion

Based on the range of research mentioned, intensive cultivation of *Gliricidia* should be promoted. *Gliricidia* has the potential as a small ruminant forage because of its high-nutrient content. Taking advantage of *Gliricidia*-based diets for small ruminants is easy because the tree has several uses and is readily available. *Gliricidia* trees can grow in almost every type of soil, especially in areas that are not used for crops. Intensive cultivation of *Gliricidia* can also provide a solution to the forage shortage problems that often occur during the dry season.

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King Grass as a Feed for Small Ruminants

I-Wayan Mathius

Abstract

Lack of high-quality forages is one constraint in Indonesian small ruminant production. Therefore, hybrid *Pennisetum purpureum* and *P. typhoides* grass (*P. purpureophoides*), referred to as king grass, was introduced to extend fodder grass during the dry season. In a field study in the Bogor area, forage yielded an average of 113,000 kg/ha per cutting. Annual fresh green yield was 791,000 kg/ha or 124,700 kg dry matter/ha/year. Preliminary studies indicate that king grass can be used for 62% of the total diet for small ruminant fodder. Digestibility and metabolism studies with sheep and goats indicate that goats consumed more dry matter than sheep. Significant differences of digestibility were found between sheep and goats. Overall, king grass is not adequate to provide enough protein for small ruminant maintenance.

Introduction

In Indonesia, forage supplies for goats and sheep are quantitatively adequate during the rainy season but are deficient during the dry months. Feed quality is a serious constraint to animal productivity and a critical problem of livestock production (Van Eys, Pulungan, Rangkuti, and Johnson, 1987).

A popular feedstuff is king grass (*Pennisetum purpureophoides*). This grass, known in other countries as hybrid napier grass, was developed in 1956 as a cross between *Pennisetum purpureum* (napier grass) and *Pennisetum typhoides*. Once introduced, the use of king grass spread rapidly throughout Indonesia. King grass is a cane-like plant with a strong stem and grows best in warm, humid conditions. The stemmy nature of king grass limits its usefulness as a feed for small ruminants. Both goats and sheep tend to eat only the leafy portions and leave the stems behind. Therefore, the potential dry matter (DM) yield and feeding value of the whole plant is not gained. To maximize the value of king grass, the plant is often chopped.

Limited information exists about the nutritive value of king grass for goats and sheep. Therefore, research focused on king grass to obtain additional information on the yields, chemical composition, and comparative value of king grass to goats and sheep.

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Summary of Findings

Cultivation of king grass

Five hundred square meters of land in the Bogor Research Institute for Animal Production (RIAP) were cultivated with king grass. At least two-joint stem cuttings were planted vertically into the soil that was ridged at a 45° to 60° angle to leave the uppermost node exposed. The soil was plowed, harrowed, and fertilized with 125 kg of triple superphosphate (P_2O_5) and 2500 kg/500 m^2 cow manure before the stems were planted. In addition, 45 kg/500 m^2 urea was added. Thirty days after planting the plants developed meristematic tissues. The first harvest occurred 90 days after planting. The next six successive cuttings occurred after 40 to 50 days of regrowth. After each cut, approximately 5 kg cow manure per crown was added. Field samples for green yield were taken when neither dew nor rainwater were present on the surface of the forages. At least 40 crowns were sampled and taken at random. The cuttings were 15 cm to 20 cm above the ground. Subsamples from each cutting were chopped, dried, and ground to pass a mesh screen and then stored in an airtight jar for subsequent analysis.

King grass grew rapidly for the first 2 months, and, consequently, the production of both fresh and dry matter was the highest at the first cutting. The next five cuttings produced decreasing amounts of green forage.

Green fodder yield of king grass ranged from 7.68 kg/crown to 15.19 kg/crown (see table 1). The average green fodder production over the seven cuttings was 11.33 kg/crown, which was equal to 113.3 metric tons/ha/harvest or approximately 808 metric tons of fresh yield/ha/year. A gradual decrease in yield, with slight fluctuations, occurred as the plants matured. These fluctuations followed the seasonal rainfall patterns. The stems were planted during the middle of the rainy season (January 1988) and the first and second cuttings were completed near the end of the rainy season. The next four cuttings occurred during the dry season (June through September), while the sixth and seventh cuttings occurred during November and December.

The average number of shoots per crown increased steadily from 13.8 shoots/crown to 25.5 shoots/crown. A marked difference existed between cuttings in response to the cutting schedule. Number of tiller or shoots was affected by cutting interval and frequency.

Although king grass produces a high yield of green fodder, not all parts of the king grass plant can be consumed by small ruminants. On average, 62% of the green fodder yield can be consumed by goats or sheep.

Table 1. Mean green yield, numbers of shoots/crown and edible portion of king grass.

Cutting	Fresh yield (kg) crown	500 m^2	1 ha	# of shoots per crown	Edible portion(%)
1	13.85	6924	138,500	13.86	52.6
2	15.19	7592	151,900	21.71	74.9
3	10.65	5325	106,600	24.6	63.9
4	7.68	3840	76,800	25.2	66.4
5	8.15	4075	81,500	28.7	65.0
6	12.07	6035	120,700	30.9	44.0
7	11.74	5870	117,400	25.5	68.1
Averages	11.33	5665	113,000	24.35	62.13

Chemical composition of king grass at different cuttings is presented in table 2, with average values for dry matter (DM), crude protein (CP), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), calcium (Ca), and phosphorus (P).

Table 2. Chemical composition of king grass at different cuttings.

Cutting	Stage of regrowth (days)	DM (%)	CP (%)	Ash (%)	NDF (%)	ADF (%)	Ca (%)	P (%)
1	90	11.2	7.96	11.13	67.86	42.46	0.25	0.12
2	40	12.1	8.91	12.46	75.96	47.53	0.21	0.09
3	42	14.7	8.17	8.32	61.09	40.71	0.19	0.09
4	47	18.2	9.89	12.31	70.44	45.28	0.27	0.11
5	41	17.2	9.26	11.54	74.29	45.91	0.23	0.12
6	50	18.9	10.13	13.17	74.91	48.21	0.26	0.09
7	49	18.1	8.92	12.41	74.27	47.27	0.20	0.11
Averages		15.77	9.03	11.62	71.26	45.34	0.23	0.10

Intake and digestibility of king grass

Fourteen small ruminants (seven kacang goats and seven local thin-tailed sheep) were used, weighing an average of 19.95 kg and 21.47 kg respectively. All animals were adults and between 1.5 to 2 years old. Animals were penned individually and weighed on the first day and at termination of the experiment. Fresh chopped king grass (204 cm length) was provided twice daily at 9:00 a.m. and 4:30 p.m. Water was available at all times.

The daily fresh forage intake of king grass was 2.9 kg/head each for goats and sheep. The fresh king grass appeared palatable to the sheep. Dry matter intake was not different between goats and sheep.

The intake and digestibility coefficients for various nutrients are presented in table 3.

Table 3. Intake and digestibility of king grass by goats and sheep.

	Goats	Sheep
Number of animals	4	4
Average initial weight (kg)	19.95	21.47
Intake/day:dry matter		
g/head	259.97	266.78
g/BW(kg)^{0,75}	27.63	27.29
g/100 kg BW	1308.01	1240.75
Crude protein/day:		
g/head	27.6	27.8
g/BW(kg)^{0,75}	2.93	2.85
g/100 kg BW	135.33	129.48
Organic matter/day:		
g/head	225.9	235.83
g/BW(kg)^{0,75}	24.0	24.08
g/100 kg BW	1132.3	1098.68
Neutral detergent fiber/day:		
g/head	189.9	195.68
g/BW(kg)^{0,75}	20.18	20.02
g/100 kg BW	951.88	911.41
Acid detergent fiber/day:		
g/head	122.45	125.93
g/BW(kg)^{0,75}	13.01	20.22
g/100 kg BW	613.78	586.54
Apparent digestibility (%)		
Dry matter	45.35	40.33
Crude protein	62.23	55.63
Neutral detergent fiber	43.87	40.80
Acid detergent fiber	40.15	39.95
Organic matter	48.00	43.40
Ash	24.43	20.18

The mean average digestibility coefficients of DM, organic matter (OM), CP, NDF, ADF, and ash were significantly lower for sheep than for goats.

Digestion and nitrogen balance

After the intake and digestion trials, all animals were moved and placed individually in metabolism crates. The experiment consisted of a 14-day adjustment period and a 7-day collection period. Fresh king grass was finely chopped (2 cm to 4 cm length). To attain maximum intake, feed refusals of up to one-third of the material offered were maintained. The digestion trials were conducted using standard collection and sampling techniques. Animals had free access to water. Feed offered, feces, and urine were weighted daily and representative samples were taken. Feces were collected for 24 hours by fitting the animals with fecal bags (made of parachute cloth); urine was collected for 24 hours using glass jars. To avoid ammonium losses, 5 ml sulfuric acid (20%) was added to the jars daily after the urine was pooled. Samples from each animal were bulked over the 7-day collection period and frozen for later analysis. The apparent digestibilities of DM, OM, CP, ash, NDF, and ADF were calculated. Nitrogen balance was calculated by subtracting total nitrogen in the urine and feces from the nitrogen intake.

No significant differences were found between sheep and goats in nitrogen consumption (4.42 g/day for goats and 4.45 g/day for sheep). When differences in size between goats and sheep were taken into account, nitrogen intake was slightly lower for goats. Nitrogen retention was negative for both animal species even though goats utilized nitrogen more efficiently than sheep. The overall nitrogen losses were similar. The difference in nitrogen losses, expressed as a percentage of nitrogen intake, was not significant.

The negative nitrogen balances obtained from this study indicate that king grass cannot meet nitrogen requirements – even for maintenance.

Table 4. Nitrogen utilization of king grass by goats and sheep.

Item	Goats		Sheep	
	Head	$BW(kg)^{0,75}$	Head	$BW(kg)^{0,75}$
Nitrogen intake (g/day)	4.42	0.469	4.45	0.456
Nitrogen excretion (g/day)				
Feces	1.96	0.207	1.68	0.169
Urine	3.42	0.362	3.73	0.374
Total	5.38	0.569	5.41	0.543
Nitrogen retention				
g/day	-0.96	-0.100	-0.96	-0.087
% intake		21.32		19.08
% digest		38.46		30.31

Conclusion

King grass can be used as an alternative fodder during the dry season if supplemented with a protein source. Because of certain shortcomings such as a negative nitrogen balance, dietary protein supplementation is needed if king grass is used as the basal diet.

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Leucaena Trees as a Source of Forage for Small Ruminants

I-Wayan Mathius

Abstract

Interest in *Leucaena* over the last few years has increased. As with other legumes, *Leucaena* forms a mutually beneficial partnership with soil bacteria for nitrogen fixation. *Leucaena* is also a drought-resistant plant that produces as much as 20 metric tons/ha/yr of edible dry matter. *Leucaena* is valuable as a protein supplement for livestock and can be fed fresh or dried to most species of domesticated livestock. Ruminant livestock can feed solely on *Leucaena* for extended periods without any adverse side effects.

Introduction

Livestock development is part of the Indonesian government's effort to improve national nutrition levels. The government also encourages livestock production for export in an effort to diversify its export portfolio.

To accomplish these objectives, government policies have focused on importing breeding stock and improving local breeds, grazing areas, management, and forages. Two factors that contribute to low animal productivity are the low nutritional value of forages and inappropriate feeding practices. Feed is the largest cost of production, amounting to as much as 80%, and feed concentrates purchased as supplements usually increase production costs beyond what is economically viable. Therefore, a readily available forage such as *Leucaena* presents a low-cost alternative.

Summary of Findings

Potential and quality of *Leucaena*

Leucaena (Leucaena leucocephala) is a long-lived (17 to 32 years) perennial that grows from 8 m to 15 m tall. With sufficient rainfall, it develops a deep, extensive root system that allows it to withstand periods of drought. Forage studies have shown that *Leucaena* can produce up to 20 metric tons of dry matter/ha/yr, and that the leaves have a reasonable nutrient content. In general, *Leucaena* nutrient content is similar to that of *Gliricidia*. The variations in nutrient content of *Leucaena* results from differences in varieties, harvest locations, age at harvest, soil type, climate, and the part of the plant used for analysis. Compared to alfalfa, *Leucaena* forage has a favorable amino acid profile, suggesting a potential for quality livestock feed. The mineral content of *Leucaena* varies with location, but a low-mineral content can be overcome through mineral supplementation.

Mimosine

Leucaena contains the antinutritional factor mimosine, which is a nonprotein amino acid. Mimosine is found in free form in all parts of the plant. The highest concentration is found in new leaves (up to 12% of the dry matter content) followed by parts of the flowers and seeds. Jones (1979) found that a *Leucaena* seed contains 4% to 5% mimosine (dry matter) while the young stems have the lowest concentration (1% to 2%). Mimosine may be present in free form or as 3-hydroxy-4-pyudoine (DHP), and free mimosine may be converted to DHP by rumen microorganisms. DHP reduces serum thyroxine levels and causes swelling of the thyroid gland (Jones and Bray, 1982), which can not be overcome by iodine doses. Mimosine content can be reduced by simple and inexpensive treatments such as heating, drying or wilting the *Leucaena* forage (Lowry, 1982). The presence of mimosine combined with the high-fiber content of *Leucaena* limits its effectiveness as a feed for nonruminant animals. However, ruminant animals (such as cattle, sheep, and goats) are able to use rumen microbial activity to convert crude fiber into useful nutrients. Ruminant animals possess rumen microbes that convert mimosine to a solution with a lower toxicity level than those found in *Leucaena* leaves (Tangendjaja and Lowry, 1984).

Conclusion

Leucaena can be planted on hilly slopes that frequently suffer from erosion, along roadsides, and as living fences. The use of fresh or dried *Leucaena* as a feed for ruminant animals has shown positive results. Therefore, *Leucaena* has good prospects and high potential as a source of feedstuffs for ruminant animals and also as a component of high-quality concentrates. *Leucaena* is easy to propagate into larger areas, requires minimal maintenance, and can be grown in a wide variety of soil types. The productivity gains to ruminant animals makes it promising as a feed. Unfortunately, a psyllia insect kills the leaves and the plant. This insect has caused widespread destruction of *Leucaena* in the Philippines and elsewhere in southeast Asia. Therefore, *Leucaena* should be planted with other tree legumes (such as *Gliricidia*) that are also sources of high-quality forages.

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Cassava Leaves as a Protein Supplement for Small Ruminants

Bambang Sudaryanto

Abstract

Cassava leaves have a 20% to 30% crude protein content (dry matter) and are readily available throughout Indonesia. They are an excellent protein supplement for sheep and goats. Research studies have determined that small ruminants prefer cassava leaves to both napier and elephant grass. In diets containing 50% wilted cassava leaves and 50% native grass, hydrocyanic acid (HCN) toxicity was not found to be a problem. Cassava leaves are widely accepted by farmers as a feed supplement, but feeding strategies should be developed for each physiological group of animals.

Introduction

Small ruminants (sheep and goats) and large ruminants (buffalo and cattle) have the biological advantage of being able to convert relatively low-quality forages into meat and other products that are valuable to people (Tillman, Ridenour, and Getz, 1986). In Indonesia, native grasses are the main feed source offered to these animals, and many tropical forages can meet the maintenance requirements of mature animals. However, growing, pregnant, and lactating animals require some type of feed supplement to optimize productivity. Supplements are needed because tropical forages have low-nutritive value (protein and energy) and, when fed alone, limit production.

Several options are available to improve the quality of the ration farmers provide to small ruminants. Cassava (*Manihot esculenta* Crantz) has become an important animal feed resource over the last 20 years worldwide, mostly in the form of dried chips. While the use of cassava chips as a dietary energy supplement for livestock is established, the use of cassava leaves as a protein supplement for small ruminants received less attention.

Summary of Findings

Potential and production of cassava

Besides tubers, cassava plants produce 7 metric tons/ha to 15 metric tons/ha of leaves (Khajarern, Khajarern, Kitpanit, and Muller, 1977). Actual yield depends on the way leaves are harvested, with higher yields if a few leaves are harvested monthly from

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each plant. As shown in table 1, Indonesia is second only to Thailand for cassava leaf production in the Asia-Pacific region.

Table 1. Cassava leaf production in the Asia-Pacific region.

Rank	Country	Production (000 ton)
1	Thailand	1,560.0
2	Indonesia	1,498.6
3	Vietnam	360.0
4	Philippines	204.8
5	Malaysia	43.7
6	Fiji Islands	11.0
7	Papua New Guinea	10.8
8	Kampuchea	3.1
9	Burma	1.8
10	Laos	1.7

Source: Devendra, 1981.

Maximum stem growth is reached at 6 months, when activity changes from growth of stems and leaves to the development of tubers (Wargiono and Sumaryono, 1982). Beginning at the seventh month, stem growth decreases steadily through the ninth month, when leaves grow slowly. Cassava leaves can be picked from the lower portion of the canopy when the plant is 4 months old, with a week's interval between pickings (Sudaryanto, Kuswandi, and Djajanegara, 1982). This harvesting process can produce a yield of four to six leaf shafts per plant without reducing tuber production.

Nutritive value of cassava leaves

The protein content of cassava leaves is 28.8% in the *Manihot esculenta* Crantz variety. The protein content of leaves and stems of the *Adira I* variety is 23.4% (Sudaryanto et al., 1983). Leaves contain more crude protein (CP) and less neutral detergent fiber (NDF) than stems or shafts (see table 2).

Meyreles and Preston (1977) investigated one of the problems of using cassava leaves as a protein source for ruminants – the rapid degradation of proteins in the rumen. They suspected that rumen microbes broke down too much of the protein, resulting in underutilization. To solve this problem, baking and chopping leaves to produce cassava meal was suggested (Ferguson, 1975). Cassava leaves baked at 100°C for 4 hours and processed into meal decreased the protein degradation in rumen, and allowed more of the protein to be digested in the intestines (Sudaryanto et al., 1983). Inclusion of cassava leaf meal at 200 g/day showed an increased body weight when compared to sheep fed only elephant grass (see table 3).

Table 2. Nutrient content of cassava leaves, stems, and shafts (dry matter percentages).

	CP (%)	NDF (%)	Fat (%)	Ash (%)	Ca (%)	P (%)	TDN (%)
Leaves	28.8	29.9	7.7	7.6	1.5	0.5	61.0
Stems	10.9	46.3	2.1	8.5	1.9	0.4	-
Shafts	12.5	44.8	2.1	7.8	1.9	0.5	-

Source: Sudaryanto, Kuswandi, and Djajanegra, 1983.

Table 3. Intake, apparent digestibility, and average daily gain of sheep fed elephant grass (EG) only or elephant grass with cassava leaf meal (CLM).

	Rations			
	EG ad lib	EG+50 g CLM	EG+100 g CLM	EG+200 g CLM
Intake (g/day)				
Dry matter	467^{a}	518^{b}	564^{c}	674^{d}
Organic matter	411^{a}	458^{b}	501^{c}	594^{d}
Crude protein	48^{a}	59^{b}	69^{c}	96^{d}
Neutral detergent fibre	287^{a}	313^{b}	337^{c}	393^{d}
Apparent digestibilities (%)				
Dry matter	54	49	53	54
Organic matter	60^{b}	53^{ac}	57^{bc}	59^{b}
Crude protein	52^{a}	52^{a}	57^{ab}	61^{b}
Neutral detergent fibre	50	42	50	50
Average daily gain (g)	43^{a}	49^{ab}	49^{ab}	66^{b}

Source: Sudaryanto, Mathius, and Rangkuti, 1984.
Note: Different superscripts in the same row are significantly different (a,b,c, and d : P<.01).

Animals fed only native grass gained 4 g/day. Those fed 50% cassava leaves gained 31 g/day. Furthermore, wilted leaves fed to growing small ruminants at 50% cassava leaves and 50% native grass showed no toxic symptoms from the hydrocyanic acid (HCN) found in bitter cassava leaves.

The highest daily gains were obtained with chopped and dried cassava leaf meal. Wilted leaves and fresh leaves also showed good results. The recommended amount of cassava meal is 200 g/day/animal. Additionally, 400 g/day to 500 g/day of wilted leaves and up to 1 kg of fresh leaves is desirable.

When various combinations of native grass and cassava leaves were fed to goats, dry matter intake increased as cassava leaves were added to the diets as shown in table 4 (Sitorus, 1985).

Table 4. Intake, apparent digestibility and daily gain of goats fed native grass (NG), cassava leaves (CL), and combinations.

	Ration				
	100% NG	75% NG +25% CL	50% NG +50% CL	25% NG +75% CL	100% CL
Intake (g/kg $W^{0.75}$)					
Dry matter	63^a	70^b	78^c	78^c	79^c
Crude protein	9^a	11^b	14^c	17^d	18^c
Neutral detergent fibre	51	53	55	53	51
Acid detergent fibre	31^a	33^b	35^c	36^c	36^b
Digestibility (%)					
Dry matter	69	69	69	71	73
Crude protein	70^a	70^a	74^b	79^c	83^d
Neutral detergent fibre	70	70	70	72	73
Acid detergent fibre	65	63	63	65	68
Energy	68	69	72	73	73
Average daily gain (g)	4^b	19^c	31^d	21^c	-8^a

Source: Sitorus, 1985.
Note: Means in the same row with different superscripts are significantly different (a,b,c and d: P<.05).

Conclusion

Cassava leaves have a 20% to 30% crude protein content (dry matter). They are an excellent protein supplement for sheep and goats. Research studies determined that small ruminants prefer cassava leaves to both napier and elephant grass. In diets containing 50% wilted cassava leaves and 50% native grass, hydrocyanic acid (HCN) toxicity was not found to be a problem. The recommended amount of cassava meal is 200 g/day/animal with wilted leaves of 400 g/day and up to 1 kg of fresh leaves.

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Reducing the HCN Content in Cassava Biomass

Bambang Sudaryanto

Abstract

One problem found in using cassava as a ruminant feed supplement is the presence of hydrocyanic acid (HCN) in all parts of the plant. Technologies for reducing or eliminating the HCN content include drying, chopping, soaking, adding linamarase enzyme, or adding sulfur.

Introduction

In Indonesia, there are two types of cassava: sweet and bitter. The difference between these two types is the level of hydrocyanic acid (HCN). Bitter cassava has a higher HCN content than sweet cassava. HCN is found in all parts of the cassava plant – from the tuber to the leaves. Although HCN content is positively related to tuber production, the acid is a toxic substance that can kill animals if consumed above their tolerance levels. Therefore, technologies for reducing or eliminating the toxic substance are important.

Summary of Findings

HCN content of cassava

All parts of a cassava plant contain HCN (see table 1). The highest HCN content is found in the skin of the stalk, especially the lower portions. The rubbery peel of the stalk has an HCN content 5 to 10 times higher than that of the tuber.

HCN poisoning

Ruminants are more prone to HCN poisoning than other animals because rumen microbes produce enzymes that hydrolyze cyanogenic-glycosides and release HCN into the bloodstream (Cheeke, 1985). In addition to acute poisoning, chronic poisoning can occur from continuous intake of small amounts of cyanic acid over long periods of time.

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Table 1. Distribution of HCN for all parts of cassava plant.

Parts of the plant	HCN (mg/kg dry matter)
Leaves	
young, in bloom	490
fully grown	590
older	380
Leaves/stems	
young, in bloom	720
fully grown	340
older	150
Skin of the stalk	
near the oldest leaves	630
2/3 part, leafless	310
1/3 part, leafless	420
the lowest part	780
Tuber peel	640
Tuber	140

Source: DeBruijn, 1973.

Technologies for reducing HCN content

Efforts toward reducing HCN content have centered on soaking, washing, steaming, drying, fermenting, or a combination of these treatments. Plants were first chopped, sliced, grated, or otherwise physically reduced to let the endogenous linamarase enzyme operate. Heating cassava was shown to reduce the HCN content (Sitorus, 1989). Soaking a mixed cassava biomass for 36 hours without the addition of thiosulfate resulted in a HCN content as low as that of heating (see table 2). This indicates that endogenous linamarase enzymes have a direct role in releasing HCN from cyanogenic glycoside. The highest activity of this enzyme occurred in the leaves, especially the young ones (DeBruijn, 1973). Mixing parts of the cassava plant, primarily the leaves, with other parts of the plant is an effective way to eliminate HCN.

The use of cassava leaves as a small ruminant feed supplement where the HCN intake was 15 mg/kg body weight had no significant effect on dry matter intake and average daily gain (see table 3). This is in sharp contrast to Cheeke's (1985) findings where a lethal dose of HCN was found to be 3 mg/kg body weight. This difference may be because of characteristics of individual animals; some are tolerant to HCN, others are not.

Table 2. HCN content of cassava biomass with different treatments (mg/kg).

Part of cassava biomass	Temperature °C	Thiosulfate mol	-----Soaking time (hours)-------- 12	24	36
Tuber	0	0	671^{a}	491^{c}	46^{hij}
		3	426^{d}	36^{e}	9^{ghi}
		6	511^{b}	95^{f}	86^{gh}
	58	0	125^{g}	64^{hij}	19^{j}
		3	83^{gh}	46^{hij}	18^{j}
		6	72^{hi}	33^{ij}	18^{j}
Separated	0	0	374^{b}	252^{e}	216^{f}
		3	437^{a}	286^{cd}	250^{ef}
		6	432^{a}	301^{c}	268^{de}
	58	0	113^{hi}	103^{i}	95^{i}
		3	164^{g}	145^{gh}	119^{hi}
		6	143^{gh}	127^{hi}	117^{hi}
Leaves+stalks mixed	0	0	105^{a}	45^{cl}	28^{efg}
		3	72^{c}	30^{e}	21^{fghi}
		6	89^{b}	26^{efgh}	12^{i}
	58	0	29^{ef}	30^{e}	28^{efg}
		3	13^{hi}	12^{i}	12^{i}
		6	89^{fghi}	16^{ghi}	14^{hi}
Separated	0	0	113^{a}	65^{c}	48^{de}
		3	99^{a}	57^{cd}	43^{e}
		6	98^{a}	49^{de}	43^{e}
	58	0	100^{a}	57^{cd}	50^{de}
		3	85^{d}	43^{c}	42^{e}
		6	96^{ab}	48^{de}	41^{e}

Source: Sitorus, 1989.
Note: Means in the same row with different superscripts are significantly different.

Table 3. Dry matter intake, HCN intake, digestibilities, and average daily gain.

	---Level of cassava leaf meal---		
	0%	20%	30%
Intake			
Dry matter (g/day)	751	716	735
HCN (mg/kg BW)	-	9.4[a]	15[b]
Digestibility (%)			
Dry matter	55	50	56
Crude protein	49	38	45
Organic matter	59	54	59
Energy	52	45	52
Neutral detergent fiber	60[a]	54[b]	53[b]
Average daily gain (g/day)	112	87	109

Source: Sudaryanto, 1987.
Note: Means in the same row with different superscript are significantly different.

Conclusion

To reduce the potential HCN toxicity in ruminants, cassava plants can be chopped, wilted, or dried. Lethal dose of HCN content seems to vary greatly among animals.

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Breeding Techniques

Breeding the Ewe Lamb

I-Ketut Sutama

Abstract

One of the largest costs in sheep production management is that of providing replacement stock. Usually, replacement stock are not productive until they reach 15 to 17 months of age for tropical regions. However, it is possible to breed ewe lambs so that the first lambing season occurs at 12 to 15 months. Adequate feeding is required to enable ewe lambs to reach puberty as early as possible. Breeding ewe lambs shortens the generation interval and increases the rate of annual genetic improvement.

Introduction

Lowering the age of first mating can increase the overall productivity in a flock. In Indonesia, ewe lambs are mated at 10 to 12 months.

The results of research that explored the possibilities of shortening the time of first mating and the consequent effects on reproduction and overall productivity are presented here.

Summary of Findings

Age of first mating

First mating before an animal is 1 year is successful in some countries such as the United States (Spencer, Schott, Phillips, and Aune, 1942), New Zealand (Lewis, 1959), Australia (Suiter and Croker, 1970) and Iceland (Keane, 1974). Research findings include the following:

- Well-developed sheep can be first mated at 7 to 8 months.
- Over half (50% to 70%) of these younger-mated sheep produce lambs that have lower growth rates than those of mature ewes.
- Adequate feed must be supplied at an early age, during pregnancy, and during lactation to avoid growth depression.
- Subsequent lambing performance is not adversely affected by mating at an early age.

- First mating at an early age does not affect longevity of ewes.

Compared with that of subtropical regions, first mating at an early age is easier in tropical regions such as Indonesia because sheep do not show seasonal reproduction cycles (Fletcher and Putu, 1985; Obst, Boyes, and Chaniago, 1980). With an average growth rate of 87 g/day, Javanese Thin-tail (JTT) sheep reach puberty between their sixth and seventh month with body weights of 17 kg to 20 kg (Sutama, Edey, and Fletcher, 1988b). Therefore, JTT may attain first lambing at the age of 12 months.

Ewe lambs should be kept under good management conditions to obtain the optimum body weight. Body weight at first mating is important to prevent ewes from body weight loss during lactation. Best body weights for first mating are 30 kg to 35 kg for sheep in temperate regions and 17 kg to 20 kg for Indonesian sheep.

In temperate zones, young animals may show signs of estrus but with lower ovulation rates. Lower ovulation rates and lamb birth weights were observed for ewe lambs compared to that of mature ewes (Spencer, 1942). However, similar information for Indonesian sheep is limited. Estrous duration is shorter in ewe lambs, resulting in lower conception rates (Sutama et al., 1988a).

Reproductive patterns and overall productivity

Reproduction is related to the ovulation rate, (the number of ova shed per cycle). Research conducted at the Research Institute for Animal Production (RIAP) in Ciawi, West Java, showed that more than 90% of the JTT sheep ovulate at first estrus. Some ewe lambs ovulate one cycle but do not ovulate in successive cycles. Sometimes, ovulation is not accompanied by signs of estrus.

Embryo mortality in ewe lambs is higher than that of mature ewes. To avoid such productivity losses, farmers should adhere to the following recommendations:

- Maintain good body conditions in ewe lambs.
- Mate ewe lambs in a mating pen with an experienced ram, or hand-mate.
- Keep the ram in the flock with the ewes for two or three estrous cycles so that an unsuccessful mating at the first cycle can be corrected in the next cycle.
- Choose ewes that have an average litter size of two if ewe lambs are obtained from the local market (parent stock center or other producers).

Conclusion

Because the cost of replacement stock in sheep production is high, ewe lambs should be bred at the earliest age possible without sacrificing their successive production and reproduction performances. Adequate feeding is an important part of an early breeding program because it affects the physiological development of the ewe.

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Reducing the Preweaning Mortality Rate of Javanese Thin-tail Sheep

Bess Tiesnamurti

Abstract

High preweaning mortality is one of the limiting factors in Javanese Thin-tail (JTT) sheep production. The preweaning mortality rate varies from 5% to 39% and is affected by the lamb's gender, birth weight and milk production of ewes. Creep feeding and grafting methods are recommended to lower mortality rate. Creep feeding can be started at 2 to 3 weeks with high-protein concentrates. A choice of several high-energy legumes can be introduced gradually to activate the lamb's rumen functions. Grafting lambs to ewes bearing singles is a simple method. Separating the lambs to allow them to nurse one at a time has also proven effective.

Introduction

The two major groups of sheep found in Indonesia are the Javanese Thin-tail (JTT) and the Javanese Fat-tail (JFT). The highest concentration of JTT sheep are found in West Java. Central Java and the western part of Indonesia also contain large numbers of these animals. JFT sheep are found predominantly in east Java and the eastern part of Indonesia, where the climate is dry. In villages, farmers raise these animals in small-scale production systems, usually with three to ten sheep per farm. The sheep population has reached 5.4 million head in 1989.

Sheep productivity depends on several genetic, climatic, and management factors. Productivity is greatly affected by the survival rate of lambs. One factor discussed here relates to lamb survival rates from birth to weaning. The preweaning mortality rate of JTT sheep in the Garut area of West Java is 9.5%. But mortality rates vary from village to village. Other studies reported 4% and 10% lamb mortality rates (Soedjana and Knipscheer, 1982; Inounu, Thomas, and Sitorus, 1982). Preweaning mortality rate of JTT sheep that were kept in the research station was 39% (Obst, Boyes, and Chaniago, 1980). Such reports indicate a large variability in preweaning mortality rates.

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Summary of Findings

Effect of milk production

Growth rate of lambs is closely related to the ability of ewes to produce milk. Tiesnamurti and Inounu (1988) found that total milk production of ewes bearing two lambs was higher than of those bearing singles. Milk production starts to decline during the third and fourth weeks after lambing. Therefore, creep feeding is recommended at 2 to 3 weeks. Creep feeding will greatly increase the lamb's survival rate and weaning weight.

Effect of lamb gender

Manurug (1981) found that male lambs have higher survival rates and vigor than female lambs. Significant differences in birth and weaning weights were also found. JTT sheep from Cikajang and Wanaraja villages had different body weights at 3 months. Males averaged 13 kg and females averaged 8.35 kg.

Table 1. Differences in birth weights, weaning weights, and growth rates between male and female JTT sheep.

	Average birth weight (kg)	Average weaning weight (kg)	Average growth rate (g/day)
Male JTT sheep	1.8	8.3	71
Female JTT sheep	1.7	7.6	64

Source: Tiesnamurti, Inounu, Siturus, and Subandriyo, 1985.

Effect of litter size

Another factor that affects preweaning survival rate is the litter size. JTT from the Garut area have a high incidence of multiple births. However, their preweaning mortality is also high. Subandriyo (1986) reported preweaning mortality rates of 25.6% for singles, 38.7% for twins, 45.7% for triplets, and 58.1% for quadruplets. Litter sizes of three or more lambs have higher mortality rates because each lamb had a lower birth weight. Also, ewes bearing large litter sizes have shorter gestation periods, which causes lower birth weights. Additionally, mothering more than two lambs is difficult because the ewe may not have sufficient milk to meet the needs of all the lambs.

Effect of birth weight

Birth weight is another factor that influences preweaning growth and is a function of breed, age of ewe, and litter size. Observations at the Cicadas research station in the Bogor district of West Java showed that lambs with birth weights of approximately 1.1 kg have higher survival rates than those weighing less than 1.1 kg at birth. On the other hand, high birth weights can also create lambing difficulties, which result in weaker lambs.

One technique to reduce mortality rates in litter sizes greater than two is lamb grafting. Lamb grafting is the practice of transferring a lamb from a large litter to a ewe whose lamb died, or to a ewe that only had one lamb and is able to accommodate two. The following lamb grafting procedure has been found successful:

1. Tie the legs of the lamb to be grafted.

2. Rub the lamb to be grafted with chorionic fluid.

3. Choose a ewe that just gave birth to a single lamb or whose lamb just died.

4. Lay the lamb close to the chosen ewe.

5. Make sure that the ewe cleans the chorionic fluid from the lamb. Doing so means she accepts the lamb.

6. After the fluid has been cleaned, untie the grafted lamb and make sure the lamb tries to nurse the ewe.

7. If the ewe refuses to allow the grafted lamb to nurse, separate both lambs from the ewe and try this approach again in 15 minutes. If the second attempt fails, try this technique on another ewe.

Conclusion

Milk production greatly affects growth rates of lambs, which, in turn, influences mortality rates. In general male lambs are larger, both at birth and at weaning.

Litter size affects mortality rates in lambs. Because one or two lambs have lower mortality rates, this litter size is recommended for farmers with little management skills. For litter sizes greater than two, grafting techniques and creep feeding are needed. If there is not another ewe that has given birth at approximately the same time, the lambs should not be allowed to nurse together. Rotating lambs for nursing ensures that each gets enough milk. High-protein concentrates can also provide lambs with additional nutrition. A choice of several legumes with high-protein contents can be introduced in small portions to activate the lamb's rumen functions.

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Managing the High Prolificacy of Javanese Thin-tail Sheep

Bess Tiesnamurti

Abstract

A major gene (F^J) seems to determine litter size in Javanese Thin-tail (JTT) sheep. Two copies of the gene (F^J F^J) results in high-prolificacy ewes (H), one copy of the gene (F^J +) results in medium-prolificacy ewes (M); no gene (+ +) results in low-prolificacy ewes (L). Mature ewes of these three groups have mean litter sizes of 2.63, 2.02, and 1.27 respectively. A breeding scheme is proposed to make maximum use of this gene in JTT flocks in Indonesia.

Introduction

Javanese Thin-tail (JTT) sheep is a breed known for high prolificacy. Data collected for this breed shows a high frequency of multiple births, including triplets and quadruplets, in villages and on research stations. These sheep are commonly raised by smallholders.

JTT sheep from Garut in West Java produced 3.37 lambs/ewe/yr and the number of lambs weaned was 2.14 (Obst, Boyes, and Chaniago, 1980). JTT sheep from the Bogor district in West Java and the surrounding area produced 2.84 lambs/ewe/yr with 2.14 lambs weaned.

In addition to the number of lambs born, the conception rate is an important measure of reproduction. Bradford, Quirke, Sitorus, Inounu, Tiesnamurti, Bell, Fletcher, and Torrell (1986) reported a conception rate of 89% for JTT sheep. Bell and Inounu (1982) reported a conception rate of 162% in villages near Garut, and Obst et al. (1980) reported a rate of 180% under research station conditions.

This paper describes some factors influencing prolificacy of JTT sheep, how to take advantage of this breed to improve productivity of smallholdings in Indonesia, and a breeding program.

Summary of Findings

Prolificacy of Javanese Thin-tail sheep

Results from research station conditions over a 4-year period showed that 10.8% of the JTT ewes bore more than two lambs in their first litters; 25.6% bore more than two

lambs in their second litters; 44.7% bore more than two lambs in their third litters (Bradford et al., 1986). Average litter sizes were 1.54 (first litters), 1.98 (second litters, and 2.47 (third litters). The number of ova shed was the principal factor determining the prolificacy of JTT sheep, which ranged from 1 ova/cycle to 6 ova/cycle. Moreover, the ovulation rate of JTT seems to be affected by a major gene, designated as F^J. The criterion used to identify F^J gene carriers was a corpora lutea count greater than or equal to 3 or a recorded litter size of three or more lambs at least once during a ewe's lifetime. In further research, Bradford et al. (1990) identified three genotypes using the following criteria:

F^J F^J group: an ovulation rate or litter size of four

F^J + group: an average ovulation rate greater than 1.7 on three or more measures or an ovulation of 3 at least once

+ + group: an ovulation rate of 1 or 2 or low number of lambs born

To fall into the F^J F^J group, a single observation of an ovulation rate or litter size of four or more is sufficient. For the F^J + group and + + group, several observations are required. For example, one litter of triplets or repeated twin births are sufficient evidence to qualify a ewe for the F^J + group. If only twin and single births are observed, the ewe more likely qualifies as + + group.

Average litter size in these groups were 2.63 (F^J F^J), 2.02 (F^J +), and 1.27 (+ +). Therefore, the presence of the F^J gene contributes to litter size at approximately 0.8 lamb/gene copy. The repeatability value was 0.55 for ovulation rate and 0.53 for litter size in this breed (Bradford et al., 1990). Productivity of ewes from three groups of ewes differing in prolificacy is shown in table 1; H represents a mix of F^J F^J and F^J +; M represents F^J + ewes which had many sets of twins but no triplets; L represents ewes classified as + +. Average lambs weaned were 2.2 (H), 1.8 (M) and 1.2 (L) with weaning weights of 9.7 kg, 10 kg, and 9.1 kg respectively. No significant differences were found in the weaning weights among these groups. Further investigation suggested that within 7 years of research, there were 4 years of observation when management was better than in the other 3 years. For those 4 years, average weaning weights of 12.2 kg (group H), 12.2 kg (group M), and 10.6 kg (group L) were recorded. The remaining 3 years had poorer feeding and sheep management which resulted in average weaning weights of 6.6 kg (group H), 6.2 kg (group M), and 8.7 kg (group L). This observation indicates that the L group performs well even when raised under poor management conditions. The H and M groups, however, require better management to fully obtain their genetic potentials.

Table 1. Productivity of Javanese Thin-tailed sheep.

	Group		
	H	M	L
Average lambs weaned per ewe	2.2	1.8	1.2
Average weaning weight per ewe per lambing (kg)	9.7	10.0	9.1

Source: Bradford et al., 1990.

Strategy for optimal litter size

Management skills need to be considered to make maximum use of the high prolificacy of JTT sheep. An increase in a flock's average litter size must be accompanied by improved management conditions to actually benefit from the larger litters. An adequate feeding scheme is also required to maintain a higher average weaning weight of lambs. The following example shows how to develop a strategy for optimal litter size. Two management performances are compared; one, we call higher level of performance, the other lower level performance. Lower level performance does not necessarily mean poor management; in some cases, an operation with lower inputs is more economical or more appropriate given household resources.

Higher level performance implies adequate nutrition for the ewe and lamb and possibly fostering lambs born in litters of three or more.

Lower level performance is characterized by high mortality rates (especially for twins and triplets). The most common cause is low-quality and/or quantity of feed.

To evaluate a strategy, record litter sizes, mortality rates and 90-day weights as illustrated in table 2. Calculate the total weight of lambs weaned by multiplying the litter size by the survival rate and the 90-day weights, which yields the kilogram of lamb per ewe. Kilograms of lamb per ewe is the criterion for evaluating optimal litter size.

With good management, the optimal kilograms of lamb per ewe is 9 kg for one lamb, 11.5 kg for two lambs and 13.0 kg for three or more lambs. Under even better feeding and management, these might reach 10.5 kg for one lamb, 16.8 kg for two lambs, and 18.0 kg for three or more lambs. With lower levels of management, kilograms of lamb per ewe is 7.2 kg for one lamb, 7.8 kg for two lambs, and only 5.4 kg for three or more lambs. The conclusion from this example is that a high average litter size is desirable only if good management is provided. For example, when litter size is three or more lambs, the total kilograms of lambs per ewe varies from 13 kg with good management and 5.4 kg with lower levels of management. This implies that with lower levels of feeding and management, a farmer is better off having + + or a mixture of + + and F^J +

ewes than having highly prolific ewes. Farmers with lower levels of feeding and management will wean more lambs per ewe if litter size is only one or two than with larger litter sizes. Obtaining the optimum litter size can be facilitated by breeding programs.

Table 2. Total kilograms of lambs weaned per ewe in different management systems.

	Management system					
	Higher level			Lower level		
Litter size	Survival rate	90-day weight	Kg lamb per ewe	Survival rate	90-day weight	Kg lamb per ewe
1	0.90	10.0	9.0	0.85	8.5	7.2
2	0.70	8.2	11.5	0.65	6.0	7.8
>3	0.60	7.2	13.0	0.40	4.5	5.4

Recommended breeding program

The following breeding program is recommended for JTT sheep in Indonesia:

1. Develop two nucleus flocks by selecting $F^J F^J$ and + + genotypes. Select + + ewes if the level of nutrition and management is not adequate for prolific ewes. Under better management conditions, select F^J + ewes (produced by mating $F^J F^J$ rams to + + ewes). A flock of pure $F^J F^J$ is not recommended for commercial production because the resulting mortality is too high. This scheme is illustrated in figure 1.

2. Encourage private companies, farmer cooperatives, or both to produce replacement rams and ewes with the assistance of Research Institute for Animal Production (RIAP). The nucleus flocks could be managed by these companies and cooperatives.

3. Encourage private companies to become distributors of rams and ewes carrying known genes. Dissemination of the prolificacy genes to the farmers could be made through these distributors.

For the overall success of a breeding program, technical assistance to farmers should include lamb grafting, creep feeding, and the nutrition of lambs. Such assistance would lower overall lamb losses.

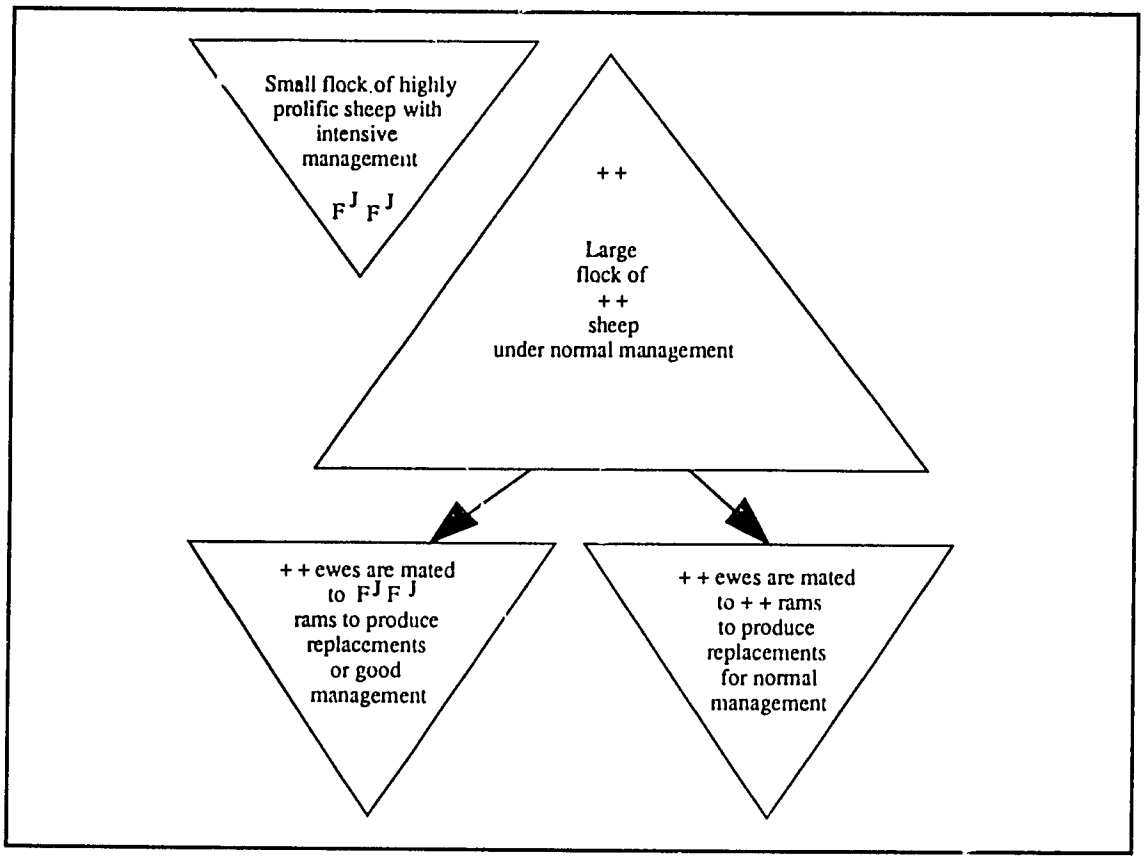

Figure 1. Development of nucleus flocks.

Conclusion

To take advantage of the prolificacy of JTT sheep, breeding techniques and management levels should be considered. A large litter of JTT sheep is desirable only if mortality rates can be kept to a minimum. For twins and litters of three or more lambs, the criterion for setting the optimal litter size should be the kilograms of lamb per ewe rather than the average number of lambs born. This measurement accounts for management level.

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Socioeconomic Considerations

Factors Affecting the Farmgate Price of Small Ruminants in West Java

Tjeppy D. Soedjana and Atien Priyanti

Abstract

A survey was conducted to determine whether prices were significantly affected by the holiday season, animal gender, and animal weight. Results showed that selling an animal, either male or female, during the holiday season yields a price increase of 25%. Price differences by sex was only 2000 Rp.

Introduction

The role of small ruminants in farming enterprises in Indonesia, particularly in West Java, have been investigated (Knipscheer and Soedjana, 1982; Knipscheer, Sabrani, DeBoer, and Soedjana, 1983; Mulyadi, 1984; Sabrani, Mulyadi, and DeBoer, 1982). Small ruminants are usually part of an integrated farming system comprised of crop production, livestock raising, forestry, and nonagricultural household activities such as handicrafts and seasonal off-farm employment. Raising sheep and goats is a secondary activity that uses low levels of family resources.

The productivity of small ruminants is below established potentials. Less-than-optimal management and marketing techniques are widespread. For example, marketing small ruminants usually occurs when cash is needed (such as before planting seasons) rather than when prices are highest. Replenishing stock usually occurs during the rainy season because feed is readily available, but the increased demand causes prices for young lambs to be higher. In summary, farmers buy high and sell low.

A survey was conducted to determine whether prices were significantly higher during the holiday seasons such as Idul Adha, which require male animals. Weight was also considered in the analysis because weight differs between males and females.

Summary of Findings

Analysis of price factors

The data came from monthly records of 29 groups of smallholders who participated in an Outreach Pilot Project (OPP) in 14 villages in the Bogor district of West Java. The following linear regression analysis, was used:

$$P = a + \beta_1 H + \beta_2 W + \beta_3 G$$

where P = Farmgate Price
H = Holiday
(H=1 if sold during holiday season,
H=0 otherwise)
W = Weight in kg
G = Gender (1 = male, 0 = female)

All coefficients are expected to be positive. No autocorrelation is expected, although hetereoscedasticity may be present.

Results

The results are all significant and the coefficients are in the expected direction. The variable that had the largest influence on price of a sale was the holiday variable with β_1=11.73 ($P < 0.01$). During the holiday season, the farmgate price is 11,000 Rp higher than off-season. The gender variable was the second most important one with β_2=2.02 ($P < 0.01$), implying that male sheep add an additional 2,000 Rp to the price. Such a small difference in prices of males and females is unexpected because a clear preference for male lambs seems to exist. However, having animals available for sale regardless of their sex might be important. This finding has important implications for production strategies, especially when lambs are purchased rather than bred.

Finally, weight had a coefficient of β_3=1.44 ($P < 0.01$), which means each additional kilogram adds 1,440 Rp to the sale price. Because preferences seem to be for younger animals, improved feeding schemes to increase weight promises good returns. The weight difference of 1-year olds varies to up to 5 kg, which means a difference in income of 7,000 Rp per animal.

Conclusion

The results are significant when considering that the average price is between 40,000 Rp and 50,000 Rp (1989). The holiday premium constitutes 25% of total price, a large marginal price increase. Gender and weight contribute about 10% to marginal price differentials, which is substantial enough to warrant more careful production decisions.

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Small Ruminant Marketing Channels in Indonesia

Tjeppy Soedjana, Atien Priyanti, and P. J. Ludgate

Abstract

An established mechanism for trade exists to bring small ruminants from rural areas to urban markets. Middlemen are numerous and provide farmers with several opportunities for sale. Local markets are integrated with national markets.

Introduction

During the past decade of collaborative research between the Research Institute for Animal Production and the Small Ruminant Collaborative Research Support Program, several sheep and goat marketing profiles and strategies were conducted in Indonesia (Damanik and Slangka, 1983; Knipscheer and Soedjana, 1982; Sabrani, Mawi, Soedjana, and Knipscheer, 1982; Sabrani and Knipscheer, 1982, Knipscheer, Sabrani, Soedjana, and DeBoer, 1987).

Every fifth household in Indonesia keeps sheep or goats. They contribute substantially to household income. Small ruminants are easy to transport and have a higher turnover rate than cattle or buffalo.

Summary of Findings

Market agents

A middle man is present in most small ruminant market transactions. This middle man is referred to as the blantik, if he acts as a broker, and the village collector otherwise. The terms vary slightly in different regions. For example, in West Java the blantik is sometimes referred to as the makelar (Sabrani et al., 1982; Sabrani and Knipscheer, 1982).

Even in isolated areas, farmers can choose between several traders. Traders travel on bicycles or motor bikes, which have baskets affixed on the back. A basket can carry as many as five animals. Local buses are used to transport the animals to urban markets. In some cases the village trader has direct connections with a regional trader who collects animals weekly.

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Market transactions

Farmers sell mostly to brokers or village collectors. Only a smaller portion of the livestock is sold directly to a final consumer in the market. About 10% of animals sold in local markets are bought by local farmers as stock replenishment (see figure 1).

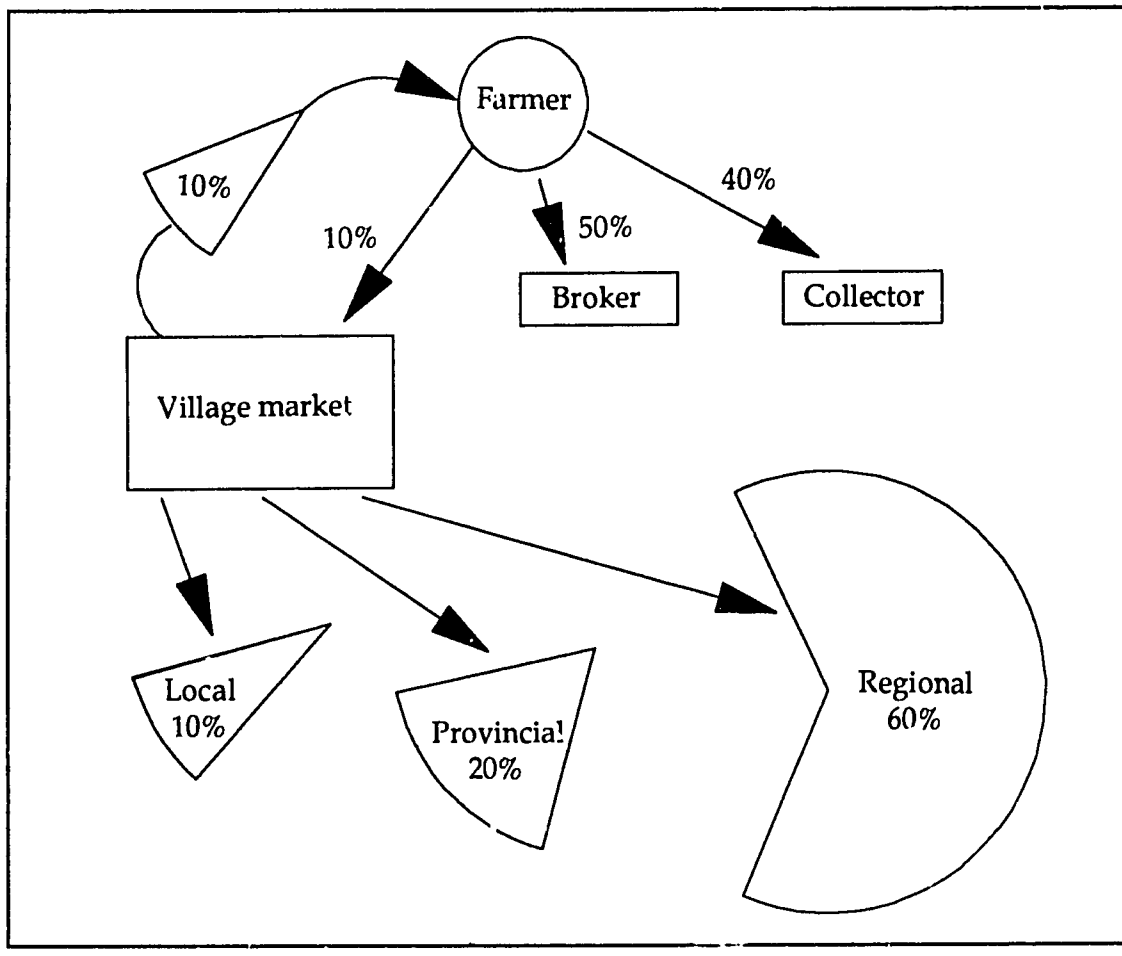

Figure 1. Small ruminant marketing channels. (Source: Soedjana et al., 1984.)

The village collector is an important link in the small ruminant marketing system. For some local traders this is a part-time activity however. In central Java the local trader is often a respected member of the village society (Damanik et al., 1983; Ihalauw, 1984). In North Sumatra this was not found to be the case.

In Java a more stable relationship seems to exist between trader and farmer, which Anderson (1980) characterized as traditional market system with cash/credit payment arrangements. A similar system was found in Aceh, but in North Sumatra no credit system seems to exist between producer and trader (Carlson and Scholz, 1991).

In Java a distinction is made between a village collector and a broker. The broker does not have full ownership of the animal, while the village collector does. The broker operates in a marketplace. Three types of brokers are common: the commission broker, the floor-price broker, and the price-fixing broker.

The commission broker sells the animal for a flat fee. The floor-price broker arranges for a floor price with the farmer and then tries to sell the animal above that. The price-fixing broker pays a percentage of an agreed upon price to the farmer and then tries to sell the animal, at which point the remainder is paid.

Market volume

The population of small ruminants in Indonesia is the largest of any country in the Asian region, with 10.5 million goats and 5.4 million sheep (see table 1).

Table 1. Small ruminant populations in Java.

	Goats (000 head)		Sheep (000 head)	
	1970	1987	1970	1987
West Java	1,189	1,456	1,818	2,423
Jakarta (district)	21	9.5	10	4.5
Central Java	1,924	2,351	885	1,249
Yogyakarta (district)	242	270	63	75
East Java	1,477	2,041	278	970
Indonesia	6,791	10,393	3,274	5,264

Source: Djajanegara and Iniguez (1989).

These animals, particularly goats, are widely distributed throughout the country. However, Java has a heavy concentration, approximately 70% of the total population. The small ruminant population has been growing at an annual rate of 3.5%.

Over the 17-year time period shown in table 1, Java's share in small ruminant population declined indicating that other regions of Indonesia increased their production substantially.

Conclusion

In general, small ruminant marketing mechanisms are well established both in short- and long-distance trade. Because much of the rural production is destined for urban markets, increase in trade is expected as income rises. Research in consumer

preferences for certain types of meat would help to evaluate the extent of demand increases.

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Farmer Groups as a Format for Technology Transfer in West Java

P. J. Ludgate, Tjeppy Soedjana, and Atien Priyanti

Abstract

An on-farm method of research and information exchange is described. On-farm experiments let researchers evaluate the impact of new technology as part of the whole farm management system, increases the probability that a new technology is adopted, provides more one-on-one discussion with farmers, and helps screen research activities for further, in-depth research.

Introduction

Technology is usually transferred from researcher to farmers in a top down mode. The researchers operate as change agents, providing management skills for components or complete technology packages.

More recently, researchers collaborated with farmers to exchange information. This approach is considerably more difficult because it requires both researchers and farmers to assume an active role in the information exchange. However, this mode ultimately yields better technology adoption rates. This collaborative type of technology exchange (on-farm research as opposed to on-station research) can also screen technology to help identify the most appropriate technologies for further in-depth research activities.

Summary of Findings

Whole-farm perspective

In general, on-farm research keeps the whole farming system in mind (Amir and Knipscheer, 1989). A farming system is an interaction between household activities, crop production, and livestock raising. None of these basic activities exist in isolation. Therefore, even when research focuses on livestock technology packages, constraints such as labor used in other activities must be taken into account. This approach to research implies that only the farmers' experiences can reveal to the researcher what farmers really need.

To develop technology packages, researchers should first describe the farm in terms of household, crop production, and livestock activities (Ludgate, Soedjana, and Kusnadi, 1989). Particularly important is a description of the roles each family

member plays in each activity. A good understanding of the division of labor within a farm system assures that recommendations for technology changes can be carried out.

Apart from the economic aspects of livestock production (income and labor), a description of livestock raising activities must include a section on the less quantifiable motives for owning animals (such as social obligations and prestige). To understand these motives assures that technology packages do not contain suggestions that are not viable.

All descriptions of a farming system should be ranked by importance within the total production system. Researchers must be able to evaluate how important individual activities are in the development of technology packages.

Outreach pilot program

After the initial description of Javanese farming systems, an Outreach Pilot Project (OPP) was set up to introduce new technologies that would increase small ruminant production. A group of farmers was divided into small units of 2 to 3 farmers each. A total of 46 farmers in 28 groups participated in this program. Initially, each group of farmers received five adult ewes, one adult ram, and sufficient funds to build a small, elevated barn. Each group was required to return two animals for each animal received after a certain time (5 years).

During the 5 years of the program a multidisciplinary team with breeding, nutrition, management, and extension backgrounds held monthly and bimonthly meetings and group discussions – the point of information exchange (Wahyuni, Ludgate, and Suradisastra, 1989). The researchers presented material that would highlight productivity improvements. Farmers discussed their successes and problems and were able to ask questions directly. Additionally, each farmer was visited by the researchers, providing further opportunities to address specific production constraints. During on-farm visits, researchers collected data to use later for production analysis.

On-farm visits provided opportunities to discuss new management techniques (such as separating animals according to physiological status). Researchers can evaluate the new technique in terms of time constraints and other factors.

Conclusion

On-farm research is a methodology for technology implementation that has been proven successful in Java. Taking the whole farming unit into account when technology packages are developed assures a greater rate of adoption. Technology packages that contain social taboos are eliminated at an early stage of research, making the research process more efficient.

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Dissemination of Information About Small-ruminant Production

Sri Wayhuni, Patrick J. Ludgate, and Michael F. Nolan

Abstract

A survey was conducted to determine how farmers receive information about new farm management technologies and which factors affect the farmers' decisions to implement them. Farmers received information from regularly scheduled meetings with extension agents and from other farmers. Farmers decided whether to implement new technologies based on cost, perceived need, and ease of implementation.

Introduction

In Java an Outreach Pilot Project (OPP) tests small ruminant production technologies by combining on-station and on-farm research with indigenous farmer knowledge. The goal of this village-level research program is to increase productivity of small ruminants through innovative production technologies.

The OPP farmers obtained information from the on-farm research team through bimonthly village meetings and monthly farm visits. Farmers also received technology and training packages. To evaluate the effectiveness of the technology transfer, a survey was conducted.

Summary of Findings

Health information

On average, 70% of the farmers had received information about animal health problems. Farmers reported that they were not actively seeking information on animal health issues. Over half of the technical information received was implemented (Adjid, Daniels, and Burton, 1989).

The level of adoptation is related to cost and availability of technology. For example, medicines that are expensive or difficult to find in some villages are less likely to be used. Also, some technologies were not adopted because they were thought not necessary. Farmers, for example, do not think that parasites and diarrhea are problems and, consequently, do not attempt prevention or treatment.

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Breeding information

On average, 46% of the farmers received information about breeding and reproduction. However, in certain categories the farmers lacked information concerning record keeping, regulating lambing and kidding intervals, and preweaning care. From the six types of information, four types (avoiding inbreeding, rotating rams and bucks, regulating lambing and kidding intervals, pregnant animal care, and record keeping) were provided predominantly by other OPP farmers. About 50% of the farmers considered the information not useful in increasing their small ruminant production (Ludgate, 1989).

Management and economic information

On average, 70% of the farmers received information about management. About 60% of this information was received during informal visits to farmers.

About 60% of the farmers received information about nutrition. The information was easy to implement and, therefore, adopted readily (Wahyuni, 1989). All the farmers rated the value of this information highly. Most of the farmers still lacked information about feed storage, and specialized animal feeding techniques.

Farmers implemented nearly 75% of the suggested information on how to estimate an animal's weight and price.

Conclusion

The survey showed that technologies are adopted more easily when farmers perceive a need and are able to implement the technology component easily. Technologies that are expensive or not readily available are disregarded. A good understanding of the farmers' perception of needed improvements and knowledge about technology price and availability is imperative.

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Appendix
SR-CRSP Working Papers

Appendix
SR-CRSP Working Papers

Number	Month/year	Title	Author(s)
1	Jan 1982	Small Ruminant Production on Small Farms in West Java, Indonesia: Preliminary Results of a Baseline Survey of Upland and Lowland Farming Systems	Mohammad Sabrani Agus Muljadi John DeBoer
2	Jan 1982	Prospects for Small Farm Goat Production in a Transmigration Area of Indonesia: Results of a Survey	Stephen Mink
3	May 1982	A Profile of the Sheep and Goat Markets in West Java, Indonesia	M. Sabrani S. Mawi Tjeppy D. S. H. C. Knipscheer
4	Jun 1982	The Productivity of Small Ruminants in West Javanese Farming Systems	H. C. Knipscheer Tjeppy D. S.
5	Aug 1982	Sheep and Goat Markets in Central Java: A Profile	M. Sabrani H. C. Knipscheer
6	Sep 1982	Productivity of Sheep Under Upland Farming Conditions in Sukawargi Village, District of Garut, West Java	Tjeppy D. S. H. C. Knipscheer
7	Nov 1982	Sheep and Goat Markets during the Islamic Holiday "Idul Adha" in Bandung, West Java	Tjeppy D. S.
8	Nov 1982	Sheep Reproduction Parameters from Sixteen Farms in Sukawargi Village, District of Garut, West Java	Monte Bell Ismeth Inounu
9	Mar 1983	A Survey of Six Specialized Small Ruminant Farms in West Java	H. C. Knipscheer Tjeppy D. S. A. Prabowo
10	Mar 1983	Small Ruminant Production in the Small-farm Perspective	Neil Thomas M. Rangkuti
11	Mar 1983	A Preliminary Analysis of Results from the Nutrition Village Monitoring Program	I. W. Mathius Hamzah Pulungan Neil Thomas
12	Mar 1983	Feeds and Feeding of Sheep in Sukawargi Village, West Java: A Profile Study	I. W. Mathius J. E. van Eys
13	Apr 1983	Social Aspects of Small Ruminant Production: A Comprehensive Study of West Java, Indonesia	Kedi S. M. F. Nolan

Number	Month/year	Title	Author(s)
14	Jun 1983	Women's Involvement in Small Ruminant Production in Cirebon, West Java	Sri Wahyuni Kedi S. E. Juarini
15	Aug 1983	A Production Function for Sheep and Goat Enterprises in West Javanese Farming Systems	Sugiyanto
16	Sep 1983	Consumption of Animal Products Among Traditional Sheep Farmers in Two West Java Villages	Kedi S. M. F. Nolan
17	Sep 1983	Small Ruminant Marketing in East Java	Tjeppy D. S. H. C. Knipscheer Sugiyanto
18	Sep 1983	Variability in Reproductive Performance of Sheep Among Twenty-two Farms in Tenjonegara and Sindangratu Villages, District of Garut, West Java	Monte Bell Ismeth Inounu Bess T. Subandriyo
19	Sep 1983	Utilization of Napier Grass With and Without *Sesbania grandiflora* by Growing Sheep	I. W. Mathius j. E. van Eys
20	Oct 1983	Livestock Farming Systems for Rural Development in Indonesia	M. Sabrani A. P. Siregar R. J. Petheram H. C. Knipscheer
21	Oct 1983	Design of Alternative Crop-Livestock Systems for Asian Farmers	John DeBoer
22	Oct 1983	The Role of Livestock in Watershed Projects on Java	Bedjo Soewardi H. C. Knipscheer M. Sabrani
23	Oct 1983	A Monitoring Program for Village Sheep and Goat Farms in Indonesia I. Breeding/Reproduction	Monte Bell Ismeth Inounu Subandriyo B. Setiadi Bess T. G. E. Bradford P. Sitorus
24	Oct 1983	Forage Composition of Sheep and Goats Diets in West Java	J. E. van Eys I. W. Mathius Neil Thomas M. Rangkuti W. L. Johnson

Number	Month/year	Title	Author(s)
25	Nov 1983	Genetic Basis of Prolificacy in Javanese Sheep – A Progress Report	G. E. Bradford J. F. Quirke P. Sitorus Ismeth Inounu Bess T. F. L. Bell D. T. Torell
26	Nov 1983	Feeding Value of Fresh and Ensiled Tropical Grasses for Growing Sheep	J. E. van Eys I. W. Mathius Hamzah Pulungan W. L. Johnson
27	Nov 1983	A Small-farm Sheep and Goat Production Model for Indonesian Conditions	Neil Thomas M. Rangkuti W. L. Johnson G. E. Bradford
28	Dec 1983	The Role of the Villages Collector (*blantik*) in the Production and Marketing Systems of Small Ruminants in Central Java	K. I. Damanik Max K. Salangka
29	Dec 1983	The Present and Potential Productivity of Indonesian Goats	H. C. Knipscheer Uka Kusnadi
30	Jan 1984	The Impact of Altitude on Sheep and Goat Production	Maria Astuti Monte Bell P. Sitorus Eric Bradford
31	Mar 1984	Economic Roles of Small Ruminant Production in Two Areas of West Java, Indonesia	Agus Muljadi N.
32	Mar 1984	A Summary of Exploratory Research on Various Socio-economic Aspects of the Goat/Sheep Production Systems in Central Java (1981-1982)	John Ihalauw
33	Sep 1984	Supplementation of Napier Grass With Three Tree Legumes; Effects on Intake, Digestibility and Weight Gain of Lambs	I. W. Mathius J. E. van Eys M. Rangkuti
34	Sep 1984	Small Ruminant Production in West Java; Results of One Year Monitoring by the Nutrition Village Monitoring Program	J. E. van Eys I. W. Mathius H. Pulungan
35	Sep 1984	Genetic and Non-genetic Factors Associated with Litter Size in Sheep: A Literature Review	Subandriyo

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36	Sep 1984	Reproductive Performance of Javanese Sheep on Different Planes of Nutrition	Ismeth Inounu P. Sitorus Bess T. I. C. Fletcher
37	Sep 1984	Performance of Etawah Grade and Kacang Goats	B. Setiadi P. Sitorus
38	Sep 1984	Regular Research Field Hearings (RRFH): A Discussion of the Contribution of Farmers' Opinions to Farming Systems Research	Kedi S. H. C. Knipscheer
39	Sep 1984	Sheep/Goat Controllership Systems and the Role of the Village Collector in the Sheep/Goat Production and Marketing Systems	John Ihalauw
40	Sep 1984	Studies on the Mineral Nutrition on Sheep in West Java, Indonesia	A. Prabowo J. E. van Eys I. W. Mathius M. Rangkuti W. L. Johnson
41	Oct 1984	Lambing Characteristics of Javanese Thin-tail Ewes at Cicadas Experiment Station and Under Village Conditions	Ismeth Inounu Neil Thomas P. Sitorus Monte Bell
42	Feb 1985	Pre-weaning Performance of Javanese Lambs	Bess T. Ismeth Inounu P. Sitorus Subandriyo
43	Feb 1985	Women's Decision Making Role in Small Ruminant Production: The Conflicting Views of Husbands and Wives	Sri Wahyuni Mark Gaylord H. C. Knipscheer
44	Feb 1985	Growth Characteristics of Indonesian Sheep	Subandriyo P. Sitorus G. E. Bradford R. L. Blackwell
45	Mar 1985	Litter Weight of Indonesian Sheep Under Village and Experimental Station Conditions	Subandriyo
46	Apr 1985	Housing of Sheep and Goats in West Java	Ruth M. Gatenby Muchji M. Sri Wening H. M. Waldron
47	Apr 1985	Survey of Small Ruminant Farmers in Sumatra	H. Pulungan Alice Reese J. E. van Eys W. L. Johnson

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48	May 1985	Secondary Village Level Data for Fifteen Villages of Kecamatans Sibolangit, Galang, and Perbaungan, Kabupaten Deli Serdang, North Sumatera	Joel Levine Setel Karo-Karo
49	Aug 1985	Reproductive Performance of Indonesian Sheep on Different Planes of Nutrition	Ismeth Inounu P. Sitorus Bess T. I. C. Fletcher G. E. Bradford
50	Aug 1985	The Role of Women in Small Ruminant Production – A Case in Ciburuy, West Java	Sri Wahyuni Ruth M. Gatenby
51	Aug 1985	Evaluation of Wilted Cassava Leaves as Protein Supplement to Napier Grass Diets for Growing Lambs	I. W. Mathius J. E. van Eys H. Pulungan
52	Sep 1985	Leucaena Supplementation to Rice Straw-based Diets for Growing Sheep	Sorta S. Sitorus J. E. van Eys H. Pulungan
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54	Sep 1985	Utilization of *Ampas Tahu*, A Soybean By-product, by Growing Goats	H. Pulungan J. E. van Eys M. Rangkuti
55	Sep 1985	Study of Some Aspects of Reproduction in Javanese Thin-tail and Javanese Fat-tail Sheep	P. Sitorus Subandriyo Ismeth Inounu
56	Sep 1985	Effects of Intermittent Feeding of *Gliricidia Maculata* on the Utilization of Napier Grass by Growing Sheep and Goats	M. Rangkuti H. Pulungan J. E. van Eys
57	Sep 1985	Women's Role in Small Ruminant Production: Motivations, Perceptions and Problems	Sri Wahyuni Mark Gaylord
58	Sep 1985	On-farm Trials of Mineral Supplementation for Small Ruminants in West Java, Indonesia	J. E. van Eys S. Silitonga I. W. Mathius W. L. Johnson
59	Sep 1985	The Role of Rural Sociology in Farming Systems Research	Mark Gaylord
60	Sep 1985	Sheep Production in Three Villages of West Java	Subandriyo

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61	Sep 1985	Livestock Marketing Survey for Kecamatans Sibolangit, Galang, and Perbaungan of Kabupaten Deli Serdang, North Sumatera	Joel Levine Setel Karo-Karo Mark Gaylord
62	Oct 1985	Labor Use for Small Ruminants in Three Indonesian Villages	Pervaiz Amir Tjeppy D. S. H. Knipscheer
63	Oct 1985	Economic Analysis of On-farm Livestock Trials	Pervaiz Amir Henk Knipscheer John DeBoer
64	Oct 1985	Gliricidia Foliage as a Supplement to Napier Grass-Cassava Leaf Diets for Small Ruminants	I. W. Mathius J. E. van Eys H. Pulungan
65	Oct 1985	Effects of Level of Feeding and Litter Size on Milk Yield and Composition from Javanese Ewes	S. S. Sitorus S. Ginting J. E. van Eys I. Inounu
66	Oct 1985	Combinations of Cassava Leaves and Native Grass in Diets for Goats	S. S. Sitorus
67	Nov 1985	Growth Rates of Lambs in Villages in West Java	M. C. Waldron R. M. Gatenby P. Sitorus Subandriyo
68	Dec 1985	A Survey of Goat Husbandry in West Timor and Recommendations for Research at Lili	Ruth M. Gatenby
69	Jan 1986	On-farm Performance of Small Ruminant Technologies in West Java: Implications for Technology Transfer and Design	Pervaiz Amir Henk Knipscheer S. Mawi Ginette Spinhoven
70	Feb 1986	The Effect of Litter Size on Birth Weight, Weaning Weight and Some Puberty Traits	P. Sitorus Bess Tiesnbamurti Subandriyo
71	Feb 1986	The Influence of Shearing and Giving Concentrate on the Performance of Javanese Thin-tail Sheep	Muchji M. Ginette Spinhoven Ruth M. Gatenby
72	Feb 1986	Evaluation of Farmers' Responses to the First Outreach Pilot Project (OPP) Farmers' Meeting	Syahrir Mawi Mark Gaylord
73	May 1986	Ovulation Rate and Litter Size of Indonesian Goats	Subandriyo B. Setiadi P. Sitorus

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74	May 1986	Survival Rates of Indonesian Sheep Under Experiment Station Conditions	Subandriyo
75	May 1986	Comparison of the Thermal Budgets of Five Different Roofs of Animal Houses	R. M. Gatenby M. M. Martawidjaja G. Spinhoven
76	Jun 1986	Baseline Survey Results of the Upland Agriculture and Conservation Project Research Locations in Central Java: How Do the Farmers of Kandangan and Klari Live Before the Project?	J. Levine A. Muljati N. Amiruddin Subiharta R. L. Watung
77	Jul 1986	Integrating Sheep with Rubber Plantations 1985-1986	A. A. Reese Y. Taryo-Adoiwiganda S. W. Handayani Sumarmadji S. Ginting G. R. Reese
78	Jul 1986	Temperature and Humidity Inside and Outside Sheep and Goat Houses in the OPP Project	M. Martawidjaja R. M. Gatenby
79	Jul 1986	Traditional Systems of Goat Production in Three Areas of Indonesia: West Java, North Sumatra and West Timor	R. M. Gatenby Subandriyo
80	Jul 1986	Barbados Blackbelly Sheep in Central Java	R. M. Gatenby Subandriyo J. M. Levine T. Prasetyo
81	Sep 1986	Heat Budgets of Virgin Island and Sumatra Rams at Sungei Putih, North Sumatra	R. M. Gatenby S. W. Handayani A. D. Pitono
82	Sep 1986	Etawah Grade Goat Production in Bogor and Cirebon Goat Station of West Java	Subandriyo Bamgang S. P. Sitorus
83	Sep 1986	Sheep Production in Villages of Garut, West Java	Subandriyo
84	Sep 1986	Small Ruminant Production in Lowland Villages of Cirebon, West Java	P. Sitorus Subandriyo
85	Sep 1986	Effect of Three Levels of Nutrition on Ovulation Rate of Javanese Thin-tail Sheep	A. D. Pitono Subandriyo P. Sitorus

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86	Oct 1986	The Potential of Small Ruminant Livestock on Rubber Plantation Schemes: A Linear Programming Analysis	Pervaiz Amir H. C. Knipscheer Setel Karo Alice Reese John DeBoer
87	Nov 1986	Effect of Management System, Legume Feeding and Anthelmintic Treatment on the Growth of Lambs in North Sumatra	S. W. Handayani R. M. Gatenby
88	Nov 1986	Report on the Second Annual Outreach Pilot Project (OPP) Farmers' Meeting	A. Priyanti A. Wilson D. Yulistiani P. Bilinsky S. Mawi
89	Nov 1986	Effect of Level of Energy Supplementation on the Birth Parameters and Pre-weaning Growth Rate of "Sumatera Lokal" Sheep	S. W. Handayani A. A. Reese S. P. Ginting
90	Nov 1986	Effect of Supplementation of Palm Kernel Sludge for Sheep Fed a Basal Diet of Native Grass	S. W. Handayani S. P. Ginting P. P. Ketaren
91	Dec 1986	Urea, Cassava Leaf and Soysauce Waste Supplements for Sheep Given Rice Straw Ad Libitum	S. S. Sitorus P. Pongsapan J. E. van Eys T. Manurung R. M. Gatenby
92	Feb 1987	On-farm Performance of Small Ruminant Technologies in West Java: Evaluation of the Introduction of *Gliricidia Maculata* to OPP Farmers	S. Mawi P. Bilinsky A. Wilson M. Rangkuti
93	Mar 1988	Report on the Third Annual Outreach Pilot Project (OPP) Farmers' Meeting	A. Priyanti B. Setiadi D. Lubis A. Adjid M. Rangkuti
94	Mar 1988	Farmers Responses to the Outreach Pilot Project (OPP): First Socio-economic Evaluation	A. Priyanti S. Mawi K. Suradisastra
95	Jan 1989	Characteristics of High and Low Performing Farmers in OPP Villages	A. Priyanti T. D. Soedjana S. W. Handayani P. J. Ludgate
96	Jan 1989	Summary Report of 1987-1988 Outreach Pilot Project Research Activities	P. J. Ludgate

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97	Jan 1989	Studies of Sheep Health Problems Among Small-holders in Bogor, West Java	A. Adjid P. W. Daniels R. W. Burton
98	Feb 1989	Participatory Research by Small Ruminant Farmers in West Java	P. J. Ludgate A. Priyanti H. C. Knipscheer
99	Mar 1989	Womans' Involvement in the Improvement of Small Ruminant Production in OPP Villages: Time and Motivation	A. Priyanti P. Bilinsky
100	Apr 1989	Group Dynamics Study with Outreach Pilot Project Farmers	S. Wahyuni P. J. Ludgate K. Suiquidara
101	Apr 1989	Effect of Technology Packets on Feeding Management with the Outreach Pilot Project (OPP) Farmers	D. Yulistiani W. Mathius M. Martawidjaja
102	Apr 1989	Improvement in the Use of Palm Kernel Cake as a Feed Supplement for Grazing Sheep	M. Boer M. D. Sanchez
103	Apr 1989	Evaluation of Selected Native and Introduced Forage Species in North Sumatra: First Report	T. M. Ibrani M. D. Sanchez
104	Apr 1989	Supplementation of Local and F_1 (Local x St. Croix) Growing Sheep Under the Rubber Trees in North Sumatra	M. D. Sanchez M. Boer
105	Jul 1989	Management of Sheep/Goat Housing Systems at the Village Level in the Bogor District	M. Martawidjaja B. Setiadi A. Priyanti D. Yulistiani
106	Aug 1989	Marketing and Utilization of Goat and Sheep Manure in the Bogor District	S. Mawi M. E. Yusnandar T. D. Soediana P. J. Ludgate
107	Oct 1989	Farming Systems Research and Extension Relationships: Methodological Issues Affecting Implementation and Extension of Research Results	P. J. Ludgate T. D. Soedjana U. Kusnadi
108	Dec 1989	Women's Participation in Agricultural Extension Services: A Southeast Asian Perspective	P. J. Ludgate A. Priyanti T. D. Soedjana
109	Feb 1990	Outreach Pilot Project On-farm Research Activities Annual Report for 1988-1989	P. J. Ludgate A. Priyanti

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110	Mar 1990	Analysis of Factors Affecting the Farm-gate Price for Small Ruminants in the District of Bogor, West Java	T. D. Soedjana A. Priyanti
111	Mar 1990	Adoption of Nutrition Techpack by Farmers Participation in the Outreach Pilot Project (OPP)	B. Haryanto D. Yulistiani I. W. Mathius M. Martawidjaja
112	Mar 1990	Barn Management Systems of Sheep and Goats by OPP Farmers	M. Martawidjaja A. Priyanti B. Setiadi P. J. Ludgate
113	Mar 1990	Allocation of Work and Leisure Time by Potential Labor Sources Among OPP Farmers, West Java	A. Priyanti T. D. Soedjana P. J. Ludgate
114	Apr 1990	A Comparative Study on Socio-economics Aspects of Small Ruminant Production in West Java	K. Suradisastra T. D. Soedjana
115	Apr 1990	The Economic Values of Production Traits in the Javanese Thin-tail Sheep	T. D. Soedjana L. Iniguez D. Yulistiani
116	Apr 1990	Cost-benefit Analysis of Sheep Production at the Village Level in the Outreach Research Project North Sumatra	S. Karo-Karo E. Sembiring M. D. Sanchez H. C. Knipscheer
117	Apr 1990	Cost-benefit Analysis of Sheep Production at the Village Level in the Outreach Research Project North Sumatra	S. Karo-Karo E. Sembiring M. D. Sanchez H. C. Knipscheer
118	Apr 1990	Survey of Traditional Medicine Use for Sheep Health Problems by OPP Farmers in the Bogor District of West Java	R. M. A. Adjid
119	Oct 1990	The Outreach Research Project Evaluation in Sei Putih – North Sumatra	T. D. Soedjana E. Sembiring M. D. Sanchez
120	Oct 1990	Farmer Oriented Research Yield Innovative Communication Technologies for On-farm Research in West Java	P. J. Ludgate T. D. Soedjana A. Priyanti H. C. Knipscheer
121	Nov 1990	Baseline Data for Research Regarding the Sociological Impact of Women Focused Strategies for Improving Small Ruminant Production	S. Wahyuni D. Priyanto A. Suparyanto P. J. Ludgate T. D. Soedjana

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122	Nov 1990	Technology Development in Integrated On-farm Animal Research: Farmer Groups in West Java, Indonesia	P. J. Ludgate T. D. Soedjana A. Priyanti H. C. Knipscheer
123	Dec 1990	Dissemination of Small Ruminant Production Information in OPP Villages in the Bogor District of West Java	S. Wahyuni P. J. Ludgate M. F. Nolan
124	Jan 1991	Ovulation Response to PMSG in Prepuberal Javanese Sheep	B. Tiesnamurti G. E. Bradford L. C. Iniguez
125	Dec 1991	Partial Budget Analysis of Feeding Supplements	S. Karo Karo S. Scholz
126	Dec 1991	The Effect of Increased Supply of Sheep on Producer Revenues	C. Carlson S. Scholz
127	Feb 1992	The Sociology of Animal Health: Traditional Veterinary Knowledge in Cinangka, West Java, Indonesia – A Case Study	S. Wahyuni T. B. Murdiati Beriajaya H. Sangat-Roemantyo A. Suparyanto D. Priyanto Isbandi E. Mathias-Mundy
128	Dec 1991	Socio-economic Survey of Farmers in Membang Muda Outreach Project	E. Sembiring S. Scholz
129	Mar 1992	Guidelines for an Agribusiness Enterprise: A Sheep Finishing Scheme	L. Batubara S. Scholz J. Verwilghen T. van Schie
130	Feb 1992	The Economics of Treating Parasites in Small Ruminants	S. Scholz
131	Dec 1991	Basis for a Program of Sheep Genetic Improvement in West Java	L. Iniguez G. E. Bradford Subandriyo
132	Feb 1992	Progress Report of Outreach Project: Membang Muda, North Sumatra	S. Scholz
133	Apr 1992	Production of Sheep in Villages Adjoining Rubber Plantations	J. Verwilghen T. van Schie A. D. Pitono E. Sembiring

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