ADVANCES IN SMALL RUMINANT RESEARCH IN INDONESIA

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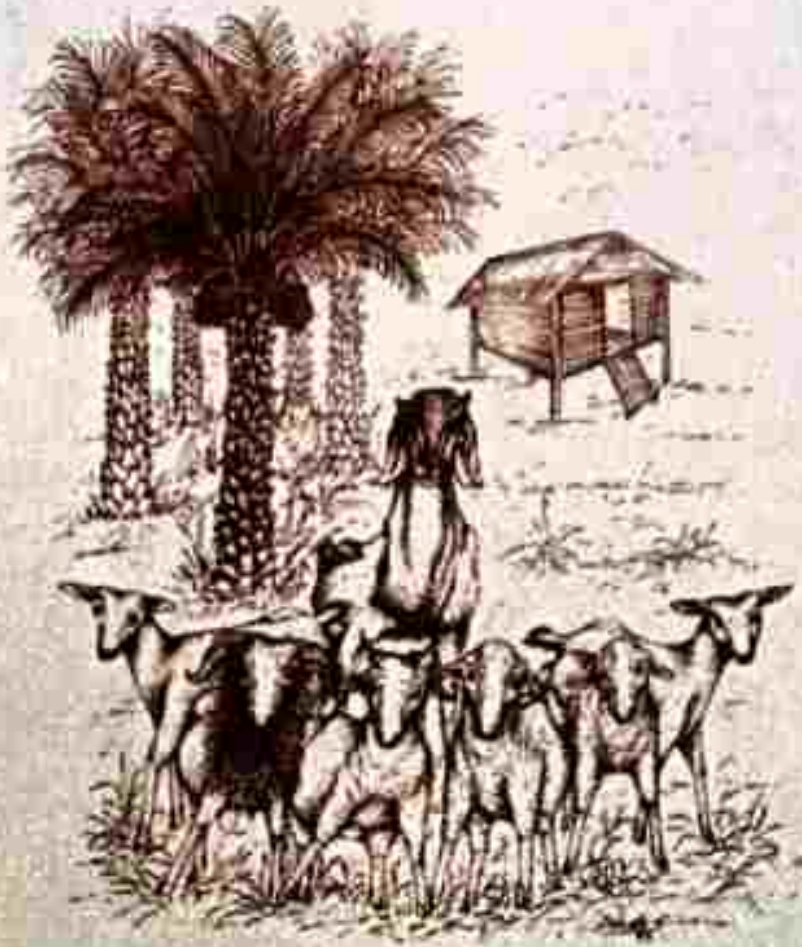

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CONTENTS

Page

Session III & IV: Forage and Nutrition Aspects

FOREWORD

Over the First Long-term Development Phase (PJPT I) from 1969-1991, the livestock sub-sector, including that of small ruminants, has developed significantly. The sheep and goats of Indonesia are prolific. However, to express their potential for high production, improvements in management, disease control and feed supply have to be made. The management of small ruminant farming has remained largely the same over the past two decades although the population of small ruminants is increasing by 3-4 percent annually. Small ruminants are important in the development of agricultural systems and for small holders farmers they have a whole range of advantages over other livestock. But of course there are also some limitations and disadvantages, for example, more animals have to be kept to meet family needs and they are more susceptible to predators and are easily stolen.

In the next Long-term Development Phase (PJPT II) starting in 1994, the livestock sub-sector has been considered as one of the most promising emerging sectors and will receive high priority in relation to improving the nutritional state and welfare of rural poor people.

In this context, it is expected that the development of the small ruminant industry will follow the agro-industrial approach set forth by the Government, keeping other development objectives, such as conserving the environment and improving farmers' welfare in perspective. The demand for meat will obviously increase in the future due to the increase in human population, increased income as the progress of the development efforts and increased awareness in nutrition. In this regard, mutton and goat meat will contribute a great deal to meet the high demand.

In addition, increased access to the international market will create competitive markets, and open attractive challenges such as that in the Middle East. One aspect that may support the creation of international markets is the development of the golden triangle zone between Malaysia, Thailand and Indonesia. When considering the development of small ruminants we will have to consider this opportunity and possibly increase the production of sheep in North Sumatra and Aceh, and probably also in surrounding areas like Riau, through production systems integrated with estate crops.

CRIAS has had the opportunity to collaborate with US scientists and institutions through the SR-CRSP for many years. Many research activities have already produced excellent results which have enriched our knowledge and skills. The project has focused on sheep, with only limited attention to goats, although, in fact, the population and importance of goats to our national economy, may well be greater.

The new technologies produced in CRIAS should be technically feasible and economically profitable, and more importantly socially adoptable and environmentally sound. The major constraint that can critically affect small ruminant production concerns the inadequate feed resource. In the introduction of exotic breeds in order to achieve high genetic potential, this important aspect is often ignored.

The results of research efforts presented in this workshop through the provision of small grants to individual researchers of different institutions would likely provide a better understanding of the state of art of science and technology in our endeavor to produce new technologies for developing the small ruminant industry. It is hoped that the conclusion and recommendations of the meeting will be useful in continuing our task in research and development towards a progressive small ruminant industry.

In this opportunity, I would like to express my appreciation to the SR-CRSP for the support given and all who have worked hard in the preparation of the workshop.

Dr. P. Sitorus
Director of CRIAS

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We wish to express our appreciation to Mrs. Josephine Prasetyo for having devoted extra hours in preparing the workshop and for her valuable help in reviewing the manuscript and format.

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INTRODUCTION

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Small Ruminant-Collaborative Research Support Program (SR-CRSP) activities in Indonesia started in 1980. SR-CRSP supports the goals of the Government of Indonesia to sustain and enhance agricultural production, especially for sheep and goat production. The first five year activities of SR-CRSP were concentrated in West Java, and the research strategies are focused on the intensive production system. The research in West Java is being conducted in collaboration with Agency for Agricultural Research and Development (AARD) through the Research Institute for Animal Production (RIAP).

In 1984, the SR-CRSP began a research project on integrating sheep with rubber plantations in North Sumatra, Indonesia. This research is being conducted in collaboration with AARD through the Sub-Research Institute for Animal Production at Sungai Putih and the Rubber Research Institute at Sungai Putih, North Sumatra.

However, working in two sites (Bogor, West Java and Sungai Putih, North Sumatra), the SR-CRSP is able to reach only a small target audience. In 1991 the SR-CRSP started the Small Grant Program in which research projects in all geographical areas of Indonesia are supported. The idea and decision to give out small grants was seen to be good, and the SR-CRSP also started to give small grants in Kenya and Bolivia in 1993.

The objective of the workshop is to present and discuss the results of research funded by the SR-CRSP Small Grant Scheme for 1991 and other research results of the scientists who are involved with the SR-CRSP program.

The workshop was organized in 5 sessions for the presentation and discussion of contributed papers, and general discussion. The first session covered socio-economic aspects. The second was devoted to animal breeding, reproduction and production aspects. The third and fourth sessions discussed forage and nutrition. The last session included animal health and networking.

There were 20 papers delivered and a total of 60 participants. Nine papers were delivered by small grants recipients from scientists of Sumatra Utara University; RIAP; Veterinary Consultant and librarians from RIAP and the

Research Institute for Veterinary Science (RIVS); Scientists from Sub-Research Institute for Animal Production at Gowa, South Sulawesi; Mataram University, West Nusa Tenggara; and the Sub-Research Institute for Animal Production at Lili-Kupang, East Nusa Tenggara Timur. Other contributed papers were delivered by scientists from RIAP, RIVS, CRIAS and SRUPNA who are involved with the SR-CRSP program.

The general discussion provided the opportunity for general participation that yielded a set of conclusions and recommendations for the various disciplines involved, the small grant scheme and networking.

We hope that these proceedings will contribute to the research and development of small ruminants. In particular, we hope that they will be serve as a reference for colleagues needing to compare and discuss their views on small ruminant research and development in Indonesia.

Session I
Socio-Economic Aspects

DIRECTION OF FUTURE SMALL RUMINANT RESEARCH AND DEVELOPMENT IN INDONESIA

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ABSTRACT

In accordance with changes in the insights or concepts, strategies, and policies of agricultural sector development, livestock research and development in Indonesia needs to be adapted and matched with the demand for research outputs and the new challenges in the next Long Term Development Plan. Accordingly, small ruminant research and development should be directed toward increasing the opportunity, ability and skill of the livestock sub-sector participants, particularly the small ruminant farmers. These objectives may be achieved through: (1) research and development in small ruminant technologies, (2) research and development in small ruminant infrastructure and facilities, (3) research and development of natural resources and environmental protection to support sustainable small ruminant production systems, (4) research and development in human resources, and (5) research and development in small ruminant policies and institutions that directly or indirectly affect livestock performance. Sufficiency, continuity, and flexibility of funding for research and development in livestock in general, and small ruminants in particular, should be improved in view of the magnitude and complexity of areas and problems to be tackled. These include funds for research operation, dissemination of research results, and maintenance and up-dating of research facilities. In addition to the existing National Development and Routine Budget and external grants and loans, financial arrangements with private enterprises and provincial governments should be enhanced. Furthermore, different sources of funding should be explored and a multi-year financing plan should be developed and sustained.

Introduction

Agricultural sector development and livestock sub-sector development, as part of the overall national development program in the past, have improved daily per capita protein consumption from 1.40 gram in 1969 to 3.10 gram in 1991 with a 3.68% annual average rate of increase (DGLS, 1992). Although the relative share of Gross Domestic Agricultural Product (GDP) declined sharply from 70% in Pelita I to around 20% at the end of the Five Year Development Plan (Pelita) V, the livestock sub-sector maintains its important roles in the national economy and has increased its GDP share in the agricultural sector from 6% to 11.3% as a result of non-oil exports, providing high quality food and creating rural job opportunities (Soehadji, 1993).

Agriculture Sector Development Programs. The four major agricultural development programs to be implemented in Pelita VI are: 1) development of integrated smallholder farming, 2) development of agricultural enterprise, 3) diversification of food and nutrition, and 4) development of agricultural infrastructure and facilities. With these programs, agricultural development is aimed at establishing a resilient, modern, and efficient agricultural sector characterized by its ability to improve the welfare of the people, and in pushing the growth of the related sectors as well as the national economy in general. The annual growth of the agricultural sector during the Pelita VI period is projected at 3.4% wherein the annual growth for various sub-sectors are: 2.5% (food crops), 6.4% (livestock), 5.2% (fisheries), 4.2% (estate crops), and 0.5% (forestry).

Livestock Sub-sector Development Programs. As a result of the livestock sub-sector development programs in Pelita I - Pelita V, the contribution of small ruminants to national meat production has increased from 3.14% (sheep) and 3.88% (goats) in 1969 to 3.40% (sheep) and 5.18% (goats) in 1991. These figures imply that there were average annual increases of 6.33% (sheep) and 7.34% (goats) during 1969-1991 (DGLS, 1992).

To accomplish the 6.4% increase in its GDP, the livestock sub-sector programs include: increasing meat, milk and egg production and livestock population through improvements in breeds and breeding, reproduction and feeding management, disease control, and forage and concentrate production. The program formulation (DGLS, 1993) for the target accomplishment consists of (1) sectoral programs: development of smallholder livestock units, establishment of large scale livestock enterprises, development of livestock facilities and infrastructure, and (2) cross sectoral programs: forestry, transmigration, civil services, and food and nutrition diversification.

Livestock Research and Development Programs. In accordance with changes in the insights, concepts, strategies and policies of agricultural development as stated earlier, livestock research and development in Indonesia have to accommodate the increase in demand for livestock products and other challenges during the PJPT II. In this respect, livestock research and development should be directed toward increasing the opportunities, the ability and the skills of the livestock development participants, particularly the farmers. The direction may be secured through the implementation of five major research programs (AARD, 1993): (1) research and development in livestock technologies, (2) research and development in livestock infrastructure and facilities, (3) research and development of natural resources and environmental protection to support sustainable livestock production systems, (4) research and development in human resources, and (5) research and development in policies and institutions that directly or indirectly affect livestock production performance.

Present Small Ruminant Research and Development

National Standing. Nearly 99% of small ruminants in Indonesia are in the hands of smallholders and less than one percent are raised under fully commercialized operations (Agency of National Export Development, 1988). This fact indicates the important role of smallholders as the rearers of the potential stock from which the national small ruminant production will be drawn. Furthermore, the national development program for increasing livestock population, including sheep and goats, through the distribution of livestock into transmigration areas and other areas outside Java has allowed small ruminants to be even more widely distributed among farm households as an alternative income-generating activity.

Small ruminant productivity at farm level has been considered low compared with levels obtained at experimental stations. The economic implication of increased small ruminant productivity is obvious since small ruminants are nearly equally distributed among smallholders and the potential income generated from them contributes a considerable share of total farm income (Soedjana et al., 1988). The potential is clearly observable and demonstrated by their populations in West, Central and East Java. It is interesting that these three provinces also carry the largest human populations in the country. Small ruminants seem to fit and complement the prevailing farming systems in this densely populated area. The above reasons stimulated the Central Research Institute for Animal Science (CRIAS) to collaborate with some US institutions through the Small Ruminant Collaborative Research Support Program (SR-CRSP) starting in 1980. The Research Institute for Animal Production (RIAP), and at the present time its Sub Balai in Sei Putih, North Sumatra, have been acting as the executing institutions.

Research Efforts. The SR-CRSP program has conducted both on-station and village-level studies for the past thirteen years. The on-station studies have covered breeding, feeds and feeding, management and environment, sociology, economics, and health disciplines that have produced numerous technology packages and technology components. The Sheep Prolificacy project and the Hair Sheep project have expanded the strength and intensity of the breeding, nutrition and health experiments. In addition, on-farm technology models have been tested starting in 1984 through an Outreach Pilot Project (OPP) in West Java, and a similar program, called the Outreach Research Project (ORP), in Sei Putih, North Sumatra (SR-CRSP Annual Reports 1988-1992).

Various research outputs produced by research institutes, universities, and private voluntary organizations in terms of breeds, technical brochures, news letters, training materials, video presentations, scientific publications, policy briefs and other forms of research results have affected traditional farm practices and farmers' visions for the future. Various annual reports of the SR-CRSP have shown many advantages of the technology packages and technology components that have both direct and indirect impacts when applied by producers.

Studies on goats, however, have been minimal although goats constitute around two-thirds of the small ruminant population in the country and are found in significant numbers in many provinces. Basic production data of goats under different production conditions and genetic improvement are still lacking.

Challenges for the Future. It is known that the national economy in general, and agriculture in particular, will depend on the availability and the quality of natural resources, human resources, infrastructure and capital resources, science and technology capability, institutions, rules and regulations. Limitations in the above factors can hamper development. For example, livestock development will have to face limited natural resources, in both quantity and quality, due to competition with non-agricultural uses. Furthermore, livestock technologies have to be applicable under the conditions of low agricultural productivity due to low quality of breeds, low inputs, inefficient production practices and low managerial ability. However, capital resources seem to be the most limiting factor, and that access to production factors is not equally available. Therefore, agro-industrial approaches need to be paced to fill in the gaps in terms of local materials, value added, labor absorption and improved foreign exchange.

Research outputs in the form of biological products such as animal breeds, grass varieties, vaccines and the like need to have an institution that will maintain their existence and reproduce them as demanded by users. So far, there is only one institution that maintains and reproduces rice varieties. Moreover, livestock facilities and infrastructure in the villages are limited and, hence, not attractive to investors. Rules and regulations that are irrelevant and not

supporting improvement in quantity and quality of livestock products have to be appraised and revised.

Prospects for exporting small ruminants and their products particularly to Middle Eastern countries has further enhanced the possibilities for these species to become an important export commodity. As an example, The Agency for National Export Development (1988) estimated an annual demand for some 500,000 small ruminants by Saudi Arabia to be sacrificed during the period of Idul Adha. One suggestion from that study was that Indonesia should develop a pilot breeding program for the Javanese Fat-Tailed (JFT) sheep, that with the 1988 demand in Saudi Arabia, the consumers were willing to pay for this species in excess of US$ 250/head (Adnam, 1988).

The Indonesia-Thailand-Malaysia Regional Development Project (ITMRDP) is one example of the future challenges for agricultural sector development in Indonesia. North Sumatra and Aceh (Indonesia), 14 provinces in southern Thailand, and 4 states of north Peninsular Malaysia are in ***the Triangle Growth Center***. The proposal was submitted by the Malaysian Government (1993) to the Indonesian Coordinating Minister for Industry and Trade. In the proposal, sheep, rubber-wood, fruits and vegetables were the selected agricultural commodities considered to have bright prospects in the future and need to be developed as export commodities from North Sumatra and Aceh.

The challenge to increase productivity and expand sheep raising in the two provinces above will have to include the intensity of sheep disease studies such as ***MCF or coryza*** as sheep is believed to be a carrier of the disease and since the two provinces, particularly Aceh, also serve as location for Bali cattle development. It is known that Bali cattle, which are particularly susceptible to ***MCF*** are one of Indonesia's most important livestock and will be developed throughout the country. Otherwise, sheep contribution to the ITMRDP will be minimal. On the other hand, expansion of sheep production in North Sumatra and Aceh will be supported by the entity of the estate crops plantation. The most promising result of a study on the integration of sheep and tree cropping is the mutual share of resources between sheep (as manure producers and as weeders) and plantations (feeds and forage resources).

Furthermore, development programs for the livestock sub-sector including small ruminant species should also take advantage of resources available in the eastern islands, in terms of comparative and competitive advantages with other agricultural commodities. The effort will, at the same time, support the decentralization concept to balance the interest of the central and the local authorities in overall agricultural development. In addition, to anticipate the global market and the trade blocks that will predominate in the future, the challenges to livestock sub-sector development include improvement in the degree of competition and production efficiency, and should no longer rely only on government intervention or protection.

Apart from the above problems and challenges, research institutes, universities and other parties working on livestock and small ruminant research will also face problems of man power availability, particularly for the subject areas that are rare but needed. Research budget, research management, and technology diffusion strategies are another factors to consider. Solutions to these problems are a pre-condition for research institutes such as RIAP, RIVS, and CRIAS to become stronger institutions.

Small Ruminant Research and Development in PELITA VI

Despite successful target attainment, there are some important lessons to learn from the first Long Term Development Plan (PJPT I). For example, increased agricultural as well as livestock production has not yet directly improved farmer's income due to price drops. In addition, from the market viewpoint, livestock products do not stand alone. They are associated with other products, and increasing or reducing the production level of one commodity will affect one or more of the others. Furthermore, increasing primary agricultural products without improvement in agro-industrial capacity causes a cutback in production due to decrease in agricultural exchange rates. Moreover, product quality, production efficiency, and competitiveness of livestock products will become more important in an open economy. Similarly, environmental issues and the conservation of natural resources will make sustainable livestock production systems as high a priority as the improvement in livestock productivity itself.

During the PJPT II, improvements in many elements of livestock production systems to support agribusiness and the rural agro-industry will be required. These programs will be initiated in Pelita VI and continued in Pelita VII, with special emphasis on agribusiness expansion and integration, while in Pelita VIII, IX and X the emphasis will be on the integration of urban and rural economies and the consolidation of agribusiness corporates.

Issues of livestock sub-sector development which will become the main themes of various programs of livestock research and development are related to the availability of meat, milk and eggs, improvement and distribution of farmers' income, improvement of livestock productivity and efficiency, improvement of productive employment and business opportunities in rural areas, human resource development, poverty alleviation, degradation of natural resources and environment, and general issues of development and application of science and technology in agriculture. These themes will be incorporated into five major areas of research namely: a) livestock technology generation, b) livestock infrastructure and facilities, c) natural resources and environment, d) human resources, and e) livestock policies and institutions.

Small Ruminant Technology Generation. Research to generate new small ruminant technologies should cover various aspects such as genetic improvement, production techniques, post-harvest handling and processing with major themes of productivity, efficiency, quality of product, added value, improvement of farmer's income and welfare, and foreign exchange earnings. As science and technology advance, the direction and methods for generating technology will also change. Biotechnology will be taking the stage in enhancing the effectiveness and the efficiency of breeding and various aspects of production and processing of livestock commodities including small ruminants. Goat research must receive high priority in many disciplinary research aspects such as breeds and breeding, nutrition, management, health and post-harvest handling and processing of meat, milk and skins.

Agribusiness Infrastructure. Small ruminants, as mentioned earlier, play an integral role in smallholder farming systems. These roles include liquidity aspects (cash to meet short term needs), income generation, supply of manure for crops and insurance against risk. All these factors interact to produce the market forces which impact upon household production decisions and help define the marketing systems that have evolved to meet the demand for their products (Knipscheer et al., 1987). Research on infrastructure and facilities for small ruminants is aimed to support improvement of the capacity and the quality of infrastructure and facilities for the development of agro-industry and agribusiness. Among research areas of importance are models of small ruminant processing industry, slaughter houses, holding grounds, and small ruminant markets. Justification of the existence of agribusiness systems through approaches to measure the economic benefits of small ruminant enterprises (Amir and Knipscheer, 1989) include ***partial farm analysis input-output budgeting***, ***production function analysis*** and ***whole farm analysis***. Furthermore, there are procedures for evaluating the effects of a farm manager's investment choices on business profit, risk and liquidity, such as ***capital budgeting or investment analysis*** (Barry et al., 1979). The steps include (1) identification of investment alternatives; (2) selection of appropriate choice criteria; (3) the collection of relevant data; (4) the analysis of data and (5) the interpretation of results in terms of the various choice criteria.

Environmental and Natural Resources. Research on natural resources and environments is aimed at more rational uses of natural resources taking into consideration productivity, efficiency, sustainability, and environmental safety. The expected outputs of this research program are information on characteristics and distribution of natural resources and the suitability of environments for various major livestock species. The research areas include: (1) identification, characterization, evaluation, and utilization of land resources, (2) conservation, characterization, evaluation and documentation of germ plasm, (3) improved management of various land types, including less favorable land types, marginal land, and critical land, (4) management of production and processing of wastes and (5) impact of production and processing on environment.

Human Resources. Research on human resources is directed towards supporting the improvement of the quality of human resources involved in livestock farming enterprises with emphasis on their independence and ability in their respective tasks. Among the important research areas are: (1) the status of man-power in various livestock farming enterprises, (2) roles of small ruminants in poverty alleviation, rural income, and employment generation, (3) gender analysis in small ruminant production, (4) improvement of materials and methods of training, education, and extension in rural areas, (5) identification, documentation, and protection of indigenous knowledge and technology.

Livestock Policies and Institution. Research on livestock policies and institutions is directed towards improving the efficiency and effectiveness of policies, rules and regulations and institutions to support small ruminant development. The target is the development of appropriate levels of intervention, regulations and deregulation for optimal utilization of resources. Research areas of importance are: (1) small ruminant price and trade policies, (2) investment policy for small ruminant businesses, (3) institutional assessment of land ownership, production share, working relationships, and cooperatives, (4) rules, regulations and institutions for livestock production: their functions, efficiency and effectiveness.

Technology Diffusion. The strategy of technology diffusion is based on the inherent characteristics of the research products such as a) breeds, b) data and other information, c) technical publications, d) scientific publications, and e) policy recommendations. The above research products will become instruments of the communication program, while information systems that consist of computerized databases of the products can be easily retrieved and exchanged through an information network within AARD, CRIAS, universities, and other parties (national and international). Information and data on small ruminants can be produced in the form of printed materials or electronic media. The existence of the Indonesian Small Ruminant Network (ISRN) serving national interests and the Small Ruminant Production Network for the Asia (SRUPNA) for regional communication must be maintained and expanded.

Research Management. Among major issues in the management of small ruminant research and development are research prioritization, improvement of research planning, staffing, and organization, flexible and integrated use of human resources, and more regionalized research activities. The implementation of the above programs requires: a) improvement of the structure and mandate of the research institute and the Sub-Balais, b) human resource development, c) improvement of research infrastructure and facilities, and d) improvement of research budgeting.

Infrastructure and facilities for livestock research and development in general should also be improved and utilized optimally. Improvement is especially needed in view of prioritized research areas such as biotechnology, and more

regionalized/decentralized research activities. Improvement of facilities for better management and communication including computerized information systems should also be done.

Sufficiency, continuity, and flexibility of funding for small ruminant research and development should be improved in view of the magnitude and complexity of areas and problems to be tackled by research and development in the future.

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ESTIMATION OF MARKET DEMAND FOR SMALL RUMINANTS IN INDONESIA

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ABSTRACT

The market demand for small ruminants in Indonesia is estimated in this study. Data from the Central Bureau of Statistics and the Directorate General of Livestock Services during the period of 1974 through 1990 are analyzed. The ordinary least squares technique is used to isolate factors determining changes in market demand. Results show that retail price of small ruminant meat, retail price of beef as substitute for mutton and goat meat, and per capita disposable income are factors that significantly affect the amount of small ruminant meat consumed. The demand for small ruminants is inelastic as indicated by its price elasticity of 0.5 and has positive income elasticity of 0.65. The goal of government policy in efforts to increase the number of small ruminants in the country may be to ensure that output of this commodity increases at the same rate as its demand.

Background

Indonesia is experiencing a rapidly changing economic environment and implementing economic reforms that influence the growth of the agricultural sector and policies designed to meet the objectives of the fifth Five-year Plan. Rising incomes and changes in the demographic composition of the population have led to changes in food consumption patterns that place increasing demands on the development of food processing and the livestock industry in general as well as small ruminant farming. Increased production of small ruminants has raised the demand for secondary crops used as animal feeds. Continued growth in the small ruminant industry, as well as in the general agricultural sector, helps to absorb Indonesia's ever-increasing labor force and to promote a stable transition to an industrialized economy.

Despite increases in total livestock production, Indonesia's consumption of animal protein is still below the recommended daily nutritional standard of 4.5 grams per capita. This is mainly due to the comparatively high population (about 185 million) vis-a-vis livestock numbers, and relatively high prices of livestock products, especially for families with low incomes who comprise the bulk of the

population. The policy of the Government of Indonesia is to increase the number of livestock, including small ruminants in the country.

Small ruminants are an important component of farming systems in many areas of Indonesia. Small ruminants are usually raised by smallholders in rural areas, and they provide 15 to 25 percent of family income (Knipscheer et al., 1983). Although farm families meet most of their subsistence needs with food crops, animals are often the primary means to generate cash, store capital, provide farming inputs such as traction and manure for crop production, and provide high-quality food for the household.

One consideration in the small ruminant industry is price. Price changes with time are the result of the complex effects of seasonal, cyclical, trend, and irregular factors. A study by Soedjana and Priyanti (1992) indicated that during the Islamic Holiday there is a-twenty-five percent increase in small ruminant prices.

The objective of this study was to quantify and qualify the market demand function for small ruminants in Indonesia during the period of 1974 through 1990. Computation of price and income elasticities for small ruminants is considered to be important in determining how responsive changes in consumption of small ruminants as a result of changes in retail price and incomes. These elasticities have important implications for the development of the small ruminant industry as well as for developing investment strategies in the agricultural sector in Indonesia.

Model Development

Underlying the assumption that the small ruminant industry has a competitive market structure is a consumption-dependent model for small ruminant demand (Tomek and Robinson, 1977):

$$(Q_{SR}/L)_t = \beta_0 + \beta_1 (P_{SR}/I)_t + \beta_2 (P_B/I)_t + \beta_3 (Y/LI)_t + \beta_4(L)_t + e_t \qquad (1)$$

where:

Q_{SR}/L = per capita consumption of small ruminant meat (kg/year),

P_{SR} = retail price of small ruminant meat (Rp/kg),

P_B = retail price of beef (Rp/kg),

Y/L = per capita disposable income (Rp/year),

I = consumer price index (1966 = 100),

L	=	population (persons),
t	=	1,2,...,17 observations,
$\beta_0, \beta_1, \ldots, \beta_4$	=	estimates of the parameter, and
e	=	error term.

Data from the Central Bureau of Statistics and the Directorate General of Livestock Services from 1974 to 1990, a 17-year period, were used in this study (Central Bureau of Statistics, 1974, 1975, 1978, 1980, 1983, 1985, 1988, 1991 and Directorate General of Livestock Services, 1975, 1978, 1980, 1983, 1985, 1988, 1991). All of the rupiah variables, such as disposable income and retail prices, were converted to real values (1966 = 100).

An ordinary least square (OLS) technique was used to estimate equation 1 (Judge et al., 1988). All the explanatory variables, except retail price of small ruminant meat, were expected to have a positive relationship with the consumption of small ruminant meat. The OLS procedure of SHAZAM (White et al., 1990) was used to perform the analysis and test for autocorrelation, heteroskedasticity and multicollinearity.

Results and Discussion

Per capita consumption of small ruminant meat and beef increased steadily during the period of 1974 through 1990 (Figure 1). The consumption of small ruminant meat was only one-third of that of beef. Table 1 shows that small ruminant meat consumption increased by between 10 and 21% each five years. The rate of increase has been rising steadily except during the third five-year plan (Pelita III). The rate of increase in beef consumption rose throughout the period.

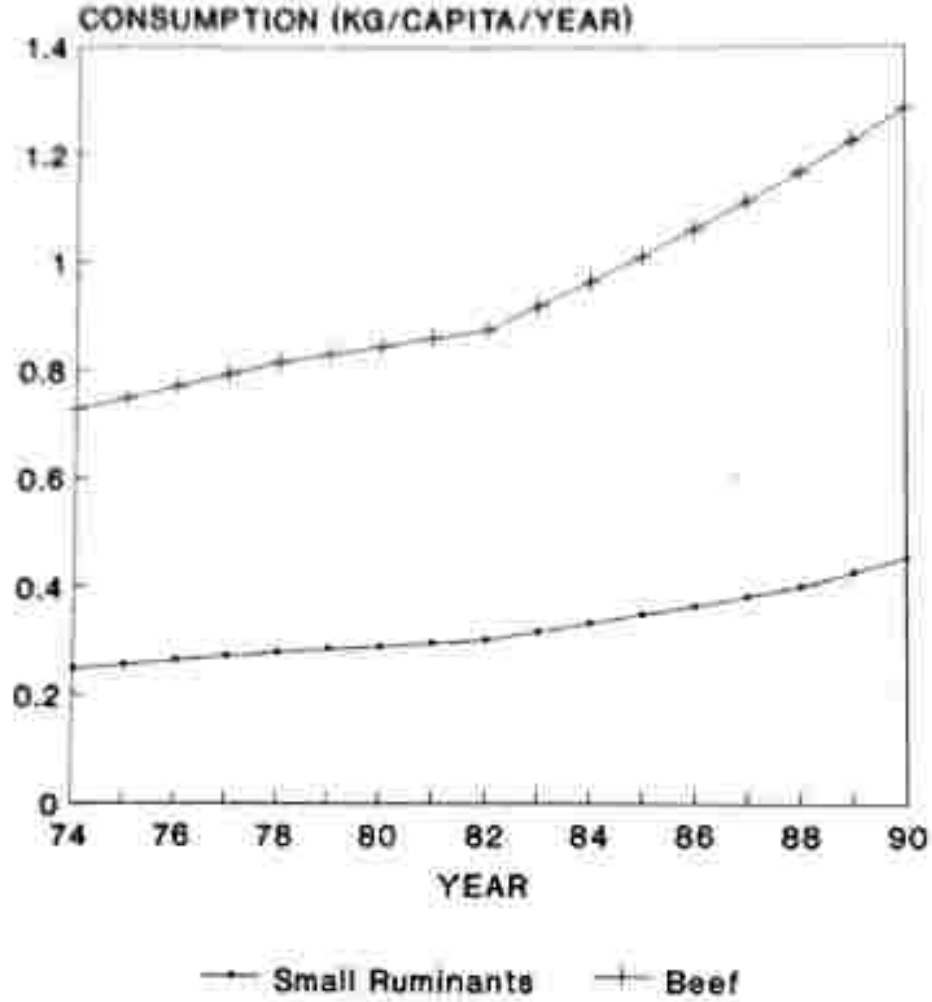

Figure 1. Small ruminant meat and beef consumption: 1974-1990

TABLE 1. PERCENTAGE CHANGE OF SMALL RUMINANT MEAT AND BEEF CONSUMPTION: PELITA II-PELITA IV (SECOND FIVE-YEAR PLAN TO FOURTH FIVE-YEAR PLAN)

Period	% Change in meat Consumption	
	Small Ruminant	Beef
Pelita II	11.95	12.05
Pelita III	10.84	14.67
Pelita IV	20.87	22.97

Source: Central Bureau Statistics (1974, 1975, 1978, 1980, 1983, 1985, 1988, 1991).

With regard to price, Figure 2 shows that there was little difference between the price of small ruminant meat and beef. During the period of 1974 through 1990, these two prices increased in parallel.

Table 2 presents a descriptive summary of the variables used to estimate the model with 17 years as the number of observations. The *STAT* procedure of SHAZAM was used to perform the analysis.

Per capita consumption of small ruminant meat (Q_{SR}/L) had a mean of 0.32 kg/year, a minimum of 0.25 kg/year and a maximum of 0.45 kg/year. The variability of Q_{SR}/L was large as indicated by standard deviation of 0.06 kg/year. The retail prices of small ruminant meat (P_{SR}) and beef (P_B) had means of Rp.2,539/kg and Rp.2,925/kg, respectively. The variability of P_{SR} and P_B were large as indicated by the standard deviations. Per capita disposable income (Y/L) had a mean of Rp.381,180/year, with very large variability as indicated by the standard deviation. Finally, the population (L) had a mean of 150 million persons. It rose from 130 million to 180 million during the period of study.

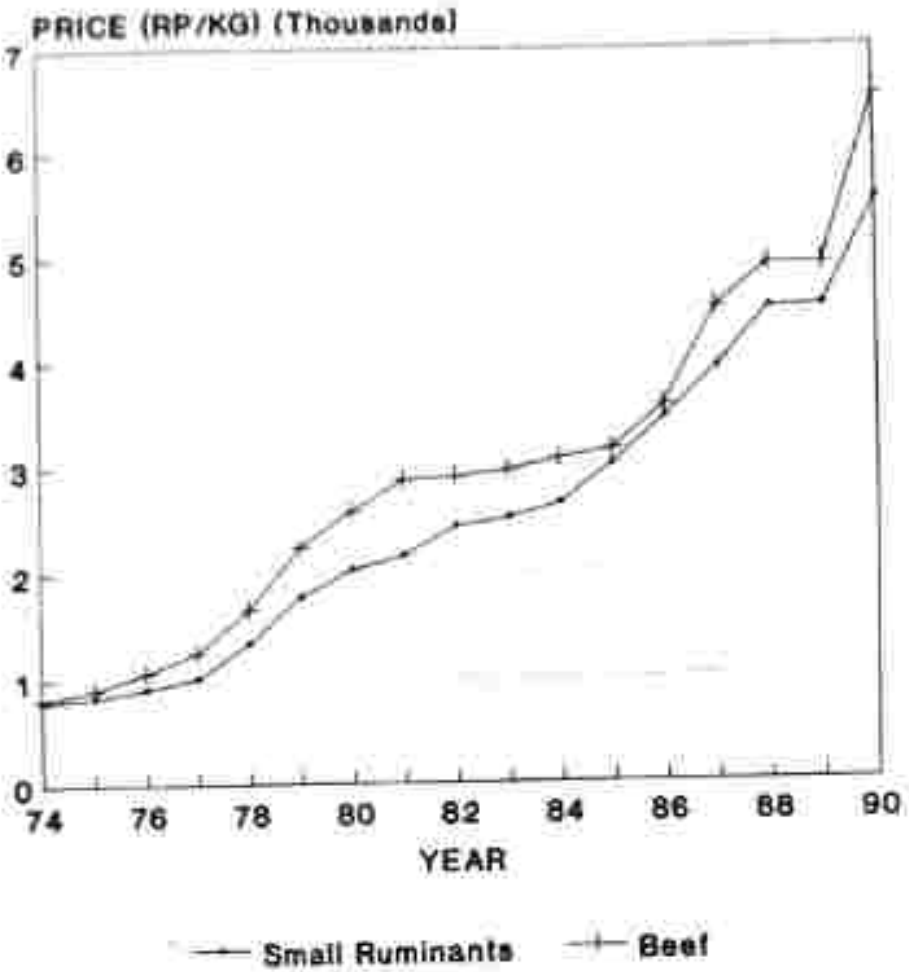

Figure 2. Small ruminant and beef prices: 1974-1990

TABLE 2. DESCRIPTIVE SUMMARY OF VARIABLES

Variable Name	Mean	Standard Deviation	Minimum	Maximum
Q_{sr}/L (kg/year)	0.32	0.06	0.25	0.45
P_{sr} (Rp/kg)	2,539	1,433.3	787	5,500
P_s (Rp/kg)	2,925	1,595	812	6,500
Y/L (Rp/year)	381,180	260,670	69,324	918,510
L (million persons)	150	15	130	180

OLS was used to estimate the coefficients of factors which determine changes in small ruminant meat demand. Results of this analysis are shown in Table 3. All of the parameter estimates of independent variables are equal to zero. All of the coefficients estimated, except that of population (L), have the expected signs and are significantly different from zero.

TABLE 3. OLS RESULTS OF THE ESTIMATION MODEL

Variable Name	Estimated Coefficient	Standard Error
Constant	0.281*	0.114
(P_{sr}/I)	- 0.505**	0.187
(P_s/I)	0.191*	0.114
(Y/LI)	0.647*	0.391
L	0.448ns	0.873

Number of observations	= 17
Adjusted R-Square	= 0.97
F-test	= 177.65**

ns non-significant
** P< 0.01
* P< 0.05
* P< 0.10

The OLS estimation indicates that the parameter estimate on retail price of small ruminant meat is negative and statistically significant which means that consumption of small ruminant meat has a negative relation with its price. This implies that decreases in the retail price of small ruminant meat increase its

consumption. This is expected because price theory predicts an inverse relationship between price and quantity consumed.

The parameter estimate on retail price of beef is positive and statistically significant which implies that increases of the retail price of beef increase the consumption of small ruminant meat. On the average, retail price of small ruminants meat is cheaper than that of beef (Rp 2,539 vs Rp 2,925). Therefore, consumers shift their purchases toward the relatively cheaper product, i.e., small ruminant meat, yielding an increase in the demand of small ruminant meat. Assuming that the consumer is maximizing utility or satisfaction, he/she tends to substitute the relatively cheaper commodity for the more expensive to remain at the highest possible level of utility within the constraint of available income.

The parameter estimate on per capita disposable income (Y/L) is positive and statistically significant. As per capita income increases consumption of small ruminant meat increases.

The parameter estimate on population (L) was not significant which implies that the study fail to reject the null hypothesis that per capita consumption is independent of population.

Regression diagnostic procedures were carried out to detect violations in the underlying regression model assumptions. The diagnostic procedures included in the study were autocorrelation, heteroskedasticity, and multicollinearity.

The disturbances are said to be autocorrelated when the equation error e_t depends on the values of the previous errors (Judge et al., 1988). Autocorrelation is usually associated with time series data, or in a situation where the sample observations Y and the control variables X occur at different points in time.

The options of *RESID* and *LIST* under the OLS procedure give the values of Durbin-Watson (d) test and estimated rho. The results show that d = 1.0485 and estimated rho of 0.407. The critical values of the bounds test are $d^*_L = 1.015$ and $d^*_U = 1.536$. Since $d^*_L < d < d^*_U$ the bounds test is inconclusive. However, there is another alternative if $d < 4\text{-}d^*_U$, accept the null hypothesis. Using this calculation, the results indicate that the study fail to reject the null hypothesis. This implies that the OLS procedure yields an unbiased and efficient estimates.

Heteroskedasticity is the formal name for a non-constant variance in the disturbance term across observations (Judge et al., 1988). The *HET* option in the *DIAGNOS* procedure of SHAZAM was used to test for the existence of heteroskedasticity. It was found that the degree of heteroskedasticity was not

significant, which means that the use of OLS procedure will yield unbiased and efficient estimates.

A major practical problem that multicollinearity poses is the large standard errors of the estimated regression coefficients which is often referred to as instability of the regression estimates (Belsley et al., 1980). Multicollinearity exists when one or more of the explanatory variables is a linear combination of others.

Under the option of the *PRINCIPAL COMPONENT* analysis, SHAZAM was used to give the values of the condition indexes and the variance proportion of the estimate accounted for by each principal component. Results indicate that the source of the linear dependence among the explanatory variables is not obvious, and thus will cause neither substantial variance inflation nor great potential harm to regression estimates.

The study focuses on the responsiveness of quantity demand for small ruminant meat to price changes. The most common interpretation of this relationship is the concept of own-price elasticity of demand. The own-price elasticity of demand coefficient is the percentage change in quantity demanded given a very small percentage change in the price of that commodity, other factors held constant (Tomek and Robinson, 1977).

Elasticities can be determined directly from the parameters estimated in the linear regression equation. With regard to price elasticity the results show that the demand for small ruminants is inelastic. A one-percent increase in the retail price of small ruminant meat reduces quantity consumed by 0.5 percent. Carlson and Scholz (1991) estimated small ruminant demand elasticity from the animal trader's point of view. They found that demand elasticities for lambs, young adults, and adults were 0.37, 0.22, and 0.09, respectively. Even though the magnitude of these estimates are a slightly different, it seems that from both the consumers' and producers' points of view small ruminant demand is inelastic.

Income elasticity of demand is a measure of the responsiveness of quantity demanded to changes in income, other factors held constant. This study indicates that for small ruminant meat in Indonesia during the period 1974 to 1990, the income elasticity is positive, averaging of 0.65 over some range of per capita disposable income. This implies that a one-percent change in per capita disposable income changes current consumption of small ruminant meat by 0.65 percent.

Conclusion

The results of the study indicate that the retail price of small ruminant meat, the retail price of beef, and per capita disposable income are the important demand shifters for small ruminant consumption in Indonesia.

The price elasticity of demand is 0.5 implying that consumption of small ruminant meat responds inversely to changes in its retail price. Income elasticity of demand is 0.65, implying that the consumption of small ruminant meat responds in the same direction as changes in per capita disposable income.

The policy implication of the preceding analysis is that changes in small ruminant production should match the demand for those products over time. If supply for small ruminants grows more rapidly than demand, prices will fall, thereby benefiting consumers who would require less income to purchase the same quantity of the commodity. On the other hand, falling prices would reduce incomes of producers, thereby potentially causing them to reduce supply. Using this idea, the goal of government policy may be to ensure that output of each commodity increases at the same rate as its demand.

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PRELIMINARY SOCIOLOGICAL EXAMINATIONS OF OUTREACH PROJECT MEMBANG MUDA (OPMM)

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ABSTRACT

This paper is a preliminary examination of the Small Ruminant-Collaborative Research Support Program (SR-CRSP) sponsored Outreach Project Membang Muda. With the introduction of SR-CRSP technology adjustments by households to previous labor practices must be made. This paper analyzes what some of those adjustments have been in terms of farming practices and labor allocation to specific household tasks and economic activities including care for small ruminants. We examined six different household types within the plantation for comparison purposes. Four different surveys were administered to the six different household types. Each household type was represented by 12 respondent households. The first three survey groups were Nucleus Estates Small Holders (NES). The last three survey groups concentrated on permanent laborers of the rubber estate. We found that two main substantive issues need to be investigated further in the OPMM project: overtapping and the problem of carrying capacity of the plantation for sheep in different stages of the trees' development.

Introduction

Indonesia is one of several countries which has emphasized projects designed to help disseminate specific technology to farmers. One such project that has been widely implemented by the Indonesian government is the Nucleus Estate Smallholder (NES) scheme. The NES provides land, new high yielding rubber clones, housing, credit, and extension services to its participants.

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In essence, it is a modern "homesteading" scheme. However, the NES project represents a major departure from previous policy in that it is the first smallholder rubber development project whose intention is to provide the above services to a group of households over a relatively small area. Additionally, NES participants--most often from the poorest economic strata of Indonesian society--are to receive a certificate of ownership after a specified period of time working the rubber trees. Though the NES is composed primarily of the "economically weak" it includes many different types of people--from those with no previous rubber experience to former plantation laborers. With the introduction of the NES concept in 1977, Government participation in estate plantations has expanded rapidly through Public Estate Companies (PTPs). These provide support to the smallholders surrounding a Nucleus Estate site (World Bank Document, 1989).

One major problem faced by NES participants is they have little or no income generation from their rubber trees during the early, immature period of the trees' growth (1 to 5 year old). This is a difficult time for the NES farmers as they are struggling "to make a go of it" in rubber harvesting. And as many NES participants have had little or no experience in rubber harvesting, it is also a critical time for the trees (that they are not tapped too early) as well as the farmers (that they survive long enough to get their first harvest). It has been observed that during this early, immature period of the trees' growth, grasses are abundant under the trees as a mature leaf canopy has not yet developed which shields the sun and thus inhibits the growth of grasses under the trees. Consequently, to augment the income of NES participants in this early growth period when the trees are not yet ready for harvesting, attempts have been made to integrate small scale sheep production to utilize the grasses under the young rubber trees. It is hoped that sheep production will provide additional income for NES participants during one of the most difficult periods of the NES scheme--getting started--and thus keep the participants in the program.

This integration of sheep and NES sites has been tried in several places to date. One such place is in Membang Muda, Gunung Lonceng, North Sumatra. Known as the Outreach Project Membang Muda, (or OPMM) OPMM is, in fact, an "on-farm" research project used to test and demonstrate the effectiveness of this sheep/rubber integration within a government sponsored program--the NES. The results of the OPMM project have potential national level impacts as it represents a sustainable and readily adoptable technology for smallholder families. At this time, however, such integration practices have only been tried on a small scale such as in the Membang Muda NES.

OPMM has two unique characteristics. First, it targets smallholder rubber producers; and second, a state rubber estate company (PTPIII) provides backstopping through loans and extension services, both of which are essential to the success of the project (Sembiring and Scholz, 1991).

Objectives of the Study

The objectives of this study were twofold: (1) to gain a better understanding of the manner in which smallholder rubber farmers and plantation laborer households respond to new technology and productive resources--the Small Ruminant-Collaborative Research Support Program (SR-CRSP) sheep and its support services, and (2) to evaluate the project and identify its strengths and weaknesses. Both objectives will help improve the development of the project in the future.

Theoretical Framework

As the objectives stated above indicate, the analysis was to be carried out at the household level. This level of analysis reveals how participating households have adapted and responded to the project and SR-CRSP technology to date.

As the OPMM farmers are part of a larger peasant economy particular to this region of Indonesia, any analysis of these farm families needs to consider the theoretical literature concerning the nature of peasant economies and the role of peasant households within them. This speaks to the notion that the two--the peasant economy and the peasant household--are inseparable. Consequently, actions from the peasant household will be closely tied to the existing ecological, social, and political constraints the local peasant economy engenders. For the purposes of our study and for future use by the SR-CRSP, this inseparable connection must be considered as any rapid change in the larger environment of the peasant household requires a dynamic response by the household to adapt to the change. It is for this reason we treat the peasant household as the basic unit of analysis and as a production unit versus individual members of the household.

Using the peasant household as a unit of analysis is also theoretically justified through the work of Friedmann (1986). She argues that the peasant household acts as the focal unit when it comes to questions of labor allocation. In essence, the household operates as a domestic economy where all major production inputs are supplied by every member of the household, each playing a role in the production process with roles being determined by the perceived economic importance of the production activity. Older members of the household will allocate the majority of their time to primary economic activities, while younger members are responsible for secondary or supplemental economic activities. Thus, the amount of labor allocated by a household and the various ways it can be allocated will be determined by the total amount of labor available to the household and the different ages of the laborers. The availability of labor, and hence the potential amount of labor that can be allocated, is contingent upon the demographic characteristics of the household. The demographic

structure (i.e., size, age, and gender) of households thus plays a major role in the amount of labor allocated and how it will be used. As mentioned by Guest (1989) "the size of the household can be expected to affect the amount of labor available. The effect is in terms of gross amounts of labor used; the larger the household the greater the availability of labor and therefore the larger the total amount of labor allocated for production activities."

Furthermore, Chayanov (1966) argues that demographic differentiation occurs throughout the life cycle and dictates the extent of the household's participation in the larger economy. It means that family size and age-sex composition have direct effects on labor inputs for the peasant household. Thus the more capable members available in a household, the greater the economic activities of the household. In sum, household size and life-cycle stages of family members affect the general labor allocation strategies that peasant families can follow. In situations where strategies of diversification of production are desired (for example, integration of small ruminants with rubber trees), smaller and younger households are forced to allocate several occupational roles to individual members, while larger households can create individual "occupational specialization" with household members undertaking different tasks.

Importance to the Indonesia SR-CRSP in Sumatra

Consideration of household demographics and labor allocation are two important areas of study for the sociology component of the Indonesia SR-CRSP in Sumatra. Documenting how peasant households have responded to induced changes--like the integration of hair sheep under rubber trees--will help the other components of the Indonesia SR-CRSP in Sumatra understand how labor allocation strategies of smallholder rubber producers affect the adoption of the SR-CRSP technologies being produced. Additionally, this information can help identify appropriate target groups for SR-CRSP technology. Indeed, the purpose of the "On-Farm" projects like OPMM is to observe the application of the SR-CRSP technologies in a natural setting. Consequently, when sociological factors such as family demographics and labor allocation strategies are accounted for under these natural conditions, more accurate assessments of the effectiveness and viability of the products of the other SR-CRSP components can be achieved. In other words, the technologies being developed as part of a holistic SR-CRSP package may be more appropriate for certain groups over others. The sociology component can address this. If these differences are not accounted for, the package as a whole or various parts, may receive undue criticism as to its overall appropriateness. It may simply be a matter of the overall appropriateness for different groups.

Research Design and Data Collection

Introduction of SR-CRSP technology has and will continue to create adjustments by households to previous labor practices. We were interested in analyzing what some of those adjustments have been. Additionally, since major changes in farming practices often require significant adjustments in the amount of labor and the times when it is required and by whom, we wanted to examine a wide spectrum of household types within the plantation to see how each has or may adjust. We administered four different surveys to six different household types. Those groups which had received SR-CRSP or Sub Balai Penelitian Ternak Sungai Putih (SBPT) sheep were given the same survey as those which had their own animals (one survey for NES and one for Permanent labor respectively). Each household type was represented by 12 respondent households. The number of respondent households was limited by the number of farmers who had received sheep from the project--twelve. The six survey groups are as follows:

1) Nucleus Estates Small Holders with SR-CRSP Sheep--Out Reach Project Membang Muda (OPMM).

2) Nucleus Estates Small Holders without SR-CRSP Sheep or other animals-- Membang Muda.

3) Nucleus Estates Small Holders without SR-CRSP Sheep but with their own animals (Sheep, Goats, or Cattle)--Membang Muda.

4) Permanent Laborers which received SR-CRSP sheep in 1988.

5) Permanent Laborers with no animals.

6) Permanent Laborers with their own animals.

The first three survey groups (1 through 3) were Nucleus Estates Small Holders (NES). The last three survey groups (4 through 6) concentrated on permanent laborers of the rubber estate. These are people who are provided housing by the plantation. Their main livelihood and potential pension comes from a monthly salary from the rubber estate and not from ownership, or eventual ownership of land. In 1988, twelve permanent laborer households received sheep from the SBPT. Though the SBPT has maintained extension links with these households through an estate extension worker, direct linkages have not been maintained. In all six survey groups, the issues of land ownership, additional income generating activities or plans for such, household labor activities, and household expenses were examined. Additionally, labor allocation and various problems associated with the keeping of animals were explored for those who had animals.

The OPMM project was developed in September, 1991 when twelve smallholder families were chosen to receive 4 ewes and 1 ram with the condition that after four years, they are to give 8 ewes back to the project as payment. OPMM is located in afdeling B about 18 kilometers from the main office of PTP III Membang Muda. There are 77 households in afdeling B involved in the larger NES project. In this plantation area, the government estate company (PTP III, in Membang Muda, North Sumatra--about 250 km from Medan) is responsible for administering credit and extension services to OPMM participants and about 700 other smallholder rubber farmers who are also part of Indonesia's resettlement scheme (Scholz, 1992).

The data from all six sample groups was collected through surveys and in-depth interviews. Two project extension personnel conducted the surveys with the project participants and laborers in OPMM. Data collected in the survey included: household composition, all sources of household income, farmer's knowledge on raising small ruminants (i.e., breeding and nutrition), farmer's attitudes on raising small ruminants, and problems and constraints in raising small ruminants. The survey also recorded labor allocation for various activities for all family members above the age of eight.

All activities of household members were categorized into domestic and non-domestic activities which included: rubber production, other on-farm work, household work (cooking, washing, tending children, wood gathering and other cores) and school (both regular and religious school). Rubber production was an aggregated variable constructed from: maintenance of stands, tapping own rubber, and working on own rubber. Interviews took place in the afternoons and evenings at the rate of approximately two households a day for each interviewer.

Research Results and Discussion

Characteristics of Household and Land Ownership. Household characteristics are reported in Table 1. The average age of the household head (considered in this report as the male head of the household) was 38.8, while the average years of formal education of the household head was 6.3 years. The average household size for all groups sampled was 6.5 members with the number of adult men and women at 1.6 and 1.5, respectively and the number of children at 3.5. The median household size for rural Indonesia is 4.5 persons (Biro Pusat Statistik, 1982), which is slightly lower than the median size of 6.8 found in our samples. In terms of occupational background of farmers before they became NES participants, most were landless laborers working either as casual labor (24%), temporary labor for a plantation company (51%), or as retirees from the plantation (12%). Among the respondents, only 35% had been farmers.

Table 2 shows that only 35% of the respondents owned land outside the NES, with an average of 0.54 hectares per household. The largest amount of land owned by any household was 0.96 hectares (permanent labor with project sheep). Many NES participants bought land or inherited it from their parents which was located outside the NES to be used for economic production, while hired laborers inside the plantation company usually bought dry land for housing to use at retirement (age 55) when they had to remove from the estate company lands.

TABLE 1. HOUSEHOLD CHARACTERISTICS AND MAIN OCCUPATION OF FARMERS BEFORE BECOMING NES PARTICIPANTS OR LABORERS IN THE PLANTATION

Variables	Over all	OPMM	NES w/SR*	Labor Proj.	Labor w/SR
Ave Age of Head House	38.8	38.5	37.0	38.2	37.2
Education of Head (yr)	6.3	6.5	6.0	7.3	5.8
Family Size	6.5	6.8	6.8	5.9	5.5
Ave.# of Adult Men	1.6	1.7	1.3	1.5	1.4
Ave.# of Adult Women	1.5	1.3	1.2	1.8	1.3
Ave.# of Children	3.5	4.2	4.4	2.8	2.8
% Occupation Farmer	35	42	25	25	25
% Casual Labor	24	42	25	17	17
% Temporary Labor in plantation	51	16	42	58	58
% Retired from plantation	12	--	8	--	--

*SR = Small Ruminants (w/ = with)

TABLE 2. LANDOWNERSHIP OUTSIDE THE PLANTATION

Variables	meter^2	Percentage (N)
OPMM	5000	33.3 (4)
NES with SR	4450	33.3 (4)
NES without SR	----	-----
Labor in Project (with SR)	9600	58.3 (5)
Labor non Project (with SR)	5333	25.0 (3)
Labor without SR	2400	25.0 (3)
Average for Total Sample	5400	

In North Sumatra's villages, the position of the household in relation to its access to resources is an important determinant of what type of household economic strategies are adopted (Handayani, 1991; Handayani, et al., 1993). Easy access to adequate land for agricultural pursuits can facilitate household members' involvement in household agricultural production or enable the household, as a production unit, to invest funds raised by sale of agricultural products for other types of economic enterprises like raising small ruminants.

Household Labor Allocation. Labor allocation patterns for household members for domestic and non-domestic work are presented in Table 3. The average household head allocated nearly 9 hours a day (8 hours and 36 minutes) in domestic and non-domestic work. Of those interviewed, NES participants spent about 6 to 7 hours in rubber production activities, while plantation laborers worked about 8 hours every day. Furthermore, most wives of NES participants assist their spouses in the field harvesting rubber, whereas wives of plantation laborers usually had a part time job as a temporary worker in the plantation. Consequently, they work everyday for 4 to 5 hours earning around Rp. 1500 per day in wages.

TABLE 3. TIME ALLOCATION OF HOUSEHOLD MEMBERS ON DOMESTIC AND NON-DOMESTIC ACTIVITIES, IN HOURS AND MINUTES PER DAY (%)

Household Members	Overall	OPMM	NES w/SR*	Labor Proj	Labor w/SR
Father[a]	8.36 (98)	7.45 (92)	8.40 (100)	9.00 (100)	9.00 (100)
Mother[a]	8.07 (100)	6.50 (100)	8.35 (100)	8.15 (100)	8.29 (100)
Sons[c]	1.45 (88)	1.08 (83)	1.27 (91)	2.10 (91)	2.14 (83)
Daughters[c]	2.55 (92)	1.49 (92)	2.33 (100)	4.14 (83)	3.02 (100)

* SR = Small Ruminants (w/ = with)

[a] Domestic and non-domestic activities for father and mother include working in the plantation.

[c] Sons' and Daughters' activities are only for household activities such as washing dishes, cleaning houses, sweeping floor, washing cloths. Schooling and small ruminant activities are not included in this category.

NES farmers are assigned two hectares of high-yielding rubber tree clones. These are normally tapped every other day. Tapping consists of removing a thin paring of bark between 15 mm to 20 mm in thickness. The cut is made on a quarter or perhaps a half circumference of the trunk of the rubber tree at an angle which permits the latex to flow down along a vertical cut into a collecting cup. The tapping panel itself runs from top left to bottom right in order to cut a larger number of the latex-bearing vessels running in the opposite direction (personal communication with Assistant Afdeling B). Tapping is done in the early morning when the tree is in turgor and the flow of latex is the most rapid. The harvesting of produce, or tapping, of any one group of trees averages about twenty five years, after which the old trees are up-rooted and the grounds replanted with new trees. Thus, in a normal day, a farmer spends around seven to eight hours working on 500 - 550 trees per hectare, rests a while, and then collects the latex from the collecting cups. After carrying the latex buckets to collecting tanks, the farmer goes home and starts working again for another two to three hours at clearing grasses which grow around the trees. Usually family

members assist in collecting latex and/or clearing grasses as the job of tapping itself requires a great deal of skill.

For household work or domestic activities like cooking, cleaning the house, washing clothes, etc., women play the major role. The mother spends about 8 hours a day doing house work. In the survey, labor allocation on domestic and non-domestic activities did not take into account child-care activities. Yet, child care is very time-intensive for women, particularly during the first few years of a child's life. It is difficult to assess the extent to which child care represents a constraint to women's income earning activities, especially for women who live inside the plantation company in which they are typically employed as temporary laborers for the plantation company. Although the job is often very hard for women, it is often the only opportunity for them to bring in extra income for the household, especially since most of them are located in an isolated plantation perhaps miles from larger communities. In support of the above argument, Handayani (1991), found that income earning activities declined when very young children (less than 3 years old) were present in the household.

Male children spent less than 2 hours per day and female children almost 3 hours in domestic work. Male children in the NES area usually help their parents collect latex or clear the grasses from around the rubber trees. While female children, after they reach age of 12, usually begin to substitute for their mother doing the domestic activities leaving the mother more time and opportunity to pursue economic activities for the household. In Table 3, schooling activities were not included, most children who attended primary and secondary schools spent about 6 hours everyday in school.

Household Income. In rural Indonesia, household income normally comes from many sources. Each head of household and their spouse were asked to report all their income-earning activities for the period of June 1991 to June 1992. The income sources were divided into six categories: (1) selling of latex for NES farmers and salary for laborers from the plantation company; (2) selling of food/garden products; (3) remittance from household members who no longer live at home; (4) trade; (5) pension or retirement payment; and (6) livestock production (livestock products reported to be sold to market during a one year period).

TABLE 4. FARMER'S YEARLY INCOME IN Rp.000 X 1,000,000* (N)

Sources	Over all	OPMM	NES w/SR*	Labor Proj.	Labor w/SR
Sell Rubber /Salary	1517 (64)	1225 (69)	1898 (76)	1571 (53)	1001 (39)
Sell Rice	282 (9)	237 (13)	76 (3)	240 (8)	309 (12)
Remittance	120 (4)	--	--	240 (8)	480 (19)
Trade	254 (8)	--	--	311 (10)	211 (18)
Retirement	259 (8)	144 (8)	150 (6)	438 (15)	396 (15)
Sell Animals	252 (8)	178 (10)	376 (15)	186 (6)	269 (10)
Total	2354	1784	2500	2986	2586

* Exchange Rate August 1992 US $ 1.00 = Rp. 2017.

* SR = Small Ruminants (w/ = with).

Although farmers' incomes are derived from many sources, selling latex or salary from the plantation company was the main source of income for both the NES farmers and the laborers in the plantation company. It consists of about 64% of their total income. The average annual farmer's income in 1991-1992 was Rp 2,354,000. (see Table 4). These findings are low compared to previous studies (see Sembiring and Scholz, 1991). These inconsistencies can, in part, be a result of the method used in this study. It is very difficult for NES participants to remember exactly how much money they earned every month during a one year period. Furthermore, the problem became even more complicated as the farmers were reluctant to reveal how much of their income comes from selling latex to local markets which, according to the PTP's by-laws, is illegal. NES participants must sell their latex to PTP to pay off the government loan given them through the PTP. At the end of the month PTP deducts 30% of the farmers' income for loan payment. We were forced to use PTP's payment record

as a measure of yearly income, which, as already mentioned, does not accurately reflect all income from rubber sales (Scholz, 1992). However, yearly household expenditure (Table 5) showed fairly consistent findings with previous studies (Sembiring and Scholz, 1991). For example, household expenditure patterns reveal that groceries are the largest single expenditure for the household and, the second largest is rice. From those two items alone, farmers spent about 53% of their total income. Furthermore, farmers spent about 13% for children's school expenses. Table 5 also shows that all households had some disposable income. Taking into account 10% inflation per year, the income of NES farmers and plantation laborers is around twice that of smallholder rubber households (Central Bureau of Statistic, 1990). However, NES farmers' income is still below World Bank standard (US $ 1,500 per year per household).

Small Ruminant Activities. Table 6 shows that 83 percent of non-OPMM and non-project laborers owned their animals and 17 percent engaged in sharing arrangements. The OPMM farmers received 4 ewes and 1 ram from SR-CRSP/SBPT, while the plantation laborers received various numbers of animals from the plantation company itself (PTP III) since 1988. NES farmers had the most experience in raising small ruminants (36 months), while OPMM farmers had the least (8 months).

OPMM households had an average flock size of 10 sheep. For the OPMM, in general, there was some progress in the project in terms of farmers' willingness to learn more about small ruminant technological practices disseminated by the field staff. For example, after 8 months the flock size increased by 100%. While, non-OPMM and non-project laborers did not raise sheep, they did raise goats with an average flock size of 7 goats (see Table 6).

Table 7 shows that small ruminant activities such as cutting grasses and grazing animals, are male dominated activities, females play a very minor role in small ruminant activities--especially older females. Furthermore, as small ruminant production is a secondary economic activity, children played the major role in raising small ruminants, especially the male children who spent about 4 hours a day in small ruminant activities (for a detailed discussion see Brown and Handayani, 1993). As shown in Table 7, eighty-eight percent of the male children were involved in raising small ruminants. From in-depth interviews, we found that cutting grasses was a male activity, performed primarily by the head of the household and his sons who were over 14 years old. Grazing animals was also a male responsibility, however, female household members were responsible for small ruminants if there was no male household members around. Females usually helped clean the barn and feed and water the animals. Table 7 shows that the head of household spent a little over 1 hour per day on small ruminant activities, while male children spent an average of 4 hours and 12 minutes a day on the same activities. Less than 50 percent of the women participated in small ruminant activities. Total average time spent by women in small ruminant activities was 38 minutes per day.

TABLE 5. FARMER'S YEARLY HOUSEHOLD EXPENDITURES
IN Rp. 000 X 1,000,000*
(% OF TOTAL)

Variables	Overall	OPMM	NES SR	Labor Proj.	Labor w/SR*
Rice	459 (24)	570 (31)	547 (30)	331 (21)	311 (22)
Grocery	540 (29)	497 (27)	450 (25)	500 (32)	534 (38)
Schooling	245 (13)	205 (11)	282 (16)	250 (16)	243 (17)
Social Activities	138 (7)	147 (7)	137 (7)	126 (8)	135 (10)
Agricultural Input	168 (9)	93 (5)	125 (6)	--	--
Animal Input	28 (1)	30 (2)	--	25 (2)	--
Cigarettes	141 (5)	175 (9)	101 (5)	106 (7)	128 (9)
Others	159 (8)	150 (8)	202 (11)	216 (14)	68 (4)
Total	1878	1867	1844	1554	1419

* Exchange Rate August 1992 US$1.00 = Rp. 2017.

* SR = Small Ruminants (w/ = with).

TABLE 6. ANIMAL STATUS, FARMER'S EXPERIENCE IN RAISING SMALL-RUMINANTS; AND AVERAGE NUMBER OF SMALL RUMINANTS OWNED BY FARMERS (N)

Variables	OPMM w/SR*	NES Project	Labor in Project	Labor outside
Animal Status				
% Owned	---	83 (10)	---	83 (10)
% Sharing	---	17 (2)	---	17 (2)
Credit	100 (12)	---	100 (12)	---
Farmers Experienced (mo.)	8.0	36.0	21.0	21.0
# of Sheep	10 (12)	---	11 (12)	5 (3)
# of Goats	6 (4)	8 (12)	8 (6)	6 (10)
# of young sheep	5 (12)	---	4 (12)	3 (1)
# of adult sheep	5 (12)	---	7 (12)	2 (2)
# of young goats	2 (4)	4 (10)	3 (6)	3 (10)
# of adult goats	4 (4)	4 (12)	5 (6)	3 (10)

* SR = Small Ruminants (w/ = with).

TABLE 7. TIME ALLOCATION OF HOUSEHOLD MEMBERS ON SMALL RUMINANT ACTIVITIES, IN HOURS AND MINUTES PER DAY (%)

Household Members	Overall	OPMM	NES with SR	Labor in Project	Labor outside Project
Father	1.14 (52)	1.18 (92)	1.07 (58)	1.18 (33)	1.10 (25)
Mother	0.38 (46)	0.36 (83)	0.30 (50)	1.05 (33)	0.26 (33)
Sons	4.12 (88)	4.42 (83)	4.08 (92)	4.38 (92)	3.23 (83)
Daughters	2.36 (38)	2.11 (33)	4.00 (17)	1.36 (42)	2.37 (75)

In terms of feeding management for the small ruminants, most farmers practiced mixed management feeding systems i.e., cut-carry and grazing systems and some also gave rice bran as a feed supplement. Table 8 shows that 100% of OPMM and NES farmers cut grasses from their neighbor's plantation areas. Eighty seven percent of them grazed their animals in the neighborhood and 13 percent in their own plantation area. All farmers in the NES area cut grasses and grazed the animals not far from their house with an average of 1 kilometer in distance (Table 8). This finding is very striking, as we assumed that integration of the sheep and rubber trees was an effort to maximize personal land utilization. There are two possible reasons why farmers were grazing their sheep on their neighbors land. First, the distance between their house and rubber trees is an average of 3 to 5 kilometers, and their neighbors which are under different NES scheme--called PRPTE--have younger rubber trees with more grasses around them than theirs. Second, since the age of their own rubber trees is around 12 years old, there are fewer grasses growing on their own lands due to a developed canopy in the older trees which shades the ground under the trees. This problem creates tension between neighbors and OPMM farmers. Last year one incident regarding the grazing of sheep in a neighbor's rubber trees was reported. Although research on carrying capacity has been done (Scholz, 1992), further investigation needs to be conducted to determine the actual carrying capacity of the land under the rubber trees for sheep for each stage (or age) of the rubber trees' growth cycle.

On average, only 50 percent of the farmers knew the quality of grasses. From the interviews, we found they did not know the quantity and quality of different grasses and feed supplements necessary for minimal nutritional requirements based on the physiological status of the animals. Farmers usually gave the same feeds to all their animals, regardless of their physiological status. Therefore, the farmers need more information about the feeding requirements for

different types of animals. Sixty nine percent of the farmers did not know why they had to give feed supplements to their small ruminants.

Table 8 also shows barn management practices by farmers. Seventy five percent of the farmers mixed their animals with each other in the barn. This practice is not recommended by the breeding program as it will create inbreeding problems. However, 75 percent of the OPMM farmers have already put their small ruminants on a group system. Ninety six percent of the farmers give water to their animals.

Table 9 showed farmers' knowledge on breeding management. On average only 56% of the farmers knew the age of their ram the first time it mated, whereas 65% of them knew the age of their ewes at first mating, and 50% of the farmers knew at what age their ewes gave birth for the first time. In general, since only half of the farmers had some knowledge about breeding management, improvement of farmers' knowledge on breeding management is essential for both the farmers and the project.

Loss due to death has been relatively high. Table 10 shows that 65 percent of the farmers encountered some diseases in their animals. The highest percentage of animal diseases were reported by NES farmers (83%). The most common health problems found in the flock were diarrhea and bloat. Ninety percent of the farmers reported that during the past year their sheep got diarrhea or bloat. The OPMM farmers and the plantation laborers in the project bought anthelmintic from the extension worker every three months. Since the only extension service for those who live in the plantation compound was that which was provided by the plantation company, about 33 % of the laborers who are not involved in the project got some extension service help. Yet in the NES, 100% of these farmers used traditional medicines to cure their animals versus medicines provided by extension service personnel. When asked why they did not ask for help from the extension services (which are provided by the Indonesian government at the sub-district level), 70 percent of the farmers said it was too expensive.

The overall loss due to death of animals has been relatively high (46%). Labor in the project experienced the highest percentage of loss due to death (75%). The lowest death rates were found in the OPMM project. Only 25 percent of the OPMM farmers had experienced loss in their flocks. Forty-two percent of farmers said that diarrhea was the main cause of loss.

TABLE 8. FEEDING MANAGEMENT PRACTICES (%)

Variables	Over all	OPMM	NES SR	Labor Proj.	Labor SR
Places to cut grasses					
own plantation	71	--	--	75	67
neighbor's plantation	100	100	100	--	--
open fields	29	--	--	25	33
Distance (Km)	1.7	1.4	2.1	1.5	1.7
Quantity/SR (Kg)	3.1	2.7	3.2	3.5	3.0
Whether they choose grasses	50	100	42	42	17
Grazing: own plantation	13	17	8	--	--
neighbor/ estate	94	83	92	100	100
Distance (Km)	1.1	0.9	1.0	1.0	1.3
SR given feed supplement	44	100	17	42	17
Reason no feed supplement expensive	17	---	17	--	--
Enough grass	26	---	17	42	17
Don't Know	69	---	66	58	83
Barn System Individual	8	---	---	8	--
Group	46	75	---	17	--
Mixed	75	25	100	75	100
Whether SR given Water	96	100	83	100	100

TABLE 9. FARMER'S KNOWLEDGE OF BREEDING PRACTICES

Farmer's Knowledge	Over all	OPMM	NES SR	Labor Proj.	Labor SR
Rams 1st mating (%)	56.1	58.5	75.0	50.0	41.0
Ave. Age of Rams 1st mating (mo)	10.6	10.1	11.5	10.0	10.6
Ewes 1st Mating (%)	64.6	75.0	75.0	58.3	50.0
Ave. Age of Ewes 1st mating (mo)	7.9	7.1	10.4	8.6	5.5
Ave. Age of Ewes 1st birth (%)	50.0	50.0	50.0	50.0	50.0
Ave. Age of Ewes 1st birth (mo.)	13.7	13.8	15.7	12.5	12.7
Ewes mated after give birth (%)	66.7	66.7	75.0	66.7	58.3
Ewes mated after give birth (mo.)	2.7	2.5	3.4	2.0	2.7

TABLE 10. FARMER'S KNOWLEDGE OF DISEASES AND PREVENTION

Farmer's Knowledge	Over all	OPMM	NES SR	Labor Proj.	Labor SR
Animals got diseases last year (%)	64.6	75.0	83.3	58.3	41.7
Type of disease					
Diarrhea	89.8	83.4	75.0	100.0	100.0
Bloat	16.7	8.3	25.0	---	---
Poison	8.3	8.3	---	---	---
Help from Extension (%)	72.2	100.0	---	83.3	33.3
Reason if No					
Expensive	70.8	---	100.0	---	41.6
Distance	58.4	---	---	---	58.4
Type of Medicine					
Anthelmentic	63.9	91.7	---	75.0	25.0
Traditional	52.1	8.3	100.0	25.0	75.0
Animals died last year (%)	45.8	25.0	50.0	75.0	33.3
Reason animals died					
giving birth	16.7	---	---	16.7	---
diarrhea	41.7	---	33.3	58.3	33.3
bloat	8.3	8.3	8.3	---	---
Poison	12.5	16.7	8.3	---	---

Table 11 shows farmers' perceptions on the factors that limit the possibility of raising small ruminants. Sixty three percent of the farmers said they needed more capital to increase the number of their animals, and only a small percentage of the farmers thought they had problems with finding grazing areas and/or the availability of grasses. Only a few OPMM and NES farmers said that they had problems with the availability of labor to help raise their small ruminants (38%); and all laborers in the plantation company said they didn't have any constraints in available household labor. However, from our field observations, labor availability was only a problem for young families since raising small ruminants is only a secondary or complementary source of household income. More affordable extension services need to be provided, as 57 percent of the farmers felt there was a lack of extension services in their area. Almost half of the farmers said diseases were a major factor limiting small ruminant productivity.

In terms of the farmers' perceptions toward limiting factors to increase their family's welfare, Table 12 shows the most common problem was lack of cheap credit. This was especially true for NES farmers (65%). This was followed by availability of farm land (42%). Other factors reported included capital, extension services, and family labor. In general, farmers' perceptions are important in predicting the behavior of members of their households and their willingness to consider changes in current practices. By understanding the farmers' perceptions, practitioners can improve, modify or change existing production system.

TABLE 11. FARMER'S PERCEPTION TOWARD LIMITING FACTORS OF RAISING SMALL RUMINANTS, REPORTED IN PERCENTAGE OF RESPONDENTS

Variables	Over all	OPMM	NES w/SR*	Labor Proj.	Labor w/SR
Lack of:					
Capital	62.5	41.6	66.7	50.0	50.0
Labor	37.5	33.3	41.6	---	---
Extension Services	56.7	16.7	75.0	---	50.0
Diseases	44.4	33.3	41.6	91.7	41.6

* SR = Small Ruminants (w/ = with).

TABLE 12. FARMER'S PERCEPTION TOWARD LIMITING FACTORS AS NES PARTICIPANTS AND LABORERS IN THE ESTATE COMPANY, REPORTED IN PERCENTAGE OF RESPONDENTS

Variables	Over all	OPMM	NES w/SR*	Labor Proj.	Labor w/SR
Lack of:					
Land	41.7	25.0	66.7	---	---
Capital	33.3	8.3	25.0	---	---
Extension Services	22.9	16.7	16.7	---	8.3
Labor	23.6	50.0	16.7	33.3	25.0
Credit System	65.3	58.3	58.3	50.0	91.7

* SR = Small Ruminants (w/ = with).

Table 13 shows the existing credit system for the different farmers. On average 67 percent of all households borrowed money. Laborers in the project had the highest percentage of borrowing (92%) compared to NES farmers who had the lowest household borrowing (42%). The most common source of credit for all farm households was the cooperative (Koperasi Unit Desa/KUD). All laborers in the plantation company could borrow a specific amount of money at a low interest rate (2.5 percent per month). For NES farmers, only about 50 percent of them borrowed from their own KUD. If the farmers borrow money from a money lender, the interest rate could range from 5 to 20 percent per month, therefore the existence of a healthy and reliable KUD is essential for NES farmers. Among households that borrowed money, 45 percent did so for basic household consumption and 33% did for children's education.

TABLE 13. TYPES OF CREDIT SYSTEMS UTILIZED BY FARMERS, REPORTED IN PERCENTAGE OF RESPONDENTS

Variables	Over all	OPMM	NES w/SR*	Labor Proj	Labor w/SR
Farmers owed $ (%)	66.7	66.7	41.6	91.7	66.7
To Whom they owed:					
Bank	8.3	--	--	--	--
Traders	8.3	--	--	--	--
Money Lenders	20.8	--	--	--	8.3
KUD	58.3	50.0	--	100.0	58.3
Relative/ Neighbor	25.0	8.3	41.7	--	--
Reason to Borrow money:					
Necessities	45.0	50.0	--	33.3	41.7
Schooling	33.3	8.3	41.7	58.3	25.0
Total owed (Rp000)	122.7	215.7	86.0	119.5	65.6
Interest Rate/month	5.7	5.5	12.8	2.5	2.5

* SR = Small Ruminants (w/ = with).

Overtapping. The issue of overtapping is a very important one for the sustainability of the OPMM project. One of the objectives of the OPMM is that the integration of sheep and rubber trees will increase farmers' income and create economic diversification for smallholders in tree crop projects. Overtapping can reduce the life-span of a plantation by as much as half its normal life. This is a very serious problem in Membang Muda. As Scholz (1992) stated: "The rate of overtapping is increasing and the seriousness of this situation cannot be overemphasized." Scholz's study reveals some indirect

problems of overtapping. Although all respondents agree overtapping will reduce the life-span of the rubber trees, from the interviews it seems there is no single agreement on a definition of what constitutes overtapping. From our survey, it showed that the problem of overtapping is not a simple matter that can be explained only through latex production (Scholz, 1992). In sum, there are four substantive issues that need to be investigated to get a clear picture of the process of overtapping and why and how farmers are doing it. Those issues are: (1) Land conversion; (2) Participant selection; (3) Pricing formula; and (4) Smallholder loan repayment.

Speaking to the methods of this future research, we feel a participant observation approach would be the most appropriate (see Brown and Handayani, 1993), however, interviews and surveys could also provide some tangential evidence on the process of overtapping.

Conclusion

This research has provided a preliminary social and economic assessment of the OPMM project. The areas where the project was operating shows there is a serious need for further development in on-farm small ruminant research from each of the disciplines involved in the project (in particular the nutrition and forage management, breeding, sociology and economics components). However, two main substantive issues need to be investigated regarding the problem of overtapping and the problem of carrying capacity of the rubber trees for sheep in different stages of development of the trees. These must be addressed if the project is to expand at a larger regional or even national level.

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Notes

1) NES participants received 2.0 hectares of rubber-trees land and 0.04 hectares of land with a house on it from the Indonesian government.

2) According to the World Bank Document (1989), there are participants who fall outside of the prescribed age bounds, who do not reside in the project areas and who have arrears on loans, typically BIMAS rice loans, to the state commercial banks. The requirements for NES participants are that: (a) the participant meets prescribed eligibility criteria i.e., is between 18 to 45 years old, married, engaged in farming, domiciled in the project area, of good character, not participating in other tree crop projects and is not in arrears on other bank debt; (b) the plantings meet the required quality standards; (c) the State Auditing Agency (BPKP) has audited the accounts establishing each individual's loan account; and a credit agreement is signed by the participant acknowledging his debt and the terms of payment obligations.

3) Based on a pricing formula issued by the Ministry of Agriculture, the agreed price is paid to the smallholder and a negotiated portion of the smallholder's earnings are paid directly into a bank account for loan repayment. The pricing regulations seek to ensure that for compulsory sales to the nucleus estates they will receive a reasonable return and an adequate incentive to invest in the processing facilities, and that there will be sufficient savings generated to repay the small holders' loans. However, there have been numerous reports of farmers selling their rubber outside the plantation to get a better price or better services on the private market. The use of the Joint Marketing Office (JMO) price as a reference standard is a poor practice, since these prices tend to be out-of-line with spot-prices provided by private traders.

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RE-EVALUATION OF OUTREACH PILOT PROJECT

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ABSTRACT

An evaluation was conducted to find out if sheep and goat management practices which had been instigated in the Outreach Pilot Project (OPP) between 1984 and 1989 were still being continued in 1992. Of the 31 farmers in the project, only 21 continued to raise small ruminants; most of those that had dropped out had sold their animals to finance a new cash-generating activity. Average flock size of the remaining flocks had decreased to 6.8 animals in 1992, from 10.3 in 1990. Almost all farmers continued to provide adequate forage for their animals, but did not continue to provide concentrate even though this gave an economic return. Some farmers had planted forage legume trees since the projected had finished. The majority of farmers no longer provided clean drinking water nor a salt lick. In 1992, inbreeding between related animals was allowed to occur in most flocks. Until 1990 the extension workers had prevented inbreeding. Diarrhoea continued to be the most common health problem. Flock health can be improved by better feeding but farmers are unwilling to invest more time and money in improving nutrition. The barns were clean and well maintained. Farmers had sold an average of 3 animals in the previous year, and used the money for household expenses, to buy items of capital value and for religious purposes.

Introduction

The Outreach Pilot Project (OPP) is a multidisciplinary "on-farm" research activity to validate the results of years of "on station" research at RIAP in small ruminant nutrition, breeding management, economics and health (Ludgate and Priyanti, 1990).

The OPP began in August 1984 and finished in September 1989. During these five years of research, the main activity was transfer of technology through monthly visits and bi-monthly village meetings. The technology developed has been compiled in a book entitled "A Collection of Training Materials for on-farm Research on Small Ruminants" (Ludgate, 1989a).

Results of the last five-years activities have been reported by Ludgate (1990). The main findings are as follows:

1. In general the reproductive performance of the animals was good, since lambing intervals were shorter than before, litter sizes were higher and pre-weaning mortality lower. But, there is concern that inbreeding may occur since farmers keep a ram or buck for a long time. An economic study reported that most animals sold by farmers were young males while the older males were kept as breeders.

2. Most farmers provide adequate forage as recommended by OPP but a large percentage of them give only grass of medium quality. When farmers were given salt by the project, about 44% farmers provided salt to their animals but then after the project finished, only 23% farmers continued provide salt to their animals. Only a few farmers gave fresh water, at least those observed at the time of visit. Health problems arose because of the lack of attention to follow recommended practices.

3. About 78% of the farmers reported that one year before the project started their animals suffered from diarrhoea, 46% reported neonatal mortality, 14% stillbirths and 8% abortion. While the project was active, these diseases were reduced: 65% of farmers reported diarrhoea, 39% neonatal mortality, 8% stillbirths and 8% abortion.

4. The farmers have implemented barn separation for their sheep and goats. Keeping animals separate based on physiological status tends to improve productivity. Farmers generally have accepted cleaning the barn as part of the basic management activities.

From these findings it can be concluded that by only improving barn cleaning, keeping the animals in the barn according to physiological status and providing adequate forage, reproductive performance is improved. Since the overall objective of the OPP is to raise the productivity of small ruminants (Ludgate, 1989b), it means that this objective has been achieved.

Yet, the remaining question is: Do farmers still maintain the improved practices?

This paper describes whether the management practices of the OPP small-ruminant farmers are still maintained. If not, then why do OPP farmers not adopt the new technologies?

Methodology

The evaluation was conducted twice. The first evaluation was during February 1992 in the wet season. The evaluation showed that 19 farmers out of the original 31 OPP farmers still raised sheep or goats. The second evaluation was conducted in July-August 1992 which was the dry season. In the second evaluation, 21 farmers raised small ruminants.

There were 16 days of field visit for each evaluation. Eight days to score the management practices of the farmers and 8 days for in-depth interviews. The scoring system followed the previous OPP scoring methods (Ludgate and Priyanti, 1990) and the same enumerator could avoid bias because the score of these findings would be compared to the data of the previous years (Ludgate and Priyanti, 1990). The in-depth interviews were based on discussions with experts from each discipline. The subjects selected for in-depth interview were the following.

Nutrition:

-Forages planted by the farmers and the use of concentrate.
-Provision of forage, salt and water.

Breeding:

-Inbreeding.

Management:

-Barn conditions.

Health:

-The health care of pregnant animals and offspring.

Sociology:

- Farmers' knowledge and beliefs related to the technology observed.

- Reasons for stopping or starting to raise small ruminants.

Economics:

-The use of money from selling small ruminants.

All the aspects mentioned above were used as guidelines for the "qualitative interview ".

Results and Discussion

Some OPP Farmers No Longer Raise Small Ruminants. From the first evaluation was found that 41% of the OPP farmers did not raise small ruminants any more. The reasons for not continuing to raise small ruminant are presented in Table 1.

TABLE 1. REASONS FOR NOT RAISE SR ANY MORE (N = 12)

Reasons	%
Have new occupation which provides regular cash	42
Become a food crop producer	42
Old	8
No time	8

Some examples of how farmers start to earn regular cash are presented in Appendix 1.

OPP farmers' Management Practices: Nutrition. To know whether there was a change in nutrition management practices, the data collected in February 1990 and July 1990 were compared. Quantitatively, most of the farmers provided too much forage to their animals (Table 2). It seemed that farmers did not practice the suggested management anymore.

TABLE 2. QUANTITY OF FEED PROVIDED (%)

Score	Quantity	Feb.1990 (n = 34)	Feb.1992 (n = 19)	Jul.1990 (n = 34)	Jul.1992 (n = 21)
0	Not adequate	17	5	24	29
1	Too much	9	58	9	71
2	Adequate	65	32	56	0
99	Other	9	5	11	0

Table 3 shows that the quality of forage provided to the animals was good enough since most farmers provided fresh medium quality forages. This finding implies that the environment provided enough forage so that farmers were able to provide good quality forage through out the year. However, all farmers believed that too young grass or leaves will make the animals bloated.

TABLE 3. QUALITY OF FORAGE PROVIDED

Score	Quality	Feb.1990 (n=34)	Feb.1992 (n=19)	Jul.1990 (n=34)	Jul.1992 (n=21)
0	Mature	0	5	12	0
1	Dry Medium	0	0	3	0
2	Dry Young	29	0	12	0
3	Fresh Mature	9	5	21	5
4	Fresh Medium	65	58	15	81
5	Fresh Young	6	16	0	0
99	Other	9	16	38	14

The type of feed provided is described in Table 4. No farmers gave concentrate to their small ruminants and only one farmer gave complete supplement. All farmers said that rice bran was very expensive. The price was Rp. 250,- per kg. Efforts to make the farmers realize the importance of rice bran must be emphasized. An explanation about the benefits of giving rice bran and the loss in production by not giving rice bran must be shown to the farmers. For example, a pregnant ewe needs 300 gram rice bran/day for three months of late pregnancy. Therefore during pregnancy farmers must provide 300 gram rice bran X 93 days = 27,900 gram or approximately 28 kg. Therefore farmers must spend 28 X Rp. 250.- = Rp. 7,000.-for each pregnant ewe. This is a large amount of money especially when two or more ewes are pregnant at the same time. An institution like a cooperative or group of small ruminant farmers to manage the availability of rice bran for the farmers should be started so that farmers can provide ricebran for their small ruminants but they pay later when they have money from selling their animals.

Most farmers provided a mixture of grass, crop by-products and legume tree forage. Grass is available throughout the year, though some farmers reported that during the dry season they had to go further than usual to cut grass. Crop by-products are easy to find even though small ruminant farmers may not have their own. For example, cassava leaves are available throughout the year. Compared to 1992 some farmers showed improvement in nutrition management. Some farmers had planted legumes trees as described in Table 5.

TABLE 4. TYPE OF FEED PROVIDED

Score	Type	Feb.1990 (n=34)	Feb.1992 (n=19)	Jul.1990 (n=34)	Jul.1992 (n=21)
0	grass only	29	0	27	0
1	grass+crop by-products	35	32	32	43
2	grass+legume tree forage	3	5	0	0
3	grass+concentrate	0	0	0	0
4	grass+crop-byproducts+ legume tree forage	0	58	3	57
5	grass+complete supplement	6	5	0	0
99	No data	27	0	38	0

TABLE 5. FARMERS WHO PLANTED FORAGES FOR SMALL RUMINANTS

Forages	Percentage	
	February 1992	July 1992
Gliricidia	44	70
Leucaena	11	3
Elephant grass	50	42
Caliandra	0	25

Most farmers did not provide water (Table 6). Compared to the earlier year, in 1990 as well as in 1992 the percentage of farmers who do not provide water was very high. The in-depth interviews found that some farmers believed that small ruminants do not need water because the forages provide enough water for their metabolism. Moreover during the rainy season some farmers said that they had tried give water but the animals did not want to drink.

TABLE 6. WATER AVAILABILITY

Score		Feb.1990 (n=34)	Feb.1992 (n=19)	Jul.1990 (n=34)	Jul.1992 (n=21)
0	no bucket in the barn	29	89	15	95
1	empty bucket in the barn	9	5	26	0
2	bucket filled with dirty water	0	0	9	0
3	bucket filled with water	3	0	9	0
4	bucket filled with fresh water	32	5	0	5
99	no data	26	0	41	0

Some farmers still provide salt in bamboo licks as suggested by the OPP team; however most do not provide salt (Table 7). Farmers have a custom of sprinkling water and salt over the forage. They believe that the forage tastes

more palatable. Giving salt in this way was enough according to them. They think that providing a salt lick will made the animals eat more and became fat and sterile. So, not giving salt lick was not a matter of economics but their belief from past experience.

TABLE 7. SALT AVAILABILITY

Score	Feb.1990 (n=34)	Feb.1992 (n=19)	Jul.1990 (n=34)	Jul.1992 (n=21)
0 no bamboo lick in the barn	2	68	9	52
1 empty bamboo lick	12	0	27	5
2 bamboo filled salt and water	27	0	18	10
3 bamboo filled powdered salt	24	32	6	33
Others	35	0	41	0

To have a picture of how a farmer in the village practices feeding management, an in-depth interview with Ms. Arpin during the first evaluation is presented below.

Mrs. Arpin, is a widow of 56 years old who lives with her son's household. She pointed out some forage trees in her yard which are usually given to her small ruminants during the rainy season or when she is sick, busy or lazy. There are 10 trees of gliricidia, about 100 banana trees, 6 jackfruit trees (*Artocorpus heterophyllus*), 6 jambu biji, 2 trees of daun huni (*Antidesma bunisius*). She also planted *Sesbania grandifora* given by the OPP team but it died. When asked what other things she had received from the OPP team she mentioned *iodine* that must be put on the umbilical cord of new born lambs but she does not use it any more because she thinks the color of the iodine stimulates cannibalism. Therefore she uses ash for the umbilical cord and the ewe's vulva. Other management practices she does not continue are to provide salt, weigh the animals and record breeding and reproduction. According to her, salt makes the ewes sterile, weighing the animals is a waste of time and without recording she always knows when the animals should be mated and when parturition is due. From her experience she never fails in mating the ewes. Once mated, the ewes become pregnant. Beside her trees, she has also planted *Ipomoea aquatica* in an area of 15 m^2. Almost every day she harvests this for sale and gives the old leaves to her small ruminants.

During the interview, her grandson brought in about 5 kg of rice bran. It was a gift from her daughter who has a rice huller. This rice bran is not only for small ruminants but also for her poultry. She has 4 chickens and 5 ducks. She said, she only gives ricebran to her small ruminants twice a week. She knows how to give feed according to the physiological status of the animals but because she is busy she just gives whatever forages she has and whenever she has time. Especially for lactating ewes she gives what she call *daun susu anjing*

or *daun Jarak* in order to produce more milk. She does not provide papaya because papaya causes diarrhoea. Following these practices she never has any problems with her small ruminants except that sometimes her sheep get diarrhoea and she can easily cure this by giving *Antidesma bunisius* leaves mixed with salt.

Breeding. The farmers' average flock size was 6.78 in 1992, lower than the average of 10.3 in 1990 (Table 8).

All farmers understood from the OPP team that they should be careful to avoid inbreeding. But, our interview revealed that their understanding of inbreeding was only superficial. For example a farmer said that inbreeding is when the ram or buck is mated with his female offspring or a ewe mated to her male offspring. Mating between male and female offspring was not recognized as inbreeding. We found that 50% of farmers still allow inbreeding. Some farmers said that they do not believe that inbreeding will cause bad performance of the offspring. Bad performance and neonatal mortality are already decided by God. Some farmers also said that there was no alternative for them. It is not always easy to borrow a ram or buck from other farmers.

TABLE 8. OPP FARMERS' SMALL RUMINANT FLOCK SIZES

No.	Name	Lambs born		Young		Ram/ buck	Ewe	Lact ewe	Preg ewe	Tot
		Male	Fem	Male	Fem					
1.	Ajun	1	6	0	3	2	0	4	0	16
2.	Hidi	1	2	1	2	0	0	1	0	7
3.	Oon S.	3	2	1	2	0	0	3	0	11
4.	Hamim	0	1	1	0	0	0	1	1	4
5.	U. Sarudin	3	5	2	0	3	2	4	0	19
6.	Arpin	0	0	0	2	1	2	0	0	5
7.	Supena	1	0	0	1	1	0	1	0	4
8.	Mad Tani	2	1	0	0	0	0	2	0	5
9.	Asmar	1	3	0	0	4	2	2	0	12
10.	Suma	0	1	0	2	0	0	1	1	5
11.	Aab	0	2	0	0	0	0	1	0	3
12.	Sohib	1	0	1	0	0	1	1	0	4
13.	Anung	0	0	2	1	0	2	0	0	5
14.	Camong	0	3	0	0	0	0	2	0	5
15.	Suryaman	1	1	0	2	0	2	1	0	7
16.	Uto S.	0	1	0	0	0	0	1	1	3
17.	Mamad	0	1	1	0	1	0	1	2	6
18.	Aming	0	2	0	0	0	0	2	1	5
19.	Badri	0	0	1	1	1	0	0	0	3
	Total	14	30	10	16	13	11	28	6	129
	Average	0.7	1.7	0.5	0.8	0.7	0.6	1.5	0.3	6.8

Health. Diarrhoea always affects most small ruminants (Table 9). Detailed research about diarrhoea must be done because diarrhoea can be caused by many kinds of disease. On the other hand, the effect of diarrhoea on production cannot be easily appreciated by the farmers.

TABLE 9. DISEASES IN THE FARMERS' FLOCKS (%)

Diseases	1989 (n=34)	1990 (n=34)	Feb.1992 (n=34)	Jul.1992 (n=21)
Diarrhoea	78	65	83	29
Bloat	0	0	28	10
Scabies	5	12	17	10
Neonatal mortality	46	38	0	0

When the farmers were asked in 1992 whether they had cases of neonatal mortality last year, all farmers said no. But, when they were asked what was the biggest problem in relation to animal health most answered "neonatal mortality". This information is similar to the previous data reported in 1989 and 1990. This findings raise a question why they did not answer diarrhoea as the biggest problem as in 1989 and 1990? Is it because mortality is easily seen by the farmers so they consider it to be a big economic loss? Which is the greater cause of economic loss, diarrhoea or neonatal mortality? From personal observations over several years, it seems that a factor contributing to neonatal mortality is poor feeding management of ewes. One thing that should be taken into consideration is that some farmers also reported that beside neonatal mortality, ewes became paralyzed. But farmers did not think this a serious economic loss because they still have time to sell the sick ewe even though the price they received may be very low. Further in-depth interviews found that paralysis often happens after the second parturition. This may be associated with poor body condition as the ewe gets older, due to inadequate feeding. The question now is: In trying to increase small ruminant production, should feeding management or health management be emphasized? Probably health can be improved through good feeding management. But, good feeding needs a lot of money and farmers do not want to spend their money. The way out is provide credit for rice bran or other concentrates.

To get more detailed information on how farmers care for ewes or does during parturition and the offspring, data were collected during the second evaluation. It was found that 57% of farmers provide additional feeding for the ewes and does. About 55% farmers helped the offspring to get milk from the ewe, 56% of them gave ash on the naval and only 18% used iodine because

they thought that ash is better than iodine and made the navel dry sooner than using iodine. One farmer said that iodine stimulates cannibalism.

Management. Table 10 reflects that the barns are relatively clean. The location of the barn is usually close to the farmer's house and the farmer or some other member of the family always cleans it as part of their daily activities.

TABLE 10. THE SCORE OF BARN CLEANING

Barn part	Score		
	1990	Feb.1992	Jul.1992
Barn floor	3.6	3.9	3.9
Barn pit underneath	2.6	2.9	2.7

The scores range from 1 to 5.

To place the animals in the barn according to physiological status, a farmer spends time and money. As a matter of fact, no farmer got a very good score for this. Any technology related with money and time seemed to be difficult to apply.

TABLE 11. PERCENTAGE OF ANIMALS PLACED IN CATEGORIES BASED ON PHYSIOLOGICAL STATUS

Animals	1990					1992				
Status	1	2	3	4	5	1	2	3	4	5
Adult male	87	9	0	0	4	0	0	100	0	0
Lactating female	77	16	4	0	3	0	0	33	50	17
Pregnant female	47	39	1	0	2	0	0	50	50	0
Adult female	51	44	5	0	0	0	0	20	80	0
Young male	65	10	0	0	24	0	0	20	80	0
Young female	41	37	11	0	11	0	0	18	82	0
Weaned young	31	52	12	0	5	0	0	33	67	0

Note: 1 = very good; 2 = good; 3 = average; 4 = bad; 5 = very bad.

Economics. Economic data were collected by recall of what had happened one year before the interview. This meant that most of the farmers could not remember the age at which animals were sold. From the first evaluation, 55% of farmers sold some of their animals. Most of the animals sold were male (Table 12). The use of money from selling the animals is presented in Table 13.

TABLE 12. THE NUMBER OF FARMERS WHO SOLD ANIMALS LAST YEAR AND THE TOTAL NUMBER OF ANIMALS

No of farmer	Small ruminant sold		Total
	Male	Female	
1	3	-	3
2	4	1	5
3	3	-	3
4	2	2	4
5	1	-	1
6	1	-	1
7	1	-	1
8	2	1	3
9	5	4	9
10	6	-	6
Total	26	8	36
Average	2.6	0.8	3.6

TABLE 13. THE USE OF MONEY FROM SELLING SMALL RUMINANTS (N = 10)

The use of money	%
Additional funds to renovate the house	60
Buy land	30
Buy motor cycle	10

The second evaluation found that 12 farmers sold an average of 3 animals per family. The money from selling the animals were used for sacrifice (25%), support education of children (25%), repair the house (17%), daily expenses (17%), buy land (7%) and buy cow (7%).

Conclusions

In general we can conclude that OPP farmers who do not keep small ruminants anymore have found a new occupation which gives a regular cash income such as operating a shop, working in a factory in a big city like Jakarta

or motor cycle renter. But, when there is no alternative activity they start keeping small ruminants again.

The remaining OPP farmers had lower management practice scores than before in most of the recommended technologies. However, some farmers also provided legume tree fodder on their own initiative. Reasons that may influence management practice are the lack of assistance or control from the scientists, lack of resources and farmers' beliefs and knowledge.

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APPENDIX 1. SOME EXAMPLES ON HOW FARMERS EARN REGULAR INCOME

Two farmers thought that operating a shop will enable them to earn regular cash. Therefore they decided to sell some of their animals and use the money to renovate their house in order to operate a shop. At the same time they shared-out the rest of their small ruminants because they did not have time to manage them. Another example is a farmer who decided to sell all of his animals and use the money to buy a motor cycle. He operated it as a rented motor cycle. By this he earned regular cash.

Another case is a farmer who decided to take along his son with him to Jakarta to work in a factory in order to earn a regular cash income for the family. Therefore they sold all their animals since there would be nobody to take care the animals. This farmer used the money for buying land close to his house. About nine months after he started working in Jakarta, his wife started to share-in small ruminants from other people. This is the detailed interview with his wife.

Ms. Jajuli decided to share-in sheep after all her small ruminants had been sold by her husband a year before. Her husband decided to work in a factory in Jakarta along with their oldest son. These new sheep have now been shared-in for three months. The number of sheep are 11, consisting of 3 ewes, 1 ram and 7 young females. She takes care the animals with her 2 sons. Roni is 14 years and finished his elementary school 2 years ago but could not continue to high school because of economic constrains. The other son is Agus, 11 years old, in the third grade of elementary school. Early in the morning Roni cleans the barn and feeds the sheep. After he has his breakfast around 09.30 a.m. he collects grass until around 12.00 a.m. This forage will be fed at 17.00 p.m. Agus who usually comes back from school at 13.00 a.m. is responsible for collecting forage for feeding the next morning. He enjoys the work because he collects the grass together with his five close friends. The remaining activities of small ruminant raising are the responsibility of Ms. Jajuli. She also takes care of her 2-year old daughter and household activities.

Mrs. Oom is another small ruminant farmer. When the enumerator visited her barn in February 12, 1992 she recognized that the small ruminants in her barn were not the previous ones. Mrs. Oom said that she sold all her small ruminants last year because she wanted to buy land from her neighbor. From selling the small ruminants she got Rp 550.000 and with this money she bought 200 m^2 of land. Then six months ago she bought 2 ewes, 1 ram and 2 lambs for a total price of 320.000,-. About 2 months later two ewes produced their offspring (1 single and 1 twin). In the enumerator's second visit to Mrs. Oom, in February 19, 1992 it was found that the original barn was empty but there was a new barn in the back yard of her house containing all her animals. She said that she had already sold all the animals for Rp. 465.000 to buy 130 m^2 land. It is not always easy to buy land so when land is for sale farmers buy

quickly. According to Mrs Oom it is very easy for her to sell the small ruminants, especially because neighboring farmers like to buy small ruminants from her because they believe that her small ruminants are good and she has considerable knowledge about small ruminants. Farmers who bought her animals asked her to share because they believe that she is good at keeping small ruminants. She also plans to buy small ruminants herself when her husband who is a security guard in a rubber plantation estate gets enough money. Yes, when she has enough money she prefers to buy small ruminants then gold. By raising small ruminants she benefits from the offspring, manure and increasing price of the ewes which she can sell at any time. But, if she has gold and suddenly she needs money she must go to the town which is expensive and takes time. Besides that the price of gold does not increase rapidly, remaining the same as before if she is lucky. If not, she will get less money because the price sometimes decreases.

From this interview one important thing to know is to check to the surrounding small ruminant farmers whether they have positive perception toward OPP farmers, what kind of technology has already been adopted and what kind is not. And also to check whether the information given is correct.

GOAT PRODUCTION IN RICE-BASED FARMING SYSTEMS IN LOMBOK

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ABSTRACT

A study to understand the goat production systems on lowland rice-based farms, and to assess differences in the level of goat production between irrigated and rainfed fields was carried out during the 1991/1992 cropping season in Lombok Island, NTB. Thirty-six farms, representing irrigated and rainfed fields were observed. Data collected included site information, background data on participating farmers, goat raising techniques, and productivity. Results indicated that: Goat production is relatively low, and improvements in management techniques could be adopted; The level of goat production in the irrigated and rainfed fields was similar; Goat production of low-resource farmers was better than that of above-subsistence farmers; Within rainfed fields, goat production on single cropping fields was higher than from double cropping fields; The contribution of goat raising in generating farm income varied among groups. Income of goat husbandry for rainfed fields and low-resource farmers was higher than that of irrigated fields and above-subsistence groups. Considering the relatively low goat productivity in the sites caused by poor management and the potential of goat keeping in increasing farm income, it is concluded that improving goat management techniques should be undertaken to increase small farmer income.

Introduction

Livestock on Lombok island, and throughout the province of Nusa Tenggara Barat (NTB), are generally raised on small-holder farms as a mixed enterprise. The two major agricultural components are food crops and animal production.

The lowland rice-based farming system, irrigated or rainfed, is the major farming enterprise. The farms are generally small (average 0.4 ha). Farm size has not altered much in recent years, but there has been an increase in irrigated land as a result of the establishment of an irrigation network. The cropping pattern of irrigated fields is a double rice crop, followed by a cash-crop (locally termed

palawija). Rainfed fields have either a single rice crop followed by palawija or rice only depending on water availability.

Increasing small farmers' welfare is the main objective of the national development program. As livestock are a component of farming in the area and it seems that farmers often do not strive to raise livestock to maximize profit, improving livestock production may increase farm income. Considering the distribution of goat keeping over the island (Djoko Sarwono et al., 1985) and the relatively low operating costs of goat production, increasing goat production might be one applicable alternative to overcome this problem. However, increasing goat production on small farms requires technologies which are appropriate and applicable. Devendra (1987) pointed out that available technology in animal production is generally designed for intensive systems and is inappropriate for small holders. There is a need for studies that can produce technologies which are appropriate to small-farmers, socially acceptable, and which significantly improve farmer income.

In order to generate such technologies, the first step is to develop a better understanding of the existing goat production systems. The study described in this paper was undertaken to accommodate this need in the lowland rice-based farming system.

Methodology

The main objectives of the study were to understand the goat production system in the lowland rice-based farming system, and to assess whether there were any differences in production system between irrigated and rainfed areas.

Specifically the objectives were to:

a. Understand the role of goat production on farming activity.
b. Understand the objective of goat raising.
c. Measure the level of goat production.
d. Assess the contribution of goat rearing in generating farm income.

Site Selection. The Island of Lombok covers 3 out of 6 regencies (kabupaten) within the Province of Nusa Tenggara Barat, namely Lombok Barat, Lombok Tengah, and Lombok Timur. Irrigated rice fields are mainly situated in Lombok Barat, while rainfed rice fields are common in Lombok Tengah and Lombok Timur (Figure 1). One desa (village) was selected from each kabupaten. The Desa of Lombok Barat represent an irrigated rice field, while the desa from Lombok Tengah and Lombok Timur represent those of rainfed rice fields.

The selection of desa was done using purposive sampling based on the type of rice field and goat population. The three desa selected were Jagaraga in Lombok Barat, Sengkol in Lombok Tengah, and Batuyang in Lombok Timur (Figure 2).

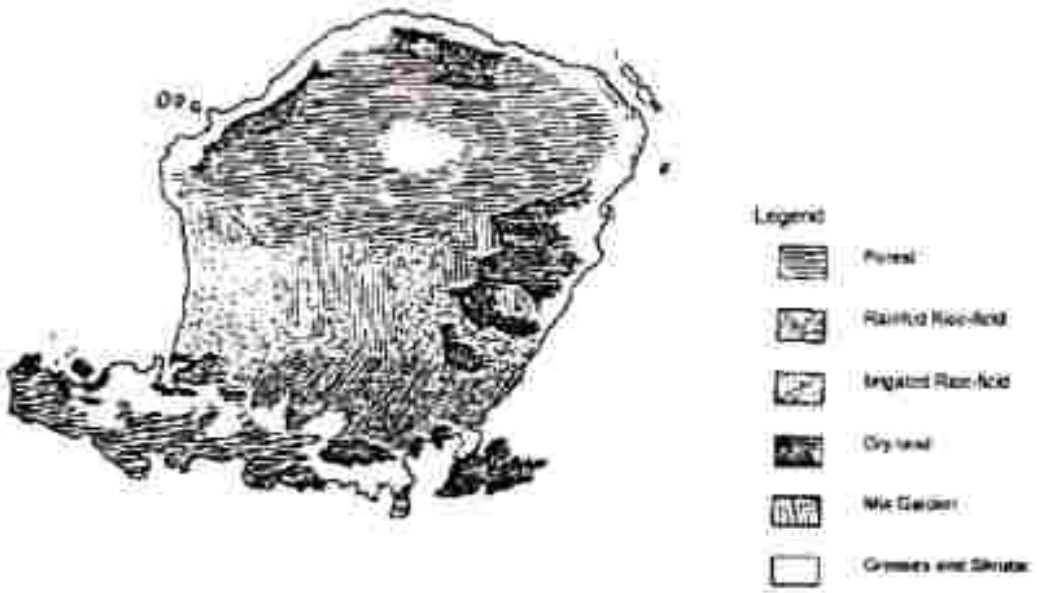

Figure 1. Simplified land-use map of Lombok island
(Adapted from Directorate of Agraria, West Nusa Tenggara Province)

Figure 2 Location of the study sites

Sampling Unit. Farmers who operated a combination of crop and goat production were used as sampling units. Twelve farmers were selected from each desa. 6 farmers who cultivated their own land were categorized as above subsistence farmers, and 6 farmers who cultivated shared land were categorized as low-resource farmers. In addition, as there were differences in cropping intensity in the rainfed rice fields, namely single and double cropping. Sengkol and Batuyang were chosen to include these two types of cropping intensities. Table 1 summarizes the distribution of the samples.

TABLE 1. THE DISTRIBUTION OF SAMPLES

Site	Type of field	Farmer Category	
		Above Subsistence	Low Resources
Jagaraga	Irrigated	6 (0.50)	6 (0.30)
Sengkol	Rainfed	6 (0.60)	6 (0.35)
	- Single cropping	2	4
	- Double Cropping	4	2
Batuyang	Rainfed	6 (0.60)	6 (0.40)
	- Single Cropping	1	5
	- Double Cropping	5	1

Note: numbers in parenthesis are average field size (ha).

Data Collection: *Site Information*. Landuse, livestock population, cropping pattern and farm components were collected from the Department of Agriculture and Department of Home Affairs at kabupaten, district (kecamatan) and desa levels.

Background Data on the Participating Farmers. Land ownership, farm components, family size, number of goats reared, motivation for goat keeping, and crops cultivated.

Goat-keeping Techniques. Housing, feeds (type, availability, source of feed, feeding practice), labor.

Data were collected by (1) Questionnaire of collaborating farmers, and (2) Monthly monitoring of crop and goat production. This included crop inputs

and income, and costs and income of goat keeping. The level of goat production was calculated in terms of increasing the number of animals.

Long period recall on inputs was avoided as far as possible since there is substantial distortion of such information (Bhati, 1979; Chambers, 1983; Von Fleckenstein and Dahlan, 1984). The collaborating farmers were taught to keep records of both crop and goat production. These records were monitored monthly by the researchers by interviewing collaborating farmers. Monitoring was undertaken over a one-year period, from December 1991 to November 1992 to cover all of the cropping seasons within 1991/1992.

Results and Discussion

Agriculture in the Jagaraga site is based on lowland irrigated rice cultivation, while in Sengkol and Batuyang rice is only cultivated in the rainy season. Farm sizes are small with an average of less than 0.50 ha in all three sites.

The Site. Table 2 indicates that ricefields in Jagaraga represent 71% of the total desa area, while ricefields in Sengkol and Batuyang cover 49% and 68% of the desa area.

TABLE 2. THE LANDUSE IN THE SAMPLE VILLAGES (HECTARE)

Desa	Total area	Rice field	Dry land	Forest	Range land	Others
Jagaraga	818	580	138	-	-	10
	(4725)	(2645)	(639)	(240)	-	(90)
Sengkol	2479	1224	220	350	-	740
	(22020)	(7101)	(2207)	(3341)	-	(3171)
Batuyang	565	387	178	-	-	-
	(25121)	(4619)	(2258)	(1226)	(125)	-

Numbers in parenthesis denote Kecamatan figures.
Source: Dinas Peternakan Propinsi Dati I NTB (1993).

The Farms and Farmers. The total area of rice field observed was 16.45 ha, consisting of irrigated rice (4.8 ha, 12 farms) and rainfed rice (11.65 ha, 24 farms). Farm size ranged from 0.20 ha to 0.80 ha.

There were three types of land tenure: owned, rented and shared tenancy; two types of animal tenure arrangement: namely owned and shared. In the shared operations, the tenant supplies all inputs other than land and the landowner receives 50% of the total yield.

Farmers who operated rented and shared fields were categorized as "low-resource farmers", whereas the description "above-subsistence farmers" was used for those who operated their own land.

Cropping Pattern. The cropping pattern on irrigated ricefields is two rice crops followed by a cash crop. On rainfed ricefields it is either a single rice crop followed by a cash crop or a single rice crop, depending on the water availability. The dominant cash crop at the sites is soybean.

Livestock. Livestock are an integral part of the farming system and fulfil a number of roles such as providing power for land cultivation (large ruminants), and as a buffer in the case of crop failure or other immediate needs. The livestock reared in the three sites are cattle, buffalo, horses, goats, sheep, and chickens. The numbers of animals in each site are presented in Table 4.

TABLE 4. NUMBER OF LIVESTOCK IN THE SITES

Sites	Horses	Cattle	Buffaloes	Goats	Sheep
Jagaraga	132	46	574	309	383
	(629)	(1451)	(2772)	(1593)	(1028)
Sengkol	74	1861	1257	1624	22
	(515)	(9758)	(9814)	(12917)	(526)
Batuyang	85	489	147	1078	441
	(1027)	(8007)	(1292)	(12597)	(6907)

Number in parentheses denote Kecamatan figures.
Source: Dinas Peternakan Propinsi Dati I NTB (1993).

Goats in Lombok are mainly of the local breed (termed kambing kacang), small bodied but prolific animals (Edey et al., 1981).

The few Ettawa-cross goats are reared only for meat. Sheep are an indigenous breed. The number of sheep has declined maybe as a result of government policy to eliminate sheep which are believed to be a carrier of MCF which is a dangerous disease for Bali cattle.

Goat Husbandry. There are about 157,000 goats in Lombok. The total number of goats observed in the initial survey of the study (December 1991) was 123, consisting of 24 males: 13 adult (>1 year old), 4 young (6-12 month) and 7 kids (<6 month); and 99 females; 74 adult, 19 young and 6 kids.

1. Husbandry. In general, farmers in Lombok concentrate more on food crop production than on livestock. Although there are large numbers of goats (Djoko Sarwono et al., 1985) goats give only a secondary income (Djoko Sarwono and Dwipa, 1984). The majority of goats are reared in scavenging systems.

2. Objectives. Goats fulfil several roles within farming life. They play a considerable role in buffering investment risk, such as a failure of cropping, and as a saving which can be sold whenever there is an immediate cash need. Being smaller and cheaper than cattle or buffalo, goats are also commonly used for subsistence food.

Goats are raised for meat and are very rarely milked or utilized for fibre, and they are considered useful as they consume leaves and shrubs not eaten by cattle or buffalo. However, goats do not confer the same status on the owner as cattle or buffalo. Djoko Sarwono et al. (1985) reported that farmers would prefer more cattle or buffalo than goats.

3. Management System. Flock sizes are small, with an average of 3 goats per farmer. The goats are released from the pen in the morning for grazing or browsing along roadside, banks and other wastelands; and housed in the evening. In the rainfed area, they may graze in uncultivated rice fields. No respondent used paid labor to look after goats.

Within the study sites, it seemed that farmers did not strive to optimize goat production by creating a conducive environment for their animals. Low standards of housing and feeding together with uncontrolled parasites may depress production.

The farmers' objectives of housing are more to keep the goats safe at night from theft than to provide a suitable environment for the animals. Ventilation and sanitation of the pen were only minor considerations.

There were no responses regarding the difficulties of providing feed. Green fodder (several kinds of leaves) is often offered to the animals for

additional feed in the evening. However concentrate is very rarely given. Neither rice nor soybean by-products were fed.

Disease and parasite control are not commonly practiced and losses of young goats are common. Stomach worms appear to be serious, especially at the onset of the wet season (December-January) when developing larvae are prevalent. Farmers suggested that kid mortality may be as high as 40% at that time.

Mating is uncontrolled and goats are free to mate indiscriminantly. Not every farmer owns his own buck. However most respondents reported subsequent kidding at the rate of three times every two years. Average age of first kidding was between 12 to 15 months. The first birth was usually a single kid, but second and subsequent kiddings produced a high proportion of twins. Castration was not practiced and some farmers culled the females after the fifth or sixth kidding, at an age of about 5 years.

Level of Production and Comparisons. Productivity of meat-producing animals can be estimated by measuring the increase in body size and the increase in number of livestock within a period of time. In this study, goat production was assessed by computing the reproduction rate from December 1991 to November 1992.

The number of goats increased by 85% during the year (88% in Jagaraga, 73% in Sengkol, 94% in Batuyang).

During the year there were 100 parturitions consisting of 75 singles and 25 twins. The total number of live kids produced was 125 giving a litter size of 1.33.

Out of 100 parturitions, 24 were cases of first kidding. The average age at first kidding was 14 months.

Within the observation period 7 does delivered twice, with an average interval of 8 months. However, during the one year observation there were only 100 births or 135% kidding rate. In addition, by better management, kidding interval can be reduced to 7 months or 170% kidding rate.

The relatively low reproductive performance of goats observed may be in relation to poor management practices. Webster and Wilson (1980) stated that increasing animal production on small farms can be achieved simply by improving management practices. With better management, litter size may be as high as 1.75 while first kidding can be reduced to 12 months.

In order to assess differences in goat production related to cropping system, samples were sorted into several sets, namely irrigated vs rainfed fields,

single vs double cropping (within rainfed fields), and above-subsistence vs low-resource farmers. The data are summarized in Table 5. Indicators used in comparison were:

Kidding Percentage: the ratio of does giving birth to number of does during one year observation.

Litter size: the ratio of kids born to number of does.

Kid Survival: the ratio of live kids at weaning to kids born.

Natural Increase: the ratio of live kids minus number of deaths to number of animals in initial observation.

Net Increase: the ratio of population increase to initial population.

Irrigated vs Rainfed Fields. Kidding Percentage, Litter Size, and Natural Increase were higher in the irrigated than in the rainfed farms, whereas Kid Survival was lower. The Net Increase of both groups was similar. The higher Kidding Percentage and Litter Size in the irrigated fields may be a result of the better feed availability, since fertility is related to body condition: the expression of feed quality consumed (Queensland Department of Primary Industries, 1985). Although irrigated fields had a higher proportion of twin births, this was not followed by a higher Net Increase because of lower Kid Survival. This perhaps was the result of the relatively lower use of family labor in rainfed farms for cropping so that there were more opportunities to look after the animals.

TABLE 5. EFFECT OF MANAGEMENT SYSTEM ON PRODUCTIVITY OF GOAT HERDS

	n	Farm size (ha)	Kidding percentage	Litter size	Kid survival	Natural increase	Net increase
Rainfed	24	11.7	134	1.64	98	95	98
Irrigated	12	4.8	138	1.83	82	100	88
Low resource	18	6.3	136	1.72	94	97	88
Above subsistence	18	10.2	134	1.66	94	86	82
Single cropping	12	6.6	132	1.57	100	90	80
Double cropping	12	5.1	135	1.71	96	94	88

Above-subsistence vs Low-resources Farmers. Farmers who cultivated share land were categorized as low-resource farmers. Those who operated their own land were classified as above-subsistence farmers. We had initially assumed that the second group had better inputs, and hence would have a higher level of goat productivity.

Table 5 shows that low-resource farmers had better goat productivity as shown by the indicators used. Observations indicated that the low-resource farmers looked after their animals more intensely than the above-subsistence group.

Single vs Double Cropping. Within rainfed fields there are 2 types of cropping intensity: double (rice followed by cash crop) and single cropping (rice only). In the single cropping fields, farmers cultivate only one food crop each year for about 3-4 months. During the rest of the year they work outside their farm to obtain additional income.

It was initially assumed that single cropping farmers had higher family labor availability to look after their animals and should have a higher productivity. Goat production on the two types of fields is presented in Table 5. Kidding percentage and litter size were slightly higher for the double cropping system so that, despite a slightly higher mortality of kids, the natural increase and net increase were higher for double cropping than single cropping.

The Importance of Goats on Small Farms. Farmers responses indicated that, as a source of income, goat husbandry is only placed third or fourth after food crops and cattle or buffalo. However, goats are the first animals to be sold to cover immediate cash needs. Computation of the goats' yearly increasing value shows the potential of this animal as a source of income generation which is summarized in Table 6.

Income was derived from increasing number and increasing class (kid, young, adult) of animals. On average, during one year, the income of goat keeping was 82% of the capital or 6.83% per month. It is also shown that, relative to the capital, the income of rainfed farms is higher than of irrigated farms, and the income of low-resource farmers is higher than above-subsistence farmers. Between double and single cropping there is little effect.

Table 6. THE INCREASING VALUE OF GOATS (THOUSANDS Rp/HA/YEAR)

	Value at Dec. 1991	Value at Nov. 1992	Potential Income
Average of 36 farms	**271**	**494**	**223 (82)**
Irrigated	220	377	156 (71)
Rainfed	292	542	250 (86)
Above Subsistence	227	407	180 (79)
Low resources	342	635	293 (85)
Double Cropping	272	506	235 (86)
Single Cropping	318	587	270 (85)

Note: numbers in parentheses are percentages of value in Dec. 1991.

The Contribution of Goat Keeping to Farm Income. Only on-farm income from crops and goat production were considered in this study. Income from trading other animals and off-farm employment were not included.

In this analysis, no input costs were used for goat keeping. The inputs used for rice cultivation by all farmers were similar: human labor, chemicals, and seed; animal power, human labor, meals for land preparation; labor and meals for transplanting; chemicals and labor for maintenance; share of the harvested rice (10%) for harvesting. The soybean cultivation was very simple. Soybean seed was broadcasted after rice harvesting without any land preparation. Inputs used were only seed and harvesting costs.

Goat keeping output was calculated from the increasing goat value based on increasing number and increasing size. Gross income from rice and other crops is shown in Appendix 6, together with net income from cultivation.

Table 7 shows the income from goat keeping relative to income from crop cultivation.

Income per year per ha from goats was about 1/4 the income from food crops. However, the proportion of goat keeping income relative to food crop income varied among groupings. The contribution of goat keeping in irrigated fields was very small (1:11); on the contrary in the rainfed fields income from food crops was only twice that of goat rearing. Within rainfed fields, single cropping income showed a larger dependency on goat production than on farms which practiced double cropping (1:1.3 compared to 1:3.1).

TABLE 7. THE NET INCOME OF GOAT HUSBANDRY RELATIVE TO FOOD CROP (THOUSANDS Rp/ha/yr)

	Food Crops	Goat	Percentage of on-farm income produced by goats
Average of 36 farms	**869**	**223**	**20**
Irrigated	1666	156	9
Rainfed	534	250	32
Above Subsistence	1015	180	15
Low Resources	578	293	34
Double Cropping	734	235	24
Single Cropping	291	270	48

Conclusions

1. In terms of Litter Size, Age of First Kidding, and Kidding Rate, goat production was relatively low. Increasing productivity can be achieved by improving management practices.

2. Goat productivity in the irrigated and rainfed rice fields (in terms of Net Increase) was similar. However Litter Size in the irrigated fields was higher.

3. Low-resource farmers had better goat productivity than that of above-subsistence farmers, indicating that the low resources group manipulated goat keeping as a source of income to a greater extent.

4. Within rainfed fields, goat production on single cropping fields was higher than on double cropping fields.

5. The contribution of goat husbandry in generating farm income varied among groupings. Income of goat keeping in rainfed ricefields and low-resource farmers was higher than that from irrigated fields and above-subsistence farmers.

Considering the relatively low goat productivity in the sites and the importance of goat keeping in generating farm income especially in the rainfed

field and low resources farmers, it is concluded that improving goat management techniques should be undertaken to increase farmer income.

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Session II
Animal Breeding, Reproduction and Production Aspects

SMALL RUMINANT BREEDING STRATEGIES FOR INDONESIA

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ABSTRACT

The basic goal of a breeding program is to match genetic potential to the existing feed resources, management systems and markets of a region. Sheep and goats in Indonesia are kept primarily for meat production, so production traits of interest are number of young weaned per breeding female per year and their growth rates. Number of young per year is determined by fertility, prolificacy, viability of young and interval between parturitions. Indonesian sheep and goats are in general quite prolific, and the existence of a major gene in Indonesian sheep breeds results in very high prolificacy in some individuals. However, large litter size leads to high neonatal mortality unless feeding and management are very good, which may not be economically feasible. A more efficient means of increasing numbers of young per year may be to utilize the year-round breeding capability of local breeds, to have 1.6 to 1.8 parturitions per year. This will permit a high net reproductive rate with only single and twin births, avoiding the special requirements associated with higher multiples. Growth rates of Indonesian small ruminants are typically quite low, <100 g/d. This is associated with small mature size. While some increase in growth rates may be desirable, fast growth/large mature size is less important than maintaining the adaptability and disease resistance of local breeds. Introduction of some inheritance from improved breeds may accelerate rate of genetic improvement, but measurement of all inputs and outputs on a flock basis is required for full assessment. Introduction of some inheritance from breeds from other tropical countries shows promise of increasing productivity without detracting from adaptability.

Introduction

Sheep and goats in Indonesia are kept primarily for meat production, with sale of wool or milk being of negligible importance in most cases. Factors determining meat production from a herd or flock are (1) number of offspring marketed per breeding female per year, which is determined by fertility, parturition interval, prolificacy, and viability of the young to market age, and (2) weight of individual offspring, which is influenced by their inherent growth potential and dam's milk production and, of course, by their nutrition and health.

The general breeding strategy for any production environment is to match genetic potential to the feeding and management system. If the genetic potential for performance traits is low and the feeding and management are adequate for higher potential animals to express that potential, productivity of the system can be increased by increasing genetic merit of the animals. On the other hand, if animals of high genetic potential, for example, for growth rate, milk production or prolificacy (or two or three of these) are kept in a production system where feeding and management are not adequate for them to express their potential, the system will again be less productive than possible. The most common indications of a mismatch of the second kind are poor reproduction and high mortality, which not infrequently occur when high performance breeds from temperate countries are imported into tropical or arid production systems. The goal of a breeding program is to have animals which have as good growth, milk and prolificacy potential as is compatible with good viability and fertility in that environment. In tropical environments, this usually means using animals derived entirely or at least in part from stocks which have evolved under natural selection in such environments.

Production Systems

The two common production systems for small ruminants in Indonesia are:

1) cut and carry, where forage (and other feeds) are brought to continuously housed animals and,
2) grazing. This may be under tree crops, along roadsides, in temporarily idle cropland, etc. The cultivation of pastures solely for small ruminant production is not a common practice in Indonesia, since human population density mandates the use of arable land for food crops.

Combinations of these two systems are also possible, but less common.

The cut and carry system has the potential for more and higher quality feed inputs on average than available in grazing systems, although forage quality in tropical cut and carry systems may or may not be high. The desired level of genetic potential for growth, milk production and prolificacy will depend to a great extent on the quantity and quality of feed resources available.

Reproduction. By far the most important factor affecting offtake rates is number of young weaned per female per year. This is a function of fertility, parturition interval, prolificacy (number of young born per parturition, i.e., litter size), and viability of young.

Because Indonesia is close to the equator, Indonesian breeds appear to be completely nonseasonal, providing the small ruminant producer the advantages of unrestricted choice of breeding season and short parturition intervals. Rather long intervals have been reported for some village flocks in a cut and carry (confinement) system, apparently because of lack of access of the females to males (Bell et al., 1983). However, consistently short intervals are possible, as evidenced by the more than 1.8 parturitions per year for two strains each of Indonesian sheep and goats reported by Obst et al. (1980), and the 201-day mean interval reported for a flock of Sumatran sheep by Iniguez et al. (1991).

Indonesian breeds of sheep and goats have high levels of prolificacy (Obst et al., 1980). Prolificacy is a trait with usually an intermediate optimum, the actual optimum depending on level of management. Under conditions where nutrient requirements can be met economically throughout the year, uniform twinning should be the goal. However, because of variation in litter size, a mean litter size of 2.0 usually means a considerable incidence of triplet births, perhaps 25% of all litters and hence 38% of all young. Since mortality of triplets is high under all except the very highest levels of management, and weaning weights tend to be low for young raised as triplets, a mean litter size of 1.70-1.75 is usually preferred to a mean of 2.0.

Numbers of young weaned per breeding female *per year* can be increased by increasing prolificacy while maintaining satisfactory viability of young, or by decreasing parturition interval. Possible interactions among these variables are illustrated in Table 1.

TABLE 1. NUMBERS OF YOUNG PRODUCED PER FEMALE PER YEAR WITH DIFFERENT PARTURITION INTERVALS, LEVELS OF PROLIFICACY AND ASSOCIATED SURVIVAL RATES

Parturitions	Interval (days)	Litter size born/survival rate (%) per year				
		1.2/90	1.5/85	1.8/80	2.1/75	2.4/70
1.0	365	1.08	1.28	1.44	1.58	1.68
1.2	304	1.30	1.53	1.73	1.89	2.02
1.4	261	1.51	1.79	2.02	2.21	2.35
1.6	228	1.73	2.04	2.30	2.52	2.69
1.8	203	1.94	2.30	2.59	2.84	3.02

While in principle all combinations listed in table 1 are biologically possible, there is limited evidence on the ability of highly prolific ewes to sustain

an accelerated lambing schedule over a normal lifetime. Performance levels in the lower right quadrant of this table may not be achievable, even with very good nutrition. In any case, the feeding and management required to achieve a mean of 1.7 to 2.0 young weaned per breeding female per year will be much less intensive for lower prolificacy/frequent parturition, e.g., litter size 1.2 to 1.5 with 1.6 parturitions per year, than for high prolificacy/less frequent parturition, e.g., litter size 1.8 to 2.4 with 1.2 parturitions per year. Furthermore, weaning weights will be more uniform and higher on average under the former.

There is a need for experimentation under Indonesian conditions, combined with a systems analysis approach, to assess the net returns from alternative strategies for increasing numbers of young weaned from small ruminant enterprises. However, we believe that the potential for frequent parturitions of Indonesian sheep and goats offers a feasible and efficient means of increasing productivity, and that this approach, combined with moderate levels of prolificacy, is preferable to setting very high levels of genetic potential for prolificacy. Weaning 1.7 to 2.0 young per female per year should be quite feasible, and it should be noted that this would put numeric productivity of Indonesian small ruminants at a level above that of most of the world's small ruminant production systems.

The situation with regard to genetic potential for prolificacy in Indonesian sheep is complicated by the presence of a gene (FecJ^{+}) with large effect on prolificacy (Bradford et al., 1986, 1991). This gene apparently is present, at least in low frequency, in all strains of Indonesian sheep studied to date, i.e., Javanese Thin Tail (JTT), Javanese Fat Tail (JFT), Semarang strain of JTT, and Sumatran. Its effect is to increase ovulation rate by 0.8 to 0.9, and litter size by 0.7 to 0.8, per copy of the gene. For example, Bradford et al. (1991) reported litter sizes (second and later litters) of 1.30, 2.11 and 2.83 for FecJ^{+} FecJ^{+}, FecJ^{+} FecJ^{+} and FecJ^{+} FecJ^{+} ewes, respectively. As a result of segregation of this gene, Indonesian sheep show great variation between ewes within flocks in prolificacy, and an unusually high repeatability of litter size.

This gene offers the opportunity to increase prolificacy quickly and permanently, but has the disadvantage that even heterozygous ewes have a level of prolificacy that requires a very high level of feeding and management to realize the potential benefits. This is illustrated by data reported by Inounu et al. (1993). A flock in which the gene was segregating was maintained under conditions of very modest levels of feeding and management for several years (C) and was then moved to a new location (B) where feed was adequate and management level higher. The effect of litter size at birth on litter weight weaned in that flock is summarized in Table 2.

TABLE 2. LITTER WEIGHT WEANED PER EWE (kg, 90d) IN RELATION TO LITTER SIZE BORN IN A JTT FLOCK IN TWO LOCATIONS DIFFERING IN FEEDING AND MANAGEMENT

Location	Litter size born			
	1	2	3	4
C - Poorest 4 yrs	7.7	7.6	6.1	5.5
- Best 5 yrs	10.5	12.3	13.1	11.9
B - 1991	15.2	20.1	24.4	33.3

Source: Inounu et al. (1993).

The $FecJ^F$ gene was thus obviously disadvantageous in the poorest years in flock C, and of little advantage at any time in this location. On the other hand, under the conditions in flock B in 1991, heterozygous ewes (with an estimated 25% singles, 40% twins and 35% triplets) would wean 22% more total weight than $FecJ^+$ $FecJ^+$ ewes, and $FecJ^F$ $FecJ^F$ ewes (with 10%, 25%, 35% and 30% 1's, 2's, 3's and 4's) would wean 50% more weight than $FecJ^+$ $FecJ^+$ ewes. Under intermediate conditions, i.e., better than in flock C but not as good as flock B, $FecJ^F$ $FecJ^+$ ewes might be superior in output to both homozygotes.

It is clear from the data in Table 2 that optimum prolificacy, and hence the most appropriate genotype at the FecJ locus, is very much dependent on level of management and nutrition. While more data are needed, our recommendation at this time is that for most grazing systems, and for the cut and carry system where concentrate feeds are not available at reasonable prices, the goal should be to eliminate the $FecJ^F$ gene, i.e., to develop flocks of $FecJ^+$ $FecJ^+$ ewes. However, where a dependable supply of supplementary feed, e.g., rice bran, palm kernel cake, cassava by-products, oilseed meals, etc., is available at reasonable prices, then a flock of heterozygous ewes is likely to be more productive. Maintaining such a flock would require a structured breeding program, in which $FecJ^+$ $FecJ^+$ ewes are mated to $FecJ^F$ $FecJ^F$ rams. An integrated program might be as shown in Table 3.

Mean litter sizes in this table are slightly lower than given earlier for adult ewes of these genotypes because 25% of the ewes in each flock would be young ewes in their first year of production.

For this system to work, a source of $FecJ^F$ $FecJ^F$ rams would be needed; these might come from a government-maintained nucleus flock. "A" flocks free of the gene should be relatively easy to establish and maintain, since any ewe producing triplets is presumed to be a $FecJ^F$ carrier and could be culled or transferred to a "C" flock. Once a $FecJ^+$ $FecJ^+$ flock were established, i.e.,

known free of the FecJ^{r} gene, selection could be practiced for twinning in addition to other performance traits such as growth rate and short lambing interval, which should increase prolificacy gradually without creating the problems associated with triplets and higher multiples.

TABLE 3. OUTLINE OF COORDINATED BREEDING PROGRAMS TO USE THE FecJ^{r} GENES BY PRODUCING FecJ^{r} FecJ^{+} EWES

	Flock "A"[a] (FecJ^{+} FecJ^{+})	Flock "B"[b] (FecJ^{r} FecJ^{+})	Flock "C"[c] (FecJ^{r} FecJ^{r})
No. ewes	100	160	400
Fertility	0.90	0.90	0.90
Litter size	1.25	1.25	2.0
Lambings/year	1.6	1.6	1.6
Lamb survival	0.85	0.85	0.75
Ewe Lambs:			
-No. wnd/yr	76	122	432
-Kept as replacements	25	---	---
-To flock B	40	100 to flock "C"	---
Ram Lambs:			
-No. wnd/yr	76	122	432
-Selected	5	---	---
Lambs to market	82	144	864

a) Large commercial flock, or many small flocks with a coordinated breeding program.
b) Mated to FecJ^{r} FecJ^{+} rams.
c) Mated to FecJ^{r} FecJ^{r} rams.
d) Mated to terminal sire breed (could be rams from flock A if no specialized terminal sire breed rams are available).

A plan such as this would ensure ewes without excessive prolificacy for moderate input level systems, and offers the opportunity to produce ewes of predictably high prolificacy potential, i.e., with predominantly twin and triplet births as adults, for situations where extra inputs are economically feasible. Such a system would result in a substantial increase in efficiency in the national flock over the present system, where a farmer does not know until a ewe lambs (sometimes for the second or third time) whether she is one that will consistently produce one or two lambs (FecJ^{+} FecJ^{+}), or one likely to produce a high frequency of 3 or more per parturition (FecJ^{r} FecJ^{+} or FecJ^{r} FecJ^{r}).

This system would also provide some owners of $FecJ^+$ $FecJ^+$ flocks the opportunity for extra income by mating a portion of their ewes to produce superior replacements ($FecJ^+$ $FecJ^+$ ewes) for "C" flocks.

As noted in Table 3, all lambs of both sexes from "C" flocks should be sent to slaughter, since they will be a mix of $FecJ^+$ $FecJ^+$ and $FecJ^+$ $FecJ^+$ genotypes and hence highly variable in prolificacy potential. This is a situation where use of a specialized sire breed, e.g., with high growth rate/superior carcass potential, could be used to advantage. While such breeds exist in Europe, North America, Australia and New Zealand, their reproductive rate as purebreds in the tropics is usually poor, resulting in high cost of such rams which themselves may have poor fertility when used as terminal sires. There is a need for a good terminal sire breed well adapted to Indonesian conditions. This need could be met by certain "A" flock putting special emphasis on growth rate, to produce rams which would sire rapid growing crossbred lambs. At this time there is no carcass grading system in Indonesia, and thus there is unlikely to be a premium paid for superior carcass conformation. (Such premiums are often small or nonexistent even under marketing systems where a carcass grading system is in use).

As far as is known at this time, there is no gene comparable to the $FecJ^+$ gene present in goats in Indonesia (or elsewhere).

Milk Production. Milk production potential should be high enough to permit females to rear twins to satisfactory weaning weights, provided survival rate of twins is satisfactory (80-85% or higher). On average, Indonesian breeds appear to have only modest milk production potential, based on rather larger proportionate differences between twin and single young in weaning weight than reported in the world literature. This suggests that, where feeding and management are adequate for good survival rate of twins, some improvement in milk production would be desirable. This can be effected by selecting for weaning weight of twin young.

Size/Growth Rate. Livestock producers universally seem to be interested in having larger, faster growing animals. It is certainly true that faster growth means more weight to sell at a given age; also, over a fixed time period, animals which grow faster usually convert feed more efficiently. However, faster growth is strongly associated with larger mature size, and hence the breeding animal cost of rapid growing offspring is greater than for those with more modest growth rates. In fact, there is no inherent association between efficiency of a production system and mature size/growth rate of the breed or cross used in the system.

Indonesian breeds of sheep, e.g., Javanese Thin Tail (JTT), Javanese Fat Tail (JFT) and Sumatran (S), and goats (Kacang-K) crosses are of relatively small mature weight (average adult weight of females 20-30 kg) compared to mature

weights of breeds of European origin (average adult female weight = 45 to 80 kg). Ettawa goats are tall and large framed, but again would be below average in weight for the species. Related to this, gains of growing animals of Indonesian small ruminants on typical local diets are often <100 g/day (Gatenby et al., 1988), compared to values of 300 g/day or more often reported for European or North American animals. Does this mean that a major effort to increase growth rate (and therefore mature size) of Indonesian sheep and goats is needed?

The answer is: not necessarily. Factors that determine optima for these traits are (1) market, e.g., is there a premium paid for carcasses of a particular weight and fat content?, and (2) adaptability, reproductive rate, health status, etc. of breeds of different sizes.

With regard to preferred carcass weight, it does not appear that at present there is a premium paid for animals of a particular weight. Competition in most export markets would require a heavier carcass than typically produced in Indonesia, but as long as there is unsatisfied domestic demand for meat in Indonesia, as appears likely for the foreseeable future (Levine and Soedjana, 1991), increasing carcass weight is not an urgent goal.

Methods of Effecting Genetic Change. Three methods commonly used for improving genetic potential for production are discussed below. Since reproductive potential of Indonesian breeds of sheep and goats is generally very good, the discussion focusses on advantages and disadvantages of these methods with regard to growth rate and adaptability to tropical conditions.

1) Import breeds selected for these traits, to replace the local breeds.

   The largest, fastest growing breeds come from temperate climates, but these breeds tend to have a restricted breeding season, carry larger amounts of wool (in the case of sheep) which can add to heat stress, and are not well adapted to the climatic, nutritional and disease stresses of the tropics. Thus their use to replace local breeds is ***not*** indicated. Problems associated with temperate zone breeds in the tropics were documented by Patterson (1983) and discussed by Bradford et al. (1987).

2) Import improved breeds, cross with local breeds, and use the F1 or later generations from the cross as the production stock.

   This approach has been widely used, in different species often with considerable success. Khusary and Ariff (1991) have reported substantial increases in growth rate of crossbred lambs sired by rams of several different imported breeds out of Malin

(local) dams in Malaysia, compared to pure Malin dams. Data were not yet available at the time of that report on reproduction of the crossbred females, which would be expected to be larger and to wean heavier lambs. The questions to be answered relate primarily to reproduction, i.e., fertility, prolificacy and, in particular, lambing interval since imported breeds may introduce some seasonality of breeding. Whenever imported breeds or their crosses are considered, an assessment of all production traits is needed. In any such assessment, measurement of inputs and outputs on a total flock, life cycle basis is essential. The results of Fletcher et al. (1985), which showed that JTT ewes required significantly less feed per kg of lamb weaned than Suffolk -, Wiltshire - or Dorset - JTT crossbred ewes, all of which weaned larger lambs, emphasizes the importance of this point. It is also important to note that there is often an intermediate optimum for the proportion of exotic inheritance to introduce, as has been well documented for dairy cattle.

For a further discussion of factors affecting the utilization of selected temperate climate breeds to improve tropical small ruminants, the papers by Lindsay (1989) and Khusary and Ariff (1991) are recommended.

3) Select within a local breed or crossbred population based on local breeds.

This usually results in slower change than (1) or (2), but utilizes the adaptability of the local breeds and introduces no new type of animal which may cause marketing problems. If practiced systematically for several generations, it can produce substantial changes in a population; this is in fact how improved breeds have been developed.

The choice between (2) and (3) will depend on the urgency of making a large change in genetic potential in a short time, and the extent of adaptation problems encountered by crosses with improved breeds. In the absence of a need for a sudden large change (as might be needed, for example, if heavier carcasses were needed for an export market), we believe (3) may be the preferred approach for small ruminants kept for meat production in Indonesia.

Whether selecting within a local or a crossbred population, it is important (except perhaps in terminal sire breeds) to select for total performance, since selection for

growth rate only can lead to a decline in fertility and livability (Lasslo et al., 1985).

Introduction of Breeds from Other Regions of The Tropics. A fourth approach, which is actually a modification of (2), is to import breeds from other areas of the tropics to cross with local breeds. This has not often been suggested because (a) there are fewer improved tropical than temperate breeds, and (b) tropical breeds are not as well known. However, where tropical breeds with traits of interest do exist, this approach appears to merit consideration (Thomas and Bradford, 1991).

The Small Ruminant Collaborative Research Support Program in Indonesia is testing crossbreds between three tropical breeds and the local Sumatran sheep. The three breeds in question are St. Croix or Virgin Island White and the Barbados Blackbelly, from the Caribbean, and the Javanese Fat Tail from East Java. These three were chosen primarily because of their comparative lack of wool; since wool is not a commercial product of most Indonesian sheep enterprises, it was felt that removing the wool by genetic means would at least save the labor of shearing and reduce ectoparasite problems, and might also improve heat tolerance. A second consideration was that these might increase growth rate, and in all three cases the tropical origin was considered an advantage over introduced temperate breeds in terms of adaptability.

Both the St. Croix and Barbados breed crosses grow significantly more rapidly than the Sumatran sheep, with the increase estimated to be of the order of 20%. Mature ewe weight and, presumably, feed requirements, are also increased. Wool cover is reduced slightly in JFT and St. Croix x S crosses compared to S, and substantially in the Barbados crosses. To date, reproduction has been evaluated only in the St. Croix x S crosses, which are fully equal to S ewes in all components measured: age at puberty, fertility, lambing interval and lamb viability. The crosses also show no increase in parasite loads to date. It appears therefore that this approach can be used to increase size and growth rate, and possibly other desired traits, e.g., freedom from a wool coat, with no adverse effect on adaptability.

A somewhat analogous approach has been used in goats, in which a popular breed to import into the tropics is the Anglo-Nubian. Although today considered an improved milk breed developed in a temperate climate, a substantial part of its inheritance came originally from India via Africa. There is evidence that Anglo-Nubian crosses are better adapted to tropical production systems than those involving European origin breeds (Garcia et al., 1982).

Conclusion

Much research remains to be done to evaluate the effectiveness of alternative strategies for genetic improvement of sheep and goats for the humid tropics. However, based on available information, it is recommended that emphasis be placed on selection to improve total productivity in local breeds, or in crossbreeds. When choosing breeds for crossing, consideration should be given to other tropical breeds, on the basis that adaptability is more likely to be maintained; in all cases, breeds considered for use in crossing should be selected on the basis of superiority in traits known to need improvement in the local populations.

Effective selection programs, in local or crossbred populations, must be based on systematically recorded performance. It is suggested that selection for total weight of offspring weaned per female to a specified age, say 3 years, will place emphasis on the components of performance important to efficiency of meat production in small ruminants, i.e., early puberty, fertility and short lambing intervals, a favorable combination of prolificacy and viability, milk production of the female, and inherent growth rate of the offspring.

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COMPARISON OF THE PERFORMANCE OF LOCAL AND VIRGIN ISLAND CROSSBRED LAMBS IN AN OIL PALM PLANTATION

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ABSTRACT

Research was conducted with 40 ewes in an oil-palm plantation in Hutaimbaru village, Padang Bolak district, South Tapanuli, North Sumatra. The objective of the research was to compare the performance of crossbred (Sumatra Thin-tail x Virgin Island) lambs with purebred local (Sumatra Thin-tail) lambs reared in a traditional system in an oil palm plantation. Birth weight, growth rate, weaning weight and mortality were recorded. The data were analyzed using the t-test. Birth weight, growth rate and weaning weight were higher ($P < 0.05$) for crossbred lambs (1.9 kg, 75 g/d and 8.8 kg, respectively) than for local lambs (1.4 kg, 66 g/d and 7.8 kg, respectively). Mortality of lambs to weaning was high, averaging 34%.

Introduction

Ruminant livestock can be integrated into oil palm plantations to use the available vegetation and to increase income. According to Malaysian experience, sheep grazing in plantations are less destructive than other animals. Sheep are easy to shepherd, and successfully consume the forage. Integrating sheep into oil palm plantations is not detrimental to soil structure nor fertility.

Seventy per cent of the area of Padang Bolak District in North Sumatra is classified as marginal land, and 30.5% of this 98,420 ha of marginal land is under oil palm, owned by large estates and smallholders. Only a small proportion of the plantations are grazed. Generally sheep husbandry provides a secondary income for workers in the plantations.

There have been few studies on the productivity of sheep under oil palm in Indonesia. According to Devendra (1979) sheep in Indonesia have a high reproductive rate, measured in terms of litter size and lambing interval, but the growth rate of lambs is low. In order to increase meat production Sudiono (1978) recommended crossbreeding with a superior ram. The ideal ewe has high prolificacy, good mothering ability and adequate milk production (Sidwell and Miller, 1971).

The objective of this research project was to compare the performance of Sumatra Thin-tail local and Virgin Island crossbred sheep in an oil palm plantation in Padang Bolak.

Literature Review

Livestock are a component of many farming systems, and they are closely interrelated with the other components of the system. To introduce sheep into a particular system can increase the overall productivity of the system, improve soil structure and fertility and water conservation (Manwan, 1988).

Sheep husbandry can help the farmer increase family income, and provides manure which is needed for growing crops. Sheep have the advantage over other livestock such as cattle or buffaloes, in that they are better suited to grazing under plantation crops.

Sheep in Indonesia. According to Mason (1978) about 96% of the sheep in South East Asia are in Indonesia. Within Indonesia, more than 90% of the sheep are in Java, where the majority of sheep are reared in traditional ways by small farmers.

The local sheep in Indonesia are small (Sumoprastowo, 1987). Body weights of mature rams are 30-40 kg, and ewes weigh about 15-20 kg. Reproduction characteristics are good, in particular lambing interval is short and average litter size is high. On the other hand, growth rates and carcass percentages are low. As a consequence meat production is limited.

Sudiono (1978) stated that to improve the quality of local sheep, they should be crossed with a good ram. According to Park et al. (1970) growth rate of lambs depends on birth weight, which in turn depends on breed, size of ewe, level of feeding and management of pregnant ewes (Fraser, 1974). Although birth weight does not itself have economic value, it is correlated with weaning weight (Butcher et al., 1964).

According to Sidwell and Miller (1971), reproductive performance is a consequence of the proportion of ewes which produce lambs, the number of lambs born per ewe lambing, perinatal survival rate of lambs, and survival of lambs to weaning. These factors are all important in determining the overall productivity of the flock. Reproductive performance is influenced by genetic factors, environmental factors and the age of ewe (Rice et al., 1957).

Hammond (1960) stated that pregnant ewes require food of an adequate quantity and quality to produce lambs with high birth weights and a good chance

of survival. Sugeng (1987) said that sheep need roughage at a rate of about 10% body weight, and concentrate at 1% body weight. But Morrison (1961) stated that sheep require roughage at 20% of body weight. The nutrient requirements of sheep are summarized in Table 1.

TABLE 1. NUTRIENT REQUIREMENTS OF SHEEP, EXPRESSED ON A DRY WEIGHT BASIS

Body weight (kg)	Food intake (kg)	ME (Mcal/kg)	Protein (%)	Ca (%)	P (%)	Vitamins (IU/kg)
Rams on finishing rations						
30	1.3	2.3	11	0.37	0.23	588
40	1.6	2.5	11	0.31	0.19	638
50	1.8	2.5	11	0.28	0.19	708
Ram lambs after weaning						
10	0.6	2.6	16	0.40	0.27	1417
30	1.4	2.6	14	0.36	0.24	1921

Source: NRC (1975).

Growth rates of twin lambs are particularly responsive to level of nutrition of ewes (Sidwell, 1956). High growth rates of lambs are often achieved from birth until two months of age. After this growth rate usually begins to fall. A good supply of nutrients is essential if lamb growth is to be sustained.

The birth and weaning weights of single lambs are usually higher than the weights of twins (Cole and Bundy, 1977). In addition, sex, age of ewe, environment, breed and breeding system influence birth and weaning weights. According to Sidwell and Miller (1971), Sugana et al. (1977) and Natasasmita et al. (1979) birth and weaning weights are higher for crossbred lambs than for local lambs.

Oil Palm Plantations. The aim of integrating sheep with oil palm plantations is to optimize the use of vegetation which grows in plantations. Ginting (1991) stated the goals of integration to be:

1. To increase income through conversion of vegetation into meat, and to decrease labor costs in the plantation by using sheep to clear vegetation.

2. To increase the meat supply locally or for export.

According to Gunawan (1990) grazing management can be beneficial for soil and water conservation, and this must be recognized when the integration of animals in plantations is being evaluated. The traditional technique of soil fertilization is to apply as a mulch the wastes of natural vegetation and crops grown specifically for green manure. Organic manure from animals is particularly beneficial in improving soil structure and fertility.

According to Padang Bolak Sub-District statistics (1984), oil palm is generally grown in marginal areas. The productivity is shown in Table 2.

TABLE 2. AVERAGE PRODUCTION OF OIL PALM IN PADANG BOLAK SUB-DISTRICT

Age of plantation (yr)	Production TBS (ton/ha/yr)
3	7
4	9
5	14

Source: Kecamatan Padang Bolak (1984).

Materials and Method

This research was conducted between November 1991 and January 1993 in a nine-hectare oil palm plantation in Hutaimbaru village, Padang Bolak District, South Tapanuli (2°N, 100°E). Altitude is about 150 m and the distance from Medan is 475 km.

A total of forty local Sumatra Thin-tail (S) ewes were used in the experiment. These sheep grazed in the plantation from 0900h to 1700h each day, and were confined at night. Water was given ad libitum. For two weeks before and two weeks after lambing, ewes were given a small amount of concentrate containing minerals. Rintal anthelmintic was given periodically.

Twenty ewes were mated by a Sumatra Thin-tail ram, and twenty by a Virgin Island (VI) crossbred ram. The crossbred ram which was of 75% Virgin Island and 25% Sumatra Thin-tail genotype was obtained from the SR-CRSP at SBPT Sei Putih in North Sumatra.

The following measurements were made on the lambs:

- Birth weight
- Average daily gain to 2 months
- Weaning weight, at 3 months
- Mortality
- Sex ratio

The data were collected and analyzed using Student's t-test (Steel and Torrie, 1981).

Results and Discussion

A total of 35 lambs sired by the two rams, were born. The data for individual animals are shown in the Appendix.

Birth Weight. The birth weights of the Sumatra Thin-tail (S) and Virgin Island crossbred (SxVI) lambs are shown in Table 3. The birth weights of the crossbred lambs are higher than those of the local lambs ($P<0.05$). A similar increase in birth weights as a result of crossbreeding has previously been reported by Sugana et al. (1977) and Natasasmita et al. (1979).

TABLE 3. BIRTH WEIGHTS OF LAMBS

Breed	Litter size	Number of lambs	Birth weight (kg)
S	1	19	1.38±0.06
VIxS	1	16	1.91±0.12

Average Daily Gain. The average daily gains (ADG) of the lambs are shown in Table 4. The crossbred lambs had higher ADGs than the local lambs ($P<0.05$). Manurung (1981) also found that crossing Indonesian sheep with introduced breeds, in his case Dorper and Suffolk, produced higher ADGs.

TABLE 4. AVERAGE DAILY GAINS OF LAMBS

Breed	Litter size	Number of lambs	Average daily gain (g/d)
S	1	11	65.5 ± 7.3
Vixs	1	8	74.5 ± 10.3

Weaning Weight. The lambs were weaned at 3 months of age, and the weaning weights are shown in Table 5. Average weaning weight was higher for the crossbred than for the local lambs. This is in accordance with previous reports of Sidwell and Miller (1971), Sugana et al. (1977), Natasasmita et al (1979) and Manurung (1981).

TABLE 5. WEANING WEIGHTS OF LAMBS

Breed	Litter size	Number of lambs	Weaning weight (kg)
S	1	7	7.81 ± 0.51
Vixs	1	7	8.80 ± 0.68

Mortality Rate. Lamb mortality was high (Table 6). About one-quarter of the Sumatra Thin-tail lambs died, and almost half of the crossbred lambs. The causes of death were infection of the navel, attack by wild pigs and unfavorable weather.

TABLE 6. MORTALITY RATES OF LAMBS

Breed	Litter size	Number of lambs		Mortality (%)
		born	died	
S	1	19	5	26
VIxS	1	16	7	44

Manurung (1981) also reported that sheep grazed under oil palm suffered high mortality, and he recommended that sheep in oil- palm plantations should be stall-fed.

Sex Ratio of Lambs. Table 7 shows that the majority of the lambs were male. A male:female ratio of about 1:1 had been expected; the surprisingly large proportion of males was probably a consequence of the small number of animals in the sample.

TABLE 7. SEX RATIO OF LAMBS

Breed	Total number	Number (%)	
		Male	Female
S	19	12 (63%)	7 (37%)
VIxS	16	11 (69%)	5 (31%)

Conclusion

From the observations and statistical analysis, some conclusions can be drawn:

- Average birth weight, growth rate and weaning weight of lambs were higher for the crossbred lambs than for the Sumatra Thin-tail lambs.
- The mortality rate for lambs in this production system is high.
- In this study more ram lambs were born than ewe lambs.

Recommendations

- In order to reach a higher level of productivity, sheep should be given a better quality diet.
- Care of ewes at lambing and lambs before weaning must be improved, so that the mortality rate is reduced.

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GROWTH AND REPRODUCTION POTENTIAL OF LOCAL GOATS IN WEST TIMOR FROM WEANING TO ABOUT 1.5 YEARS OLD WITH OR WITHOUT SUPPLEMENTATION OF SESBANIA LEAF (*SESBANIA GRANDIFLORA*) AND PALM PITH (*CORYPHA GEBANGA*)

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ABSTRACT

A study was conducted to evaluate the growth rate and reproductive performance of local goats in West Timor by supplementing tree legumes as a protein source and local palm pith as a carbohydrate source. Sixty local female goats were divided into four treatments (i) grazing during the day and penned at night without supplement (control), (ii) control plus supplementation of sesbania leaf, (iii) control plus supplementation of local palm pith and (iv) control plus supplementation of mixed 50% sesbania and 50% palm pith. Each treatment consisted of 15 animals starting at 4 to 6 months of age. Supplemention with mixed 50% sesbania plus 50% palm pith produced the best body weight gains. All supplementation treatments reduced kid mortality and improved reproductive performance.

Introduction

East Nusa Tenggara (NTT) has unique agro-ecological and socio-economic characteristics with unpredictable rainfall patterns and a dry season from April to November. This affects the development of farming systems in the region. Grazing lands in East Nusa Tenggara account for 47% of the total area. Animal production is dominated by large and small ruminants. There are about 415,000 goats and 90,000 sheep in NTT (Dinas Peternakan Propinsi Dati I NTT, 1989), of which 60% of the goat population and 80% of the sheep population are found in West Timor.

Methods of raising goats in East Nusa Tenggara are still traditional and goat rearing is only a secondary farming activity. Gatenby (1985) found that 71% of goat herds in West Timor were under extensive systems (grazing alone or shepherding) and only 29% under intensive systems (tethered or penned).

Low growth rates and relatively high mortality of young goats in West Timor have been reported by Gatenby (1985) and Bamualim and Saleh (1991). Improving growth rates and reducing mortality of young goats, especially weaner

goats, by better feeding systems using tree legumes and other non-conventional feedstuffs which are available locally would ultimately increase offtake.

Sesbania (*Sesbania grandiflora*) has been widely planted by farmers in NTT and is becoming a main source of animal feed. There is also another local palm tree (*Corypha gebanga*) which has been traditionally used by farmers as a source of carbohydrate feed. However there have been few studies on growth rates and subsequent reproduction performance of goats using these feeds as supplements.

The objective of this study was to determine the growth rate and reproductive performance of grazing goats supplemented with sesbania, local palm or sesbania and local palm.

Methods

A study of the growth and reproduction potential of local goats in West Timor with or without supplementation was conducted at the Sub-Research Institute for Animal Production in Lili starting in November 1991.

Sixty female goats were divided into four treatments: (i) grazing during the day and penned at night without supplement (control), (ii) control plus supplementation of Sesbania leaf at night, (iii) control plus supplementation of local palm pith and (iv) control plus supplementation of mixed 50% Sesbania and 50% palm pith. Each treatment comprised 15 animals, 4 to 6 months of age with an average initial live weight of 8.51 ± 1.32 kg. The goats were kept in individual pens. Supplementation of fresh leaves and chopped palm pith was provided daily. Goats were weighed weekly before feeding in the morning and average daily gains were determined by regression. Reproduction parameters such as weight and age at first kidding, mortality and distribution of kid birth were also recorded.

The chemical composition of supplements is shown in Table 1.

TABLE 1. FEEDSTUFFS COMPOSITION OF SUPPLEMENTS

Feedstuffs	CP (%)	CF (%)	Fat (%)	Ash (%)	Ca (%)	P (%)	ME Kcal/kg
Palm pith	2.4	56.7	-	6.4	0.76	0.003	1512.23
Sesbania*	29.6	15.4	4.9	8.0	1.36	0.43	-

* Hartadi et al. (1986).

Results and Discussion

Growth. The body weight gains of goats receiving 50% sesbania + 50% palm pith supplementation, sesbania supplementation, palm pith supplementation and control were 35.2; 33.5; 25.8; and 23.7 g/head/day respectively. Supplementation treatments produced better gains than other treatments. Monthly body weights of goats are shown in Figure 1.

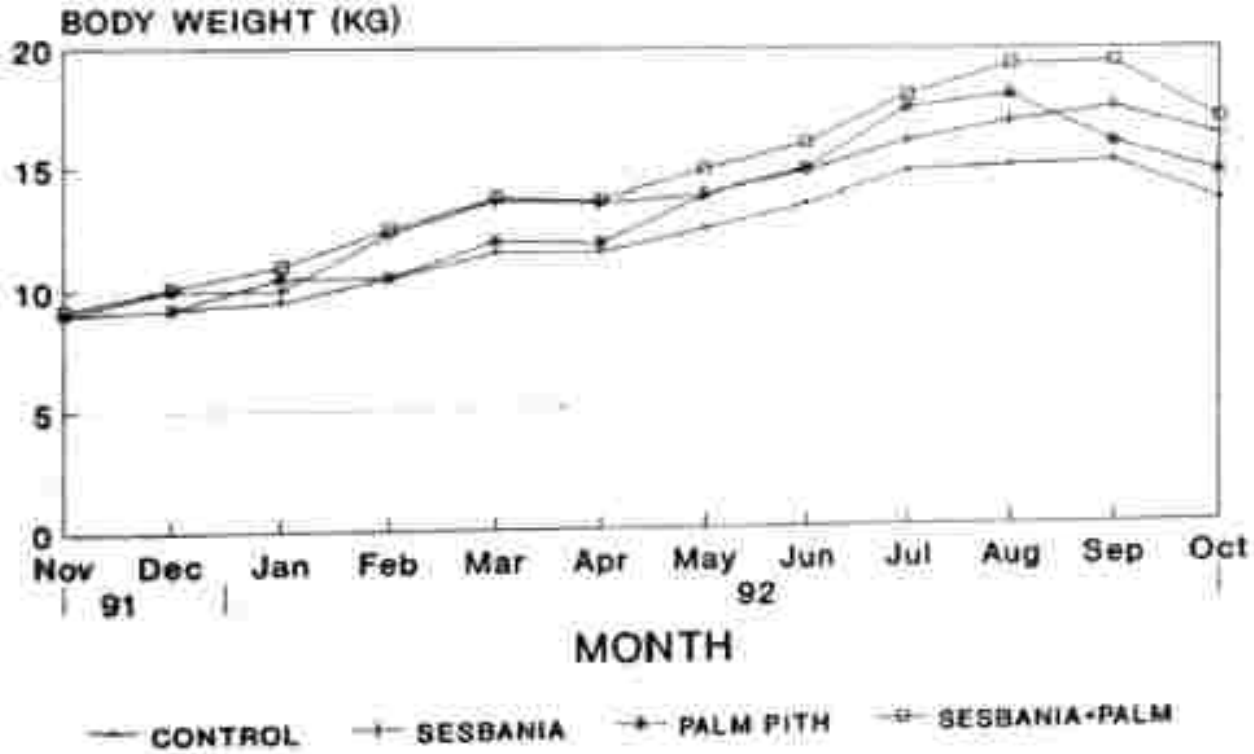

Fig. 1. Body weights of goats

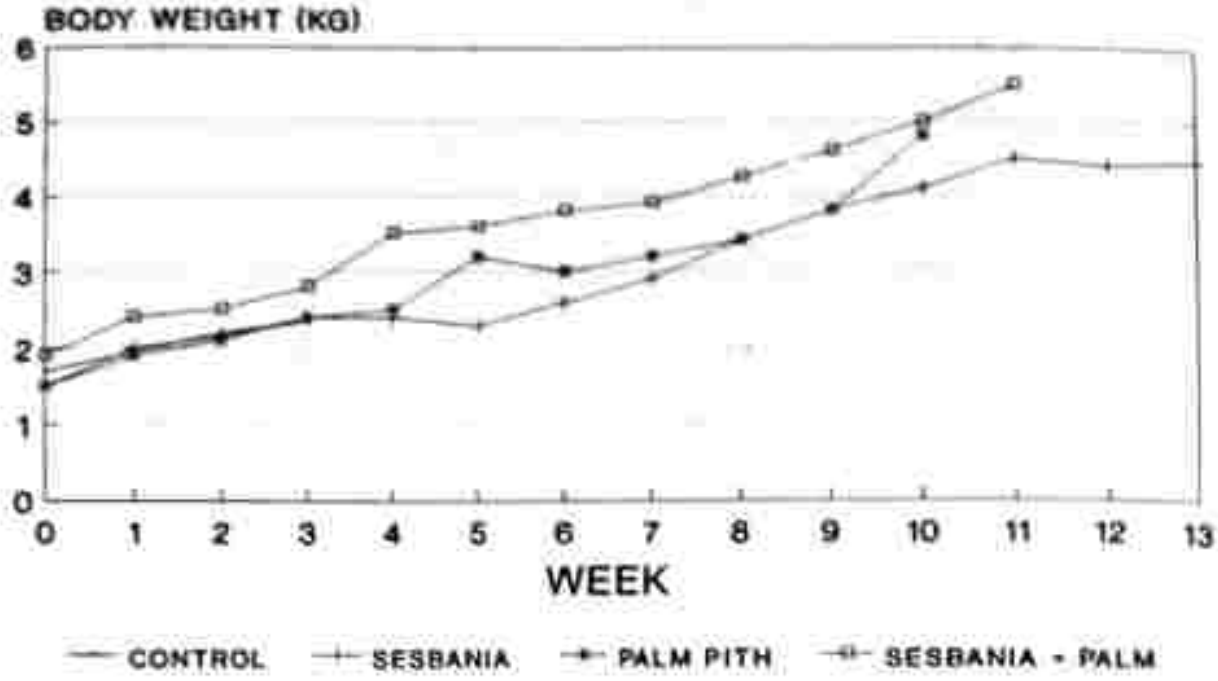

Figure 2. Body weights of kids from birth to 12-19 weeks old

Figure 2 shows that supplementation with mixed sesbania + palm pith produced kids with the highest weight gain, followed by palm pith supplementation, sesbania supplementation and control respectively.

Reproductive Performance of Local Goats. The reproductive performance of local goats given different types of feeds is shown in Table 2. All supplementation treatments increased the number of kids born and reduced the abortion rate. Ewe weight at first lambing and birth weight were improved by given the supplementations.

TABLE 2. NUMBER OF KIDS BORN, RATE OF ABORTION, WEIGHT AT FIRST LAMBING AND BIRTH WEIGHT OF LOCAL GOATS

Trait	Control	Sesbania	Palm pith	Sesbania + Palm pith
Kids born				
(head)	3	11	9	9
(%)	20	73.33	60	60
Number of abortions				
(head)	5	1	3	2
(%)	41.7	7.7	20.0	14.3
Ewe weight at first lambing				
(kg)	12.3 ± 1.1	16.9 ± 0.8	15.9 ± 0.7	18.8 ± 3.5
Birth weight (kg)				
male	1.80 ± 0.00	2.30 ± 0.20	1.55 ± 0.07	1.95 ± 0.49
female	1.50 ± 0.00	1.49 ± 0.12	1.44 ± 0.28	1.80 ± 0.47

The distribution of kiddings is shown in Figure 3.

Kidding was concentrated between July and October (90% of total kids) which was during the dry season, and this may have contributed to high kid mortality. Similarly the calving period of Bali cattle in Timor is from May to August (Wirdahayati and Bamualim, 1990). However the pattern of the kidding period cannot be confirmed at this early stage of research.

Kid mortality is summarized in Table 3.

TABLE 3. KID MORTALITY IN LOCAL GOATS

Age (weeks)	Number of dead kids, n (%)			
	Control	Sesbania	Palm pith	Sesbania + Palm pith
0 - 1	3 (100.0)	1 (11.1)	1 (11.1)	2 (22.2)
2 - 4	-	0 (0.0)	1 (11.1)	2 (22.2)
5 - 8	-	1 (11.1)	1 (11.1)	0 (0.0)
8 - 12	-	0 (0.0)	0 (0.0)	1 (11.2)

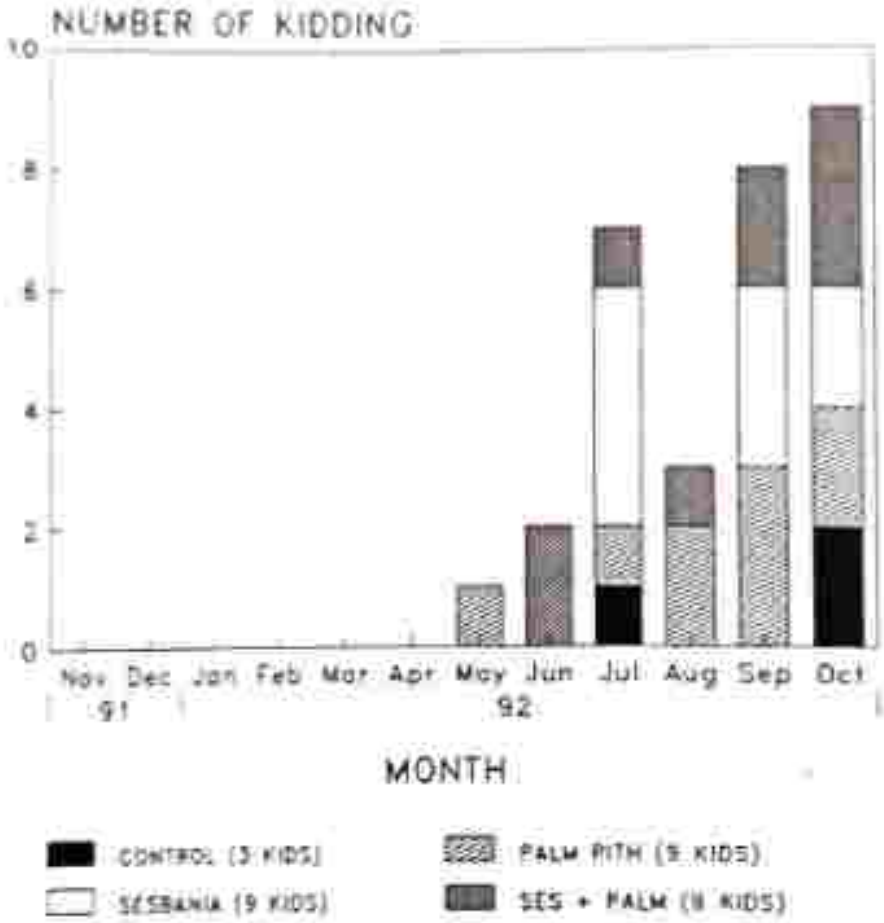

Fig.3. Month of kidding of goats with or without supplementation

According to Bradford et al. (1987), supplementary feeding can reduce pre-and post-weaning mortality. The highest kid mortality occurred during the first 7 days after birth (average 23% over all the treatments).

Conclusion

Supplementation of mixed Sesbania + palm pith produced the best performance in local goats in terms of growth rates. There is a need to provide supplements during the dry season to reduce kid mortality and body weight loss. There is a need to continue the experiment to gather more basic information on local goat performance in West Timor.

Acknowledgements

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Session III & IV
Forage and Nutrition Aspects

RECENT ADVANCES IN SMALL RUMINANT RESEARCH IN INDONESIA
FEEDING AND NUTRITION STRATEGIES FOR INDONESIA

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Introduction

Small ruminant production throughout Indonesia is primarily limited by the quantity and quality of feed available. Regardless of region in Indonesia, sufficient quantity and quality of feed throughout the year for desired reproduction and growth is lacking. Small ruminants have developed in many systems of production from cut-and-carry where forage and other feeds are brought directly to the animal to extensive grazing in areas of large forage availability such as in tree crop plantations. In addition, small ruminants utilize forage from the arid regions and fit in as an integral part of the cropping systems in many areas. Near large cities, growing or fattening schemes have been developed to provide animals for the local markets.

The purpose of this paper is to describe many of the feed resources that are and should be used to supply feed for small ruminants, to briefly discuss the nutritional requirements of small ruminants in Indonesia and to describe feeding strategies to meet the requirements for desired production.

Feed Resources

The major feed resource for small ruminants is the forage that is grown in conjunction with other crops or grown in areas not utilized for crop production. Forage can include grasses, legumes, forbs, shrubs and trees that can be utilized as effective feed resources for small ruminant feeding. The forage usually will provide the nutritional base for all animals. Tropical forages are generally of lower quality than temperate forages; however, by harvesting at a young, immature stage of growth, the quality of the forage in tropical regions can be adequate for good production. The Australian Centre for International Agricultural Research (ACIAR) has published proceedings of conferences on forages in Southeast Asia (Blair et al., 1986) and on forages specifically for plantation crops (Shelton and Stür, 1991) that contain an excellent compilation of information on forages appropriate for Indonesia. The International Development Research Centre (IDRC) sponsored and published (Devendra, 1990) the proceedings of a workshop in Denpasar on shrubs and tree fodders for farm animals. Many of the papers are directed toward Indonesia and small ruminants.

Forages are often times supplemented with agro-industrial by-products or grains unsuitable for human consumption. Agro-industrial by-products include the agro-by-products associated with the harvesting of food crops for humans (i.e. rice bran, rice straw, broken rice, crop residues associated with wheat, maize, millet, sorghum and other stalks and tubers) and industrial by-products from the processing of rice, cotton, soybeans, etc., and products associated with oil palm, rubber and coconut production. Agro-industrial by-products are generally of low value to humans, a waste product to be disposed of and therefore potentially economical feed sources for ruminants. Depending on the region in the country, various agro-industrial by-products are available for livestock. The chemical composition and quality of by-products can be very variable and should be evaluated before feeding. Many of these feeds can contain either high fiber contents which may limit the voluntary intake and lower the productivity from the animal, or may contain anti-nutritional, anti-quality factors or toxins that should be avoided. Examples of such toxicities would include the high copper level in oil palm by-products which can be potentially toxic to sheep. Treatments to improve quality (alkali, anhydrous ammonia, urea, etc.) although successful in the lab, have not been well adopted by the small farmers (Preston and Leng, 1987).

Many trials have been conducted to evaluate various forages and by-products in Indonesia. These trials are summarized in various proceedings of conferences and meetings. A variety of papers covering general nutrition, forages, by-products and minerals for sheep and goats have been published as working papers from the Small Ruminant Collaborative Research Program (Table 1). The working paper titles, authors and date of publication are included in the appendix of Ludgate and Scholz (1992). In addition, feeding techniques are covered in several papers contained in New Technologies for Small Ruminant Production in Indonesia (Ludgate and Scholz, 1992).

Nutritional Requirement Guidelines

Nutritional requirements for small ruminants in tropical countries have received little attention. Generally less research has been completed on the nutrient requirements of small ruminants than for other livestock. Early information was merely an extrapolation from cattle requirements. Currently there are several sources that can be appropriate depending on breed, type, size and environment.

The most recent composition publication "Ruminant Nutrition: Recommended Allowances and Feed Tables," from the French (Jarrige, 1989) includes full chapters on sheep and goats. The book is available in both French and English and is an excellent reference for nutrient requirements of dairy goats.

However, most of the requirement tables are for large sheep (weighing 40-80 kg) or goats (50-120 kg). Another disadvantage is that the energy and protein system utilized are unique and not easily converted to other systems. Values for feedstuffs worldwide are limited but sections on Feeds of the Dry Tropics (Senegal) and Feeds of the Humid Tropics (West Indies) add to the data base.

TABLE 1. WORKING PAPERS ON NUTRITION TOPICS PUBLISHED BY THE SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM (SR-CRSP)*

Topic	Working Paper Number	
	Sheep	Goats
General Nutrition	11, 12, 71, 77, 85, 89, 101, 104, 135	11
Forages	19, 24, 26, 33, 34, 52, 56, 64, 87	24, 34, 56, 64, 66
By-products	51, 52, 90, 91, 102	54
Minerals	40, 58	58

*Working papers are available from SR-CRSP office in Bogor or from the Management Entity in Davis, CA; A full listing is in Appendix 1 of Ludgate and Scholz.

Requirements for small ruminants in developing countries are addressed by Kearl (1982). Sections deal exclusively with sheep and goats and include thorough literature references of nutrient requirements. Daily nutrient requirement tables for various physiological states and for animals weighing from 5 to 70 kg are presented. This is one of the few publications that includes requirements for smaller sheep and goats. Most tables were derived from literature values based on body weight and then extrapolated to the various body weights. These tables should be a good guide but need to be refined with experimental data. A summary of the nutritional requirements of breeding goats was updated by Pond and Buntinx (1990) and covers small goats.

The first attempt by the United States National Research Council to report the nutrient requirements of goats (NRC, 1981) relied heavily on the world goat research data base. A wealth of information current through 1981 is contained in the bibliography which is grouped by topic. They include requirements for goats in various physiological states and for animals weighing 10 to 100 kg. In addition, requirements are listed for maintenance at different levels of activity (minimal to high activity), for different environments (tropical to arid), for different levels of milk production and for mohair production. The feed

composition tables are extensive; however, since this is the first edition, refinement is probably needed. Unfortunately plans are not certain for future editions.

Unlike for goats, the nutrient requirements of sheep have received much more attention in the United States (NRC, 1985). The sixth edition of Nutrient Requirements for Sheep is currently available. However, the requirement tables are of little value for sheep in Indonesia because they are for larger ewes (50 to 90 kg) and growth rates of lambs begin at 200 g/d. Similar to the goat NRC (1981), the reference section for sheep (NRC, 1985) is complete and grouped by general topic.

Conferences and symposia on sheep and goats are also excellent sources of specific nutritional information. These include the International Symposium on Nutrition and Systems of Goat Feeding held in Tours, France (1981), the Third International Conference on Goat Production and Disease held in Tucson, Arizona (1982), the Fourth International Conference on Goats held in Brazil (187) and the Fifth International Conference held in New Delhi, India (1992).

Books on sheep and goat production are also sources of nutritional management for temperate (Ensminger et al., 1989) and tropical (Devendra and Burns, 1970; Devendra and McLeory, 1982; Gatenby, 1986) regions. A world bibliography on goats (Sands and McDowell, 1979) contains over 100 references on nutrition and feeding efficiency of goats. Most recently, a compilation of trials to look at energy and protein requirements for growing sheep and goats has been published for Indonesia (Haryanto and Djajanegara, 1992). This should serve as a good guide for humid Indonesia. Another new publication (McDowell et al., 1993), covers the minerals for grazing ruminants in tropical regions.

Nutrition of Small Ruminants in Indonesia

The Javanese and Sumatra Thin-Tailed Sheep are among the most productive sheep in the world. It is not uncommon to have two lambings per year whereby ewes are bred during lactation, conceive and produce multiple births twice a year. The kidding interval of many of the does is also short and, therefore, nutritional requirements of these animals is higher than those in more temperate climates where lambing and kidding occur only one time per year. To meet the nutrient requirements of these highly productive animals requires careful attention to meet their needs and maintain this high productivity.

Requirements are also increased when animals are crossed with larger size imported breeds such as the Barbados Blackbelly, St. Croix, or wooled breeds. The offspring of these crosses are generally larger at birth, grow faster, and

obtain a higher mature weight than that of the local sheep breeds, if fed accordingly. To obtain growth to genetic potential adequate feed must be given.

The general principles of nutrient requirements for small ruminants are the same throughout the world. Maintenance has the lowest requirement whereas the end of gestation and lactation have the highest nutrient demands. Since many of these breeds of sheep and goats breed during lactation the requirements for lactation are high. The requirements for growth/fattening have not been well defined for sheep and goats grown in Indonesia. In recent years, there has been more of a push towards obtaining rapid rates of gain by feeding agro-industrial by-products in a confinement situation to improve gains and reduce the time between weaning and slaughter. This is especially true as producers move from subsistence production (where the small ruminants are used for security, stored wealth and reserve) to production for economic returns. Specialized feeding units where animals from several farmers are purchased and fed out at one location is becoming more common. Economy of scale also allows for better use of by-products. Rate of growth and therefore time to marketing can be modified by feeding level to meet seasonal marketing demands. Eastern Indonesia has a predominantly dry climate with a prolonged dry season. Lack of feed resources during the dry season adds further challenges to small ruminant production. Some of these constraints and strategies for production in Eastern Indonesia were covered in a conference supported by the Indonesian Small Ruminant Network (Subandriyo and Tiesnamurti, 1992).

Feeding to Meet Requirements

To improve performance, whether it be reproductive performance or survival and growth rate, supplementation is often required. Although many of the tropical grasses have adequate protein to meet the requirements (Haryanto et al. 1992; Sanchez and Pond, 1991), total intake of these grasses is limited by the small size of the gastrointestinal tract of small ruminants. Unless these grasses are harvested or grazed at an immature stage, the animals productive capacity can be reduced. In the case of the reproducing female, the forage resource should be utilized to a maximum since this is generally the lowest cost feed available. In many cases; however, the labor involved to harvest the forage and bring it to the animal can be very high. In densely populated areas where farmers have to travel a long distance to obtain grass, the number of animals maintained by the farmer may be limited because of the constraints of bringing feed. In more extensive areas (Eastern Island) or in tree crop plantations, the grazed forage resource is the most important part of the production system. Not only is it important for grazing sheep but it is also important to maintain environmental quality and reduce the use of herbicides. Grazing sheep in tree crop plantation areas can improve the soil characteristics, improve the nutrient cycling, and improve the yield from the trees.

Where forage is in short supply or requires long times to transport or when the production is limited, supplementation may be a good alternative. Supplementation of the ewe or doe flock can be accomplished in several manners. If the animals are grazing during the day, then supplementation can occur in the kandang after returning from grazing or before going out to graze. Generally, it is considered better to supplement following grazing rather than before grazing to prevent sheep or goats substituting supplement for some of the forage that they would have consumed during the day if they had not been supplemented. Reducing the length of time for grazing by sheep from 7 to 4 hours reduced intake by 20% (Merkel et al., 1992). This reduction in intake should be replaced by supplementing cut-and-carry forage or by other supplementation.

Supplementation of ewes can be done by several methods. Reese et al. (1990) supplemented ewes daily at 0, 1.0, 1.2 and 1.4% body weight with a mixed concentrate and improved productivity. Reducing the daily supplementation to only during critical nutrient demands (6 weeks before through 3 months after lambing) was successful in maintaining high productivity while reducing costs (Sanchez et al., 1993; table 2). In experiment 3 (table 2) replacing 50% of the concentrate with locally available rubber seed or supplementing rubber seed and a tree legume *Gliricidia* had equal biological improvements but were more economical than the concentrate supplement. Strategically supplementing to meet needs according to critical demands is a key way to reduce supplementation costs during periods of high nutrient demand. Strategic supplementation limited to two weeks before expected lambing through four weeks after lambing has proved to be beneficial (Sanchez et al., 1993).

One problem with strategic supplementation is that lambing dates need to be known in order to feed appropriately. Another alternative is to feed a low cost by-product as a supplement daily. Molasses is generally cheap and can be fed ad libitum to ewes in the kandang. It is economical and gives improved biological performance (Experiment 2, Table 2). Molasses is given free choice to all ewes grazing under rubber in the SR-CRSP project of North Sumatra. Unfortunately, molasses is bulky and usually only available in large quantities; thereby, reducing its use by small farmers unless cooperative buying can be accomplished.

When a cut-and-carry system is utilized, supplementation with agro-industrial by-products can replace the nutrients from forage and thereby reduce the time spent gathering forage. In addition, tree legumes are excellent quality protein sources that are palatable to sheep. Some initial conditioning may be required to obtain desired intake level, but tree legume are important supplements especially during times of drought or during the dry season.

TABLE 2. EFFECTS OF SUPPLEMENTATION ON BIRTH WEIGHT, WEANING WEIGHT, LAMBING INTERVAL AND EWE PRODUCTIVITY PER BODY WEIGHT PER YEAR (kg LAMB WEANED/kgBW/y)

Treatment	weight (kg)		lambing interval(d)	Productivity
	Birth	weaning		
Experiment 1				
Grazing only	2.11	8.97	241	.67
plus concentrate*	2.17	9.30	218	.80
SEM	.04	.24	5.3	.03
Experiment 2				
Grazing only	1.61	7.55	232	.71
plus molasses	1.79	8.90	216	.88
SEM	.04	.26	6.2	.04
Experiment 3				
Grazing				
plus concentrate*	1.92	9.30	222	.93
plus concentrate & RS[b]	2.23	9.76	229	.88
plus RS & Glir.[c]	2.13	9.64	222	.93
SEM	.08	.33	6.6	.03

*Concentrate consisting of 44.3% rice bran, 20.7% molasses, 31.4% Cassava meal, 1.4% fish meal, 1.0% urea and 1.2% limestone fed at 1.4% BW.

[b]Rubber seed (RS) fed at .5% BW and concentrate fed at .5% BW.

[c]Rubber seed (RS) fed at .5% BW and *gliricidia* (Glir) leaves fed at .5% BW.

For growing or fattening sheep, it may be desirable to limit the amount of forage fed to these animals and to keep them in confinement. Parasites can be an extreme burden on young, fast growing animals. By keeping these young, fast growing animals in the kandang and not allowing them to have access to fresh growing forage, the level of parasite infestation can be markedly reduced. This helps in increasing rate of gain and in reducing losses including death that can be associated with heavy parasite burden. Utilizing mixed concentrates and agro-industrial by-products can be very effective in improving rates of gain, reducing time until market and has worked very satisfactorily for many producers especially in regions close to markets. To obtain maximum biological growth and to utilize by-product rations for growing lambs and kids is not an easy task. An example of a trial utilizing palm kernel cake and molasses compared to a corn soy diet is presented in Table 3.

TABLE 3. INTAKE AND AVERAGE DAILY GAIN OF LAMBS FED BY-PRODUCT AND CONCENTRATE FEEDS*

Ration	Major Ingredients	Intake	ADG
1	100% PKC	687[c]	53[a]
2	75% PKC -- 25% molasses	683[c]	59[a]
3	50% PKC -- 50% molasses	684[c]	74[ab]
4	PKC at .5% BW -- molasses ad libitum	489[b]	53[a]
5	57% corn - 18% soybean meal - 10% PKC	937[d]	100[b]
6	40% Cassava meal, 20% PKC, 11% Rice bran, 10% rubber seed	867[d]	106[b]

*Molasses contains 3% urea. All rations have added minerals.

Palm kernel cake supplies protein that escapes rumen fermentation and in this case microbial activity in the rumen may have been limited due to low ruminal ammonia levels (Preston and Leng, 1987). Adding molasses with urea tended to improve performance. Rations can be developed (ration 6) that are composed of by-products that equal performance of expensive corn and soybean meal based rations (ration 5). Mineral and molasses blocks have been used to remedy deficiencies. The blocks can be locally made without any equipment. Salt blocks can be manufactured with cement as the binding agent, in four liter pots lined with plastic for easy removal of blocks. Before adding the mixture, a bent wire (12 gauge) should be placed in the middle and extended vertically from the bottom of the pot to about 15 cm above the pot. Once the mixture hardens, the wire can be used to hang the blocks from the ceiling. The best proportion of cement for salt blocks in North Sumatra was 8%, a compromise between hardness and cost. Cement should be wetted first before mixing with the salt. Drying can be done in the sun, or more rapidly in an oven. The consumption of salt from these blocks was 20 g/d per head, during the time animals spend in the barns (16 h a day). The percent of cement was increased to 11% when a commercial mineral mixture (in powder) was added: 69% salt; 11% cement; 20% mineral mix (Ultra-mineral mix, Medan, containing 20% Calcium, 25% phosphorous, 22% sodium, 0.35% manganese, 0.20% zinc, 0.8% iron, 0.2% iodine and 0.15% copper). Average animal intake of this block was 9 g/d. An additional formula that includes a source of phosphorus is: 65% salt, 15% cement and 20% bone meal. The estimated copper intake from this block is 21 mg per head per day. Modification of formulas are required to

provide other minerals or ingredients in various proportions. Salt blocks have facilitated the task of providing adequate salt and minerals to sheep.

Future Research in the Nutrition of Small Ruminants

Rather than spending a lot of time and money trying to fine tune the nutrient requirements for growth, maintenance, gestation and lactation, it may be more advisable to work out systems and combinations of feedstuffs to meet the needs of maximum growth of animals. Therefore, high priority should not be given to the determination of energy, protein and mineral requirements of many of the different breeds of sheep and goats in Indonesia. But perhaps more emphasis should be placed on utilizing the existing knowledge obtained from past research in determining the right feed combinations needed to give the animal nutrients for desired production.

In Southeast Asia, the best natural resource is the sun. Consistent day lengths, relatively consistent temperatures and adequate moisture should be taken advantage of in developing feeding systems for small ruminants in the future. The use of single cell protein grown on manure waste, rubber waste, or on other agro-industrial by-products could be extremely important in providing a protein and energy source for several types of livestock including small ruminants. This area of work in the future should be extremely important in small scale production of protein that can be utilized by small ruminants. Value added processing to existing feedstuffs is also another way to improve the economic return from feeding livestock. New technologies such as extracting fat from rice bran and treating with calcium to form protective fat (this proceedings) will be important advances in the future of small ruminant production. To reduce the problem of lack of quantity and quality of feed, programs will have to be initiated where complimentary feeds are given to the animal to provide for the required nutrients. As new breeds and breed crosses are introduced into the livestock system, an adjustment in how livestock are fed will be required. If there is no adjustment, and animals are fed at the same level as present, then these animals will be slow growing, will not reach market in a minimal time and will be a problem for the producer. Putting together the appropriate feedstuffs to maximize the use of by-products, minimize the cost while maintaining the desired production will be the key role for the future.

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SCREENING OF SECONDARY COMPOUNDS IN TREE AND CREEPING LEGUMES

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ABSTRACT

Fourteen tree legumes and twelve creeping legumes were analyzed for their phenolic compounds, tannin, non-protein amino acids and saponin. The leaves were successively extracted by methanol and 50% methanol solution. The total phenol level in methanol extracts of tree legumes measured by calorimetric method varied widely (0.03-5.9%) compared to those in creeping legumes (0.2-0.9%). Individual phenolic acids were identified and quantified by HPLC; gallic acid was the most common phenolic acid in both tree and creeping legumes. Para-benzoic acid was commonly found in tree legumes but not in creeping legumes while p-coumaric acid was found mostly in creeping legumes and some tree legumes. Tannin values measured by the Vanillin-HCl method were always higher than those measured by the protein precipitation method. The highest tannin level was found in *Calliandra sp.* followed by *Leucaena diversifolia* and *Albizia falcataria*. Tannin levels in creeping legumes were insignificant. Qualitative analysis using TLC showed that all fourteen legumes contain non-protein amino acids and nine of them produced a peak on HPLC which could be quantified relative to arginine. The highest level of non protein amino acid was found in *Acacia villosa* (2.88%). The saponin concentration in tree and creeping legumes varied from 0.4 to 2.42% and was generally lower in creeping legumes.

Introduction

Forage crops are grown to provide digestible energy and other nutrients, including protein and minerals for ruminants. Chemical composition in terms of protein, fat, carbohydrate and minerals has been used to describe the value of forage crops for livestock. However, during photosynthesis and metabolism, the plant produces not only primary components but also secondary components which can be described as "by-products" of metabolism. These secondary compounds have diverse chemical structures and sometimes do not have a clear function in the plant. Some secondary compounds can be called "toxicants".

A toxicant can be defined as a substance, which under practical circumstances, can impair some aspect of animal metabolism and produce adverse biological or economic effects in animal production (Cheeke and Schull, 1985). Although virtually everything is toxic if given in a large quantity, the term toxicant refers only to those substances which might normally be encountered at a toxic level.

Thousands of chemical compounds have been identified as toxicants in many species of plants including grasses and legumes. It is believed that the low digestibility of tropical forages compared to temperate forages may be related to the presence of toxicants beside lower protein and mineral concentration (Lowry, 1989). Toxicants can be classified in various ways, including chemical structure. They include alkaloids, glycosides, protein, non-protein amino acids, lipids, metal-binding substances, phenolic compounds, sequiterpene lactone and others.

Toxicants in forages have been studied in temperate areas in countries such as North America, Australia, and New Zealand. Recently many species of tropical legumes, other than leucaena, are attracting great interest. These include gliricidia, acacia, calliandra, desmodium, sesbania, albizia etc. These species have several advantages including use as firewood, shade for plantations and high protein content due to their ability to fix nitrogen. The feeding value of leguminous tree for ruminants is rarely reported and very little research has been conducted on toxicants in leguminous fodder.

In this report, several toxicants such as phenolic compounds (phenolic acid, hydrolyzable tannin, condensed tannin, saponin) and non-protein amino acids were analyzed in leaves of leguminous trees and creeping legumes. Possible toxicities arising from these toxicants are also discussed.

Materials and Methods

Materials. All leaf materials, both fresh and freeze-dried, were collected in Ciawi, West Java. Most creeping legumes for saponin analysis were collected from Pakuwon, West Java.

Extraction of Phenolic Compounds. A successive extraction was conducted based on the method developed by Wina (1988). A dried sample (1g) was extracted 4 times with absolute methanol (10 ml). It was centrifuged after each extraction. The supernatant (combined methanol solution) was evaporated by rotary evaporator until dry then dissolved in 10 ml water. This aqueous solution was extracted 4 times with 10 ml ethyl acetate. The top layer was separated and evaporated by rotary evaporator and redissolved with 5 ml methanol. This fraction was named **Fraction A**. The bottom layer (aqueous layer)

was evaporated and redissolved in 10 ml water and named Fraction B. The residue after absolute methanol extraction was extracted 4 times with 10 ml of 50% methanol solution. It was centrifuged after each extraction. The solution was evaporated and redissolved in 10 ml of 50% methanol and named Fraction C. These three fractions were then analyzed for their total phenol and total tannin concentrations.

Phenolic Compound Analysis. Total phenol analysis by Swain and Hillis (1959):

One milliliter of a sample aliquot (fractions A, B and C) was diluted to 7 ml with distilled water followed by the addition of 0.5 ml of Folin-Denis reagent. After mixing by vortex, 1 ml of saturated sodium carbonate was added. The mixture was made up to 10 ml with water. After 30 minutes of reaction, the mixture was centrifuged at 3000 rpm for 15 minutes. The absorbance was recorded at 725 nm wavelength. Standard solutions from 0 to 100 ppm were prepared from p-coumaric acid in absolute methanol.

Phenolic Acid Analysis by HPLC Developed by Wina (1988). The solution of Fraction A was filtered through a 0.45 um millipore filter and 10 ul of the sample was injected into the HPLC using RP Resolve C18 (Waters) column 15 cm x 3.9 mm ID. The eluent was 15% HPLC-grade methanol in 2% acetic acid solution with a flow rate 1.0 ml/min. The compound was detected in a UV detector at 280 nm wavelength.

Tannin Analysis. Total tannin was analyzed by the Vanillin-HCl method developed by Broadhust and Jones (1978):

Half of milliliter of a sample aliquot (Fraction B and C) was reacted with 3 ml concentrated hydrochloric acid and 1.5 ml of 4% vanillin in methanol solution. The absorbance was recorded at 500 nm after 20 minutes. The blank sample was made by reacting 0.5 ml aliquot of sample with 3 ml of concentrated HCl and 1.5 ml of 25% methanol. The standard solutions from 0 to 250 ppm were prepared from catechin in 25% methanol.

Total tannin analysis by protein-precipitation method developed by Hagerman and Butler (1978) :

One milliliter of a sample aliquot was added to 1 ml of a standard protein solution (pepsin) 2mg/ml, prepared in acetate buffer, pH 3.0. The combined solution was mixed, allowed to stand in a cool-room for 30 minutes, then centrifuged at a cool temperature for 15 minutes at 3000 rpm. The supernatant was discarded and the precipitate was carefully washed with buffer. The precipitate was then dissolved in 4 ml sodium dodecylsulfate (1%)-triethanolamine (5% v/v)solution. After the addition of 1 ml of 0.01 M ferric chloride solution in 0.01 N HCl, the absorbance of the violet-colored

complex was read at 510 nm after 30 minutes. Tannic acid was used as a standard and a series of solutions was prepared for the calibration curve (0.2-1 mg/ml).

Non-protein Amino Acid Analysis: Qualitative Analysis. Fresh leaves of 2.5 g were extracted with 20 ml of 5% trichloroacetic acid in 50% isopropanol in a blender for 2 minutes. For free-fat dried samples 0.3 g of the sample was extracted with 8 ml of the above solution. Then, it was transferred to a 100 ml plastic tube and shaken for 30 minutes. The solution was left at room temperature overnight. The next day, it was centrifuged at 3000 rpm for 15 minutes. The top layer (supernatant) was separated and 2 ml poured into a chromatography column made from a plastic tip containing 2.5 cm of resin (Dowex AG 50 W-X4, 100-200 mesh H^+). Then 8 ml of distilled water was added to wash the column, followed by 8 ml of 2N ammonia solution as an eluent. One milliliter of this solution in a tube was placed in a rotary evaporator to eliminate the ammonia, which was checked with pH paper (pH 8-10). This solution was ready to be spotted on the thin layer plate (20ul) or injected into the HPLC column. The plate used was an aluminum plate layered by Silica G 60, F254 with the developing solvent the top layer of a mixture of n-butanol: acetic acid: water (4:1:5 v/v, freshly prepared). When the elution was complete the plate was removed from the chamber, air dried and sprayed with 0.5% ninhydrin in n-butanol (freshly prepared). The plate was placed in an oven at 105°C to develop the violet color for non-protein amino acid compounds.

Quantitative Analysis. Before injecting the solution into the HPLC it was diluted 10 times and filtered through a 0.45 um millipore filter. Ten ul of this solution was injected in HPLC using post-column derivatization and detected by a fluorescence detector (Hitachi). The column was a Zipax-SCX (Dupont Instrument) 50 cm x ID 0.21 cm and the eluent was a 0.1 M citric acid solution: 0.2 M Disodium hydrogen phosphate (80:20 v/v) and the flow rate 0.5 ml/minute. The OPA solution was pumped into the column at a flow of 1.1 ml/min. The excitation wavelength was 350 nm and the emission wavelength was 450 nm with a sensitivity of 0.5 fsd (full scale deflection).

The OPA solution was made fresh by weighing 125 mg OPA dissolved in 2.5 ml ethanol and 50 ul 2-mercaptoethanol and made up to 250 ml with 3% borate buffer having a pH of 10. The standard solution was prepared from l-arginine in buffer with a pH of 10 (0.02%).

Saponin Analysis: Qualitative Analysis Based on The Method of Price et al. (1986). Half a gram of free-fat sample was extracted with 15 ml absolute methanol for 24 hours using a shaker. Then, it was centrifuged for 15 minutes at 3000 rpm. The supernatant was separated and 5 ml of the supernatant was evaporated and redissolved in 1 ml of methanol. This solution was put through a Sep-Pak (Silica cartridges, Waters Ass) and washed with hexane, washed again with chloroform and then the saponin eluted with 5 ml methanol. All the

methanol was evaporated and the residue redissolved in 1 ml methanol. Then 5-10 ul of this solution was spotted on a thin layer plate which had been activated in the oven at 105°C for 2 hours. The standard solution was prepared from saponin white (0.2 mg/ml, from Gysophila). The plate was Silica Gel 60 and eluted with a mixture of ethanol: n-butanol: ammonia (2:7:5) for 6 hours. When the elution was complete, the plate was taken out from the chamber and allowed to air-dry. The plate was sprayed with a mixture of sulfuric acid: glacial acetic acid: 4 - methoxy benzaldehyde (1:50:1). After being air-dried, the plate was placed in the oven for 10 minutes at 105°C. The color appeared greenish blue for saponin.

Quantitative Analysis Based on The Modified Method of Gestetner et al. (1966). After activating the Silica Gel 60 plate in the oven, a line was drawn across the middle of the plate. All the samples were spotted on each half of the plate. The standard solution was prepared from saponin white (1mg/ml) which was spotted on the plate with in volumes of 200, 400, 600, 800 and 1000 ul. The same sample solution as for qualitative analysis was used and 75-200 ul, depending on the qualitative result, were applied on the plate not as a spot but as a band (1.5 cm width). After the elution was complete, the plate was cut in two. The first half was sprayed with the same solution used for qualitative analysis to get the Rf values of the saponin. The other half of the plate was used for quantitative analysis. The bands were scraped from the plate according the Rf value. Because the saponin standard consisted of 5 bands the plate was scraped from the top band to the lowest band. The scrapings were extracted twice with 10 ml methanol in an ultrasonic bath, then centrifuged. The supernatant was separated into a test tube and evaporated till dry by rotary evaporator. Two ml of concentrated sulfuric acid added and left to stand in the cool room for 22 hours, then 3 ml glacial acetic acid was added. The orange color was developed and absorbance read at 530 nm wavelength.

Results and Discussion

Total Phenol and Phenolic Acid. Total phenol analysis is normally carried out as the first estimate of phenolic acids in the plant. The total phenols from tree and creeping legumes are presented in Table 1. These legumes are the common types grown in Indonesia, except for certain species such as arachis which are newly introduced. However, all of them may be potential sources of protein supplements for ruminants. The method used for measuring the total phenol was the widely-used Folin-Denis calorimetric method. The total phenol in the methanol extracts of tropical tree legumes varied widely (0.0-5.9%) compared with those of creeping legumes (0.2-0.9%). The different solvents for extraction (A,B and C) resulted in different amounts of phenol being detected by calorimetric measurement. The highest value of total phenol in methanol extract was found in *Acacia villosa* (5.91%). Different species of leucaena contain a

considerable amount of total phenol (2-4%). Sesbania and most calliandra spp. except *Calliandra surinamensis* which is normally not fed to animals, have a relatively low concentrations of total phenol. The higher levels of total phenol may reduce the feeding value of the legume. In some cases phenolic compounds may cause toxicities as reported by Hegarty et al. (1986).

TABLE 1. TOTAL PHENOL IN ABSOLUTE METHANOL (ETHYLACETATE (A) AND AQUEOUS (B)) FRACTION AND 50%-METHANOL FRACTION (C)

Legumes	Methanol fraction A	Methanol fraction B	50% Methanol (C)
	%		
Tree legumes			
Acacia villosa	5.91	0.10	0.69
Albizia falcataria	1.35	2.95	nd
Calliandra calothyrsus	0.47	0.12	0.31
Calliandra haematocephala	0.49	0.16	1.55
Calliandra surinamensis	4.84	2.63	1.11
Leucaena colensii	1.89	4.95	9.63
Leucaena diversifolia	2.81	1.79	9.96
Leucaena leucocephala	1.84	1.72	5.32
Leucaena pallida	3.77	2.98	11.11
Samanea saman	1.62	0.51	1.23
Sesbania grandiflora	0.03	1.31	0.43
Sesbania sesban	0.34	0.42	0.52
Creeping legumes			
Arachis glabrata	0.20	0.24	1.17
Arachis hybrid	0.32	0.49	1.41
Bohemia sp.	0.20	0.24	0.89
Calopogonium caeruleum	0.49	0.50	0.93
Clitoria ternatea	0.86	0.77	0.73

Feeding acacia as a sole diet to sheep resulted in mortality (Tangendjaja, unpublished). However, feeding leucaena or *Calliandra calothyrsus* did not result in adverse effects to animals, although leucaena contained higher amounts of total phenol.

The limitation on the measurement of total phenol by the Folin-Denis method is that other plant constituents such as amino acid and protein may also react with the Folin-Denis reagent and interfere with the color. Leucaena species contain mimosine in considerable amounts and an unidentified non-protein amino

acid was detected in acacia (see Table 4). So the estimates of phenol in methanol extracts of acacia and leucaena might be affected by the presence of non-protein amino acid compounds. Also the total phenol in 50% methanol extract of some leucaena species was extremely high, possibly as a result of interference with other compounds.

TABLE 2. CONTENTS OF INDIVIDUAL PHENOLIC ACIDS IN METHANOL FRACTION

Legumes	Phenolic acid					
	Gallic acid	Proto-cate-chuic acid	p-OH benzoic acid	Benzal dehyde	Couma-ric acid	Ferulic acid
	ppm					
Tree legumes						
Acacia villosa	580		446			
Calliandra calothyrsus	937		943			
Calliandra haematocephala	1802		1196			
Calliandra surinamensis	580		466			
Leucaena colensii	1643	407	611		1491	
Leucaena diversifolia	1099				587	
Leucaena leucocephala			1099			
Leucaena pallida	1677				1777	
Sesbania grandiflora	1999					
Sesbania sesban			789			
Creeping legumes						
Arachis glabrata		520			3207	4410
Arachis hybrid					1124	
Calopogonium caeruleum	745	548				
Clitoria ternatea	506				2145	

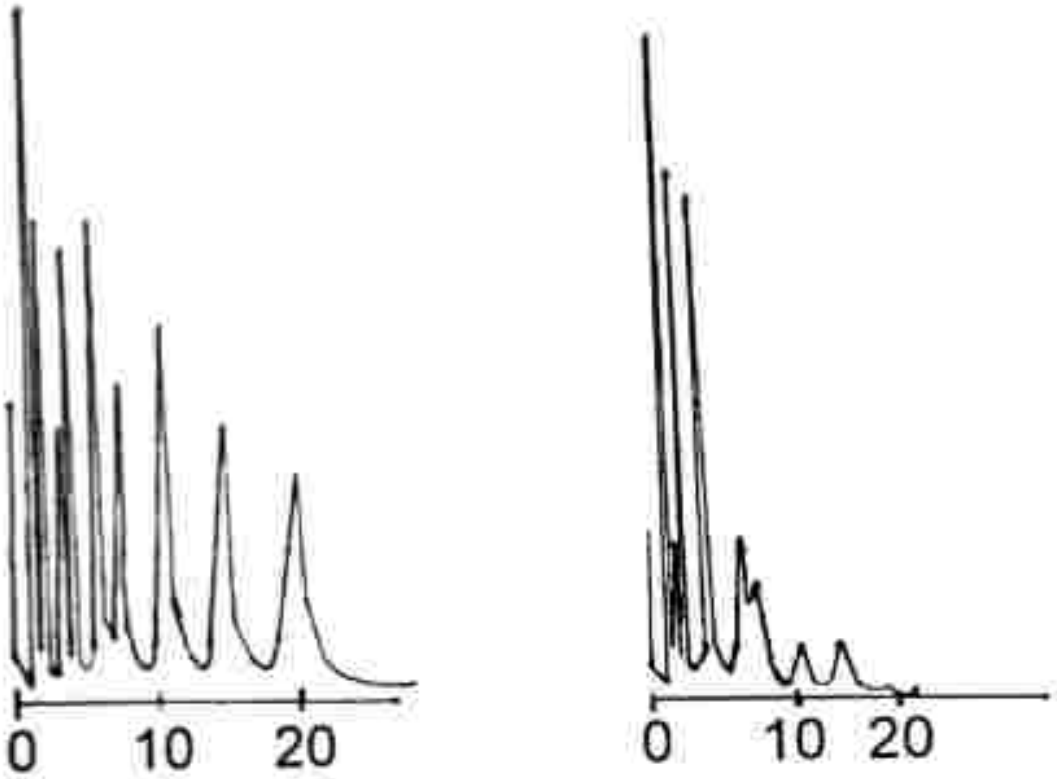

Figure 1. A HPLC chromatogram of phenolic acids in standard (a) and Calliandra Calothyrsus (b)

It was therefore difficult to interpret the total phenol measurements obtained by the Folin-Denis method. However, this method gives a preliminary indication of possible antinutrient factors in tropical legumes.

The individual phenolic acids can be identified by high performance liquid chromatography on the reverse phase of a bonded column. Figure 1 is a typical chromatogram of phenolic acids from tree legumes and the quantities individual phenolic acids identified are presented in Table 2. The phenolic acids that are identified from methanol extract are free phenolic acids which do not bind with any other compound. The common compounds that could be identified were gallic acid and p-OH benzoic acid and p-coumaric acid. In general, the quantities of phenolic acids found in tree legumes were higher than in creeping legumes. Most legumes contain gallic acid with concentrations from around 500 ppm to almost 2000 ppm (0.2%). In contrast to tree legumes, creeping legumes contain less than 800 ppm gallic acid and there was none in the arachis sp. Para-hydroxy benzoic acid was also not detected in creeping legumes, but there was more p-coumaric acid in creeping legumes than tree legumes. Para coumaric acid and ferulic acid have been reported to inhibit *in vitro* cellulose degradation by rumen bacteria and fungi, but there is no evidence that these compounds are toxic *in vivo* which may be because they are metabolized in the rumen (Hartley, 1990). Gallic acid is commonly the monomer of hydrolyzable tannin but it can react with catechin and has the properties of both hydrolyzable tannins and condensed tannins (Woodward and Reed, 1989). Gallic acid, at a certain levels can cause toxicity to monogastric animals such as chickens; however, it can be metabolized by ruminant and excreted as hypuric acid in the urine.

Tannin. Tannin concentrations were measured by the two most common methods, which are vanillin-HCl and protein precipitation. The results are presented in Table 3. The vanillin-HCl method measures condensed tannin, and the protein precipitation method measures tannin or phenolics that can precipitate protein. Tannin level in creeping legumes was considerably lower than in tree legumes.

The aqueous fraction contained much lower tannin than the 50% methanol fraction in both tree and creeping legumes. Albizia was an exception. This result is in agreement with the statement that tannin is more soluble in aqueous methanol than in absolute methanol (Ribereau-Gayon, 1972).

The highest tannin level was in calliandra species, especially *Calliandra calothyrsus* (1.95%). This is in agreement with a previous report (Lowry et al., 1992). However, the value found in this experiment was much lower than that of the previous report, which can be attributed to the difference between methods. Besides calliandra species, leucaena, acacia and albizia contained substantial amounts of tannins.

The protein-precipitation method also showed that calliandra contained the highest tannin level among tree legumes, although the value was much lower than that measured by the vanillin-HCl method. The protein precipitation value for tannin measurement has more meaning in terms of its biological effect, since tannin binds protein to make it less digestible. According to Waghorn (1990) incorporating condensed tannin into forage diets at concentrations of between 1 and 4% of DM is likely to result in significant advantages in efficiency and productivity of ruminants. However, type of condensed tannin could be important with regard to its effect on forage digestion. A previous experiment showed that sheep given fresh calliandra as a supplement could achieve good daily gains. Drying will reduce the digestibility of forages which contain high levels of tannin.

TABLE 3. TOTAL TANNIN CONCENTRATION IN 50% METHANOL FRACTION DETERMINED BY VANILLIN-HCl AND PROTEIN PRECIPITATION METHODS

Legumes	Aqueous from Methanol fraction	50% Methanol Fraction	
	Vanillin-HCl	Vanillin-HCl	Protein precipitation
	%		
Tree legumes			
Acacia villosa	0.06	0.42	0.26
Albizia falcataria	0.52	0.28	0.10
Calliandra calothyrsus	0.42	1.95	0.84
Calliandra haematocephala	0.43	1.67	nd
Calliandra surinamensis	0.18	1.54	nd
Flemingia congesta	nd		0.23
Gliricidia sepium	nd		0.04
Leucaena colensii	0.03	0.26	nd
Leucaena diversifolia	0.06	0.95	0.26
Leucaena leucocephala	0.08	0.27	nd
Leucaena pallida	0.05	0.13	nd
Samanea saman	0.01	0.02	0.06
Sesbania grandiflora	0.05	0.11	0.03
Sesbania sesban	0.03	0.09	nd
Creeping legumes			
Arachis glabrata	0.02	0.04	
Arachis hybrid	0.02	0.09	
Bohemia sp.	0.02	0.01	
Calopogonium caeruleum	0.02	0.02	
Clitoria ternatea	0.05	0.07	

Non-protein Amino Acids. Identification of non-protein amino acids using thin layer chromatography showed that there are various types of non-protein amino acids in tree and creeping legumes (Figure 2). This can be seen by the different Rf values of the spots shown in pink. Fourteen legumes positively contained this compound. In some legumes, there are several non-protein amino acids, whereas others only contained one.

Quantitative results were obtained using high performance liquid chromatography. Each compound appeared as a single peak. However, only nine of the 14 legumes showed the presence of a non-protein amino acid. This is in contrast to the results of thin layer chromatography. The HPLC column used might not be useful anymore, or to obtain a good separation on the HPLC chromatogram a gradient system may need to be developed. Further research needs to be done to develop anantitative methods of analysis of non-protein amino acids. Calculated relative to arginine, the highest concentrations of non-protein amino acids was in *Acacia villosa* (2.83%) followed by *Sesbania grandiflora* (2.73%) and *Leucaena leucocephala* (1.85%). Creeping legumes contained relatively low levels of these compounds compared with tree legumes.

TABLE 4. NON-PROTEIN AMINO ACID CONTENT RELATIVE TO ARGININE IN SOME LEGUMES

Legumes	Non protein amino acid
	(%)
Tree legumes	
Acacia villosa	2.88
Leucaena colensii	0.45
Leucaena leucocephala	1.85
Leucaena guatemala	0.15
Leucaena pallida	0.67
Sesbania grandiflora	2.73
Sesbania sesban	0.75
Creeping legumes	
Desmodium gyroides	0.24
Neotonia weightii	0.24

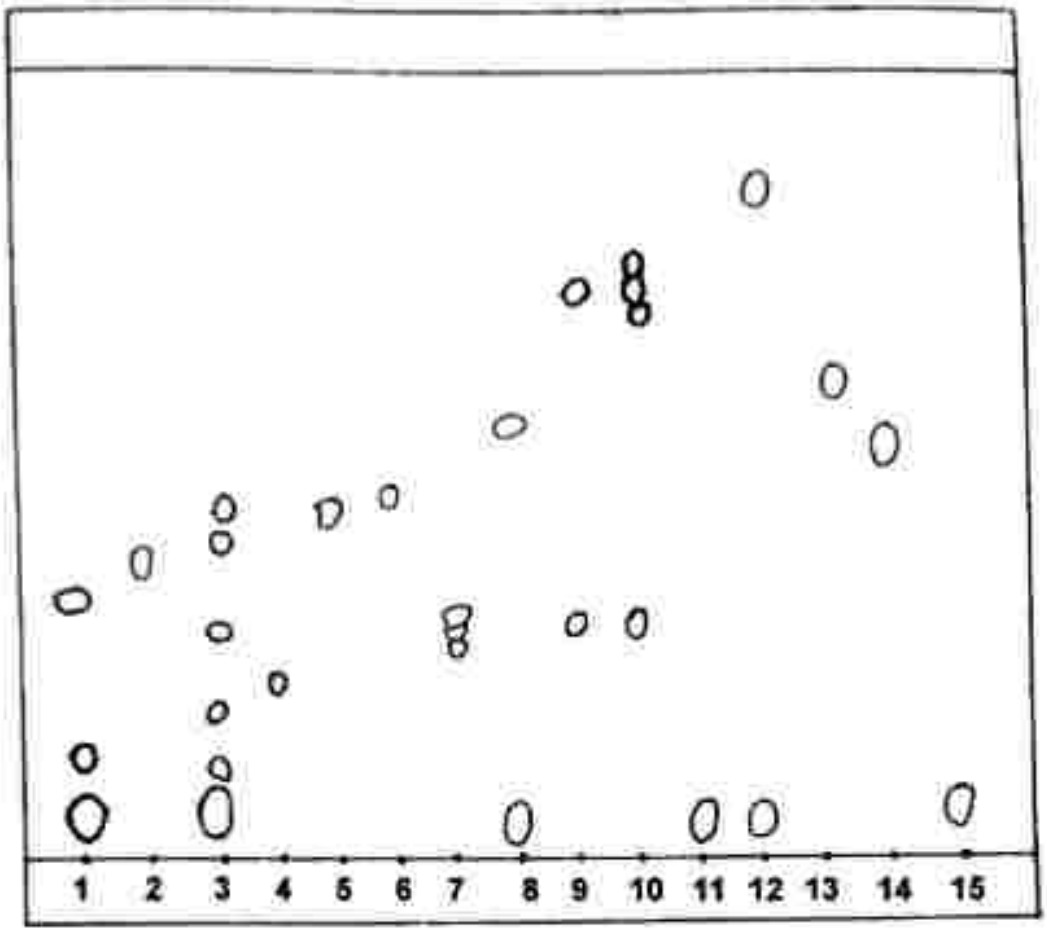

Figure 2. TLC chromatogram of non-protein amino acids from different legumes: 1. *Leucaena diversifolia*; 2. *Desmodium rensonii*; 3. *Leucaena leucocephala*; 4. *Calliandra calothyrsus*; 5. *Sesbania grandiflora*; 6. *Gliricidia sepium*; 7. *Acacia villosa*; 8. *Leucaena guatemala*; 9. *Sesbania sesban*; 10. *Desmodium gyroides*; 11. *Leucaena pallida*; 12. *Leucaena colensii*; 13. *Calliandra rubra*; 14. *Netonia weightii*; 15. Mimosine standard.

Mimosine is one of the non-protein amino acids that has been identified in a few species of mimosa and all species of leucaena. As mimosine is structurally similar to tyrosine, an essential amino acid, when absorbed by the animal mimosine disrupts or interferes with amino acid metabolism. Mimosine has a cytotoxic effect on animals and is readily converted to 3,4 DHP which has a goitrogenic effects in mammals. In Australia, cattle fed with leucaena develop a toxicity whereas in Indonesia, Hawaii and some other countries, no toxicity of ruminants due to leucaena has been reported. Rumen microbes in ruminants from these countries can degrade 3,4 DHP (Dihydroxy Pyridone).

In *Sesbania grandiflora*, canavanine was identified as the non-protein amino acid. The structure of canavanine is closely related to arginine and it acts as an arginine antagonist in many microorganism but only a weak hepatoxin in rats when given orally. There are no reports of toxicity in sheep which have consumed sesbania (Hegarty, 1978).

The non-protein amino acid in *Acacia villosa* is still unidentified. In a feeding experiment with sheep, acacia caused death when sheep consumed acacia as the sole diet. *In vitro* experiments showed that this non-protein amino acid survived undegraded after 48 hours in the rumen, indicating that this compound might cause death in sheep (Tangendjaja, unpublished). Further research is required to work out the structure of this compound and how to overcome it.

Saponin. The saponin measured in this experiment was the free saponin called sapogenin. Saponin itself is bound with glycosides and a step of hydrolysis is required before methanol extraction. The saponin level in tree legumes varied from 0.40 to 2.42% and in the creeping legumes from 0.40 to 1.42%. Generally, as with other secondary components, tree legumes contain higher saponin levels than creeping legumes. The highest saponin level was found in *Albizia falcataria* (2.42%). Beside saponin, albizia also contained quite high tannin levels. The biological test of dried albizia showed that it was palatable and no toxicity was detected with sheep, although the digestibility was low.

In this experiment, the saponin standard isolated from gysophila was used. This standard gave five greenish-blue bands on the thin layer chromatogram with Rf values of 0.04; 0.08; 0.15; 0.24 and 0.39. Other greenish-blue spots which did not have the same Rf values as did the standard, were not considered to be saponin. Commercially, there are other saponin-type compounds isolated from different plants. Price et al. (1986) found that these type saponin contain different components which gave different Rf values. Therefore, the quantitative result in this experiment may be an underestimate of the total saponin concentrations.

TABLE 5. SAPONIN LEVEL IN SOME TREE AND SHRUB LEGUMES

Legumes	Saponin
	(% fat-free DM)
Tree legumes	
Acacia villosa	0.52
Albizia falcataria	2.42
Calliandra calothyrsus	0.40
Calliandra rubra	0.68
Flemingia congesta	1.53
Gliricidia sepium	1.58
Leucaena colinsii	0.74
Leucaena diversifolia	1.28
Leucaena pallida	1.18
Samanea saman	1.43
Sesbania formosa	0.60
Sesbania glabrata	0.71
Sesbania grandiflora	1.77
Sesbania guenesis	0.61
Creeping legumes	
Arachis sp.	0.40
Clitoria ternatea	1.33
Desmodium discolor	0.60
Desmodium gyroides	0.74
Desmodium inferium	0.51
Desmodium resonii	0.75
Desmodium unchinatum	0.74
Marcophylla etropurpureum	0.64
Neotonia weightii	1.42
Puereria phasiolide	0.64

Saponins can decrease surface tension and cause foaming. This can be a problem in animals which consume forages containing high amounts of saponin. However, with the same characteristics as detergent, saponin may have the function as a defaunation agent. Saponins also possess the ability to hemolyze red blood cells. They alter the permeability of the cell wall and therefore exert a general toxicity on many tissues (Bondi et al., 1973). However, *in vitro* analysis showed that commercial saponin did not have any negative effect on dry matter digestibility of elephant grass when added to *in vitro* fermentation at rates of up to 80 mg in the test tube or equivalent to 4% in the diet. The same result was found when crude saponin isolate from *Samanea saman* was added to *in vitro* fermentation (Wina and Tangendjaja, unpublished).

In conclusion, most tree legumes contain higher levels of phenolics, tannin, non-protein amino acids and saponin than creeping legumes. Most of these compounds were found at levels of not more than 3% in the leaves except for total phenol. Studies on extracts containing these compounds are reported in the second paper (Wina et al., 1993).

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REDUCTION IN *IN VITRO* DIGESTIBILITY OF ELEPHANT GRASS BY METHANOL EXTRACTS FROM TREE LEGUMES

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ABSTRACT

An *in vitro* technique using rumen liquor and pepsin cellulase was used to evaluate extracts of tree legumes in affecting dry matter, cellulose and protein digestibilities of elephant grass and casein as substrates. The legumes used were leucaena, calliandra, acacia, gliricidia, albizzia, sesbania, flemingia and samanea. Most methanol extracts of tree legume, using either pure methanol or 50% methanol, reduced the dry matter digestibility much more than the protein digestibility. The highest reduction in digestibility was caused by extracts of *Acacia villosa*, followed by *Calliandra calothyrsus* and *Samanea saman*. Increasing the amount of the extract reduced the digestibility either using rumen liquor or pepsin cellulase. Tannin isolated from calliandra was found to reduce digestibility more when using rumen liquor than when using pepsin-cellulase.

Introduction

Although there are many types of secondary components in plants, the most abundant and diverse chemicals are phenolic compounds. They are considered to have broadly defensive functions for the plant. In terms of plant-animal interactions, it is generally considered that they reduce intake and digestibility rather than cause direct toxicity (Swain, 1979). Polyphenolic compounds, known as tannins, are classified into hydrolyzable tannins which contain gallic acid as a monomer, and condensed tannins which contain flavonol as a monomer.

There are reported cases of hydrolyzable tannins causing mortality in ruminants under conditions where gallic acid (or pyrogallol) is apparently liberated and absorbed in such quantities that it swamps the detoxification system. This has been shown for cattle on *Quercus lavardi* in the USA, and more recently in Australia for sheep and cattle on *Terminalia oblongata* (Hegarty et al., 1986). Although there are no direct phytochemical comparisons of different flora, it is evident that many species of tropical plants, including some used as

animal feeds, contain higher levels of phenolic compounds than occur in temperate forages. Therefore, there is a possibility that toxicity may arise from the absorption of phenolics, whether from hydrolyzable tannins or from large levels of simple phenolic compounds.

The lack of protein sources for ruminants owned by the small farmer leads to the recommendation that tree legumes be used as a supplement. There are many tree legumes adapted to and established in tropical countries such as Indonesia. However, many of these legumes contain large amounts of phenolic compounds. Studies of tree legumes are limited to certain species such as leucaena. In some tropical legumes such as *Calliandra calothrysus*, tannin concentration is extremely high and causes low digestibility (Wina et al., 1993a). The effect of tannins from tropical legumes on rumen micro-organisms depends on the structure of tannin and its molecular weight (Mangan, 1988), but has not been studied in great detail.

Most phenolic compounds are extracted from plants by water or methanol, according to chemical structure, and evaluated by the *in vitro* bio-assay in the laboratory. Absolute methanol, 50% methanol and water are commonly used in extracting tannins (Ribereau-Gayon, 1972).

In this study extracts of various tropical legumes extracted by absolute methanol, 50% methanol or water were added to *in vitro* fermentation takes to assay their effects on dry matter, cellulose and protein digestibilities. Tannin isolated from calliandra was also studied.

Materials and Methods

Preparation of Plant Extracts. A successive extraction procedure was used to obtain different plant extracts. The method was based on Wina (1988). A sample of fresh legume leaves (10 g dry matter) was blended for 2 minutes with absolute methanol to make a mixture containing 80% methanol at the end of extraction. The mixture was transferred to a plastic centrifuge tube and was centrifuged at 3000 rpm for 15 minutes. The supernatant was separated from the residue, evaporated by rotavapour and redissolved with 20 ml of water (**methanol extract**), whereas the residue was extracted with 50% methanol solution (the same volume as methanol) using a shaker for 30 minutes and was then centrifuged. The supernatant was separated from the residue, evaporated using rotavapour until dry, then redissolved with 20 ml of water (**50% methanol extract**). The residue was extracted with water (the same volume as methanol) using a shaker for 30 minutes and then centrifuged. The supernatant was removed and evaporated until dry and redissolved with 20 ml of water (**water extract**). These extracts were frozen for later use.

Isolation of Tannin from Calliandra Calothyrsus. The method used was based on Hagerman and Butler (1980) for purifying condensed tannin in sorghum.

Fresh calliandra leaves were blended with absolute methanol containing 10mM ascorbic acid. The extract was separated after centrifugation and was evaporated until the methanol disappeared. An equal volume aqueous 1 mM acetate buffer with a pH4 was added. The aqueous solution was extracted with ethyl acetate twice to get rid of the simple phenolic compounds. The aqueous solution was evaporated to a very small volume, then redissolved in 80% ethanol. The solution was mixed with 4 volumes of Sephadex LH-20 to form a slurry. It was washed repeatedly with absolute ethanol until the ethanol gave no color. Then, the ethanol was replaced with 50% acetone and washing was repeated several times. The 50% acetone solution was evaporated until all the acetone disappeared. The aqueous solution was extracted three times with phenol (1:1 v/v) to get remove the protein. The aqueous phase was redissolved in ethanol and applied onto a chromatography column containing Sephadex LH-20 (22.8 cm long, 1.7 cm diameter). The first eluent, ethanol, was used until all the colour had disappear. This was done to remove other phenolic compounds. The second eluent was 50% acetone which solubilized the tannin. The fraction was evaporated to remove the acetone and lyophilized. For the *in vitro* fermentation, the tannin isolate was dissolved in water for subsequent evaluation in bioassay.

In Vitro Fermentation: *Elephant grass as a substrate.* Half a gram of dried milled elephant grass was weighed into *in-vitro* tubes and 10 ml strained rumen liquor was added to each. McDougall's buffer (pH 6.9-7.0) was added to make up the volume to 50 ml. The methanol, 50% methanol or water extract was added separately into the tube (1.0 ml). The tube was then incubated for 48 hours in a shaking water bath at 39°C. In the second experiment, the tubes were incubated only 24 hours since the effect could be seen after 24 hours. The solution was filtered through sintered glass and the residue on the sintered glass was dried overnight at 105°C. After weighing the residue, its cellulose concentration was determined.

Casein as a Substrate. Half a gram of casein was weighed into and in-vitro tube and 10 ml strained rumen liquor was added. McDougall buffer was added to make up the volume to 50 ml. Methanol, 50% methanol and water extract was added (1.0 ml) separately into to each tube. The incubation was conducted as described above. At the end of the incubation, 20% trichloroacetic acid (16.6 ml) was added to precipitate undegraded protein. The tube was left in the cold room overnight and centrifuged at 3000 rpm for 15 minutes. The supernatant was separated and analyzed for ammonia concentration. The residue was transferred to a Kjeldahl tube using very little water and was analyses for nitrogen concentration.

Results and Discussion

Effect of Plant Extracts on In Vitro Digestibilities. The experiment evaluating the effect of absolute methanol, 50% methanol and water extracts from legume leave on *in vitro* fermentation was conducted twice. Tables 1 and 2 show the IVDMD of elephant grass and protein digestibility of casein after methanol, 50% methanol or water extracts of eight different tree legumes were added. The values in Table 1 were calculated after 48 hours incubation and the values in Table 2 after 24 hours.

TABLE 1. EFFECT OF ABSOLUTE METHANOL, 50% METHANOL AND WATER EXTRACTS FROM *ACACIA VILLOSA, CALLIANDRA CALOTHYRSUS* AND *LEUCAENA DIVERSIFOLIA* ON *IN VITRO* DRY MATTER DIGESTIBILITY OF ELEPHANT GRASS AND PROTEIN DIGESTIBILITY OF CASEIN

Legume extract	Dry matter digestibility			Protein digestibility		
	Effect of			Effect of		
	MeOH	50% MeOH	H_2O	MeOH	50% MeO	H_2O
	%			%		
Blank (48h incubation)	48.15	48.15	48.15	89.91	89.91	89.91
Acacia villosa	6.80	10.09	19.11 (2ml)	77.56	82.42	77.56
Calliandra calothyrsus	10.02	26.33	30.62 (1ml)	76.06	82.42	76.06
Leucaena diversifolia	20.42	12.37	31.92 (2ml)	83.11	79.80	83.11

Both tables show that all extracts reduced IVDMD and protein digestibility. The absolute methanol extract caused the more inhibition of IVDMD than 50% methanol or water extracts. However, the effect on protein digestibility caused by the additive of the absolute methanol extract was similar to those of the 50% methanol and water extracts. Inhibition by methanol or aqueous extracts from several plants has also been reported from plants such as *Lespedeza cuneata* (Smart et al., 1961), carob pods (Henis et al., 1964; Tagari et al., 1965), *Zizyphus nummularia* and *Quercus incana* (Kumar and Singh, 1984).

TABLE 2. EFFECT OF METHANOL, 50% METHANOL AND WATER EXTRACTS OF ALBIZZIA, FLEMINGIA, GLIRICIDIA, SAMANEA AND SESBANIA ON *IN VITRO* DRY MATTER DIGESTIBILITY OF ELEPHANT GRASS AND PROTEIN DIGESTIBILITY OF CASEIN

Legume extract	Dry matter digestibility			Protein digestibility		
	Effect of			Effect of		
	MeOH	50% MeOH	H_2O	MeOH	50% MeOH	H_2O
	%					
Blank (24h incubation)	34.50	34.50	34.50	82.56	82.56	82.56
Albizzia falcataria	22.64	26.00	25.00	78.74	75.05	78.74
Flemingia congesta	29.72	27.68	28.60	78.74	78.74	80.16
Gliricidia sepium	31.58	32.60	24.36	76.47	79.73	79.73
Samanea saman	20.64	17.96	27.18	75.48	78.74	79.73
Sesbania grandiflora	30.92	21.40	24.50	75.05	68.82	76.89

The extracts of *Acacia villosa* showed the biggest inhibition of IVDMD in Table 1. Strong inhibition was also shown by extracts of *Calliandra calothyrsus*. The extracts from *Samanea saman* showed the strongest inhibition in Table 2. Methanol extracts of these three legumes were therefore chosen for further study since methanol caused the highest reduction in IVDMD.

Effect of Methanol Extract on Degradation Rate. The degradation rate of elephant grass and of casein was followed by taking samples after various durations of incubation. The methanol extract of samanea was used to determine its effect on IVDMD and protein digestibility (Figure 1).

The reduction in IVDMD caused by the methanol extract started slowly and after 24 hours incubation the effect was evident. The IVDMD at 24 hours incubation without and with methanol extract was 35.1 and 20.2%, respectively. Therefore, we concluded that incubation for 24 hours in the *in vitro* tube was required to see a significant effect of plant extract on the dry matter digestibility. When elephant grass was replaced by casein as a protein substrate, the methanol extract also showed an inhibition of protein digestibility. This inhibition also could be seen after 24 hours incubation, although it was not as strong as the inhibition of dry matter digestibility. It seems that the methanol extract of several legumes causes more inhibition of cellulolytic activity than of proteolytic activity.

Effect of Methanol Extract on IVDMD. Tables 3 and 4 show the reduction in IVDMD as the volume of methanol extract of *Acacia villosa* and *Calliandra calothyrsus* was increased. Digestibility was measured by incubating elephant grass with rumen liquor or with pepsin-cellulase. For each 0.5 ml increase in extract, the reduction in IVDMD using rumen liquor was more than 50%, whereas using pepsin-cellulase the reduction in IVDMD was less than 40%. This indicates that methanol extracts of acacia and calliandra had more

effect on the rumen microorganisms than on the cellullose degrading enzyme. The extracts inhibited the activity of rumen microbes producing cellulase enzymes since the cellulose concentration in the residue after being fermented with rumen liquor for 48 hours increased with increasing volume of the methanol extract.

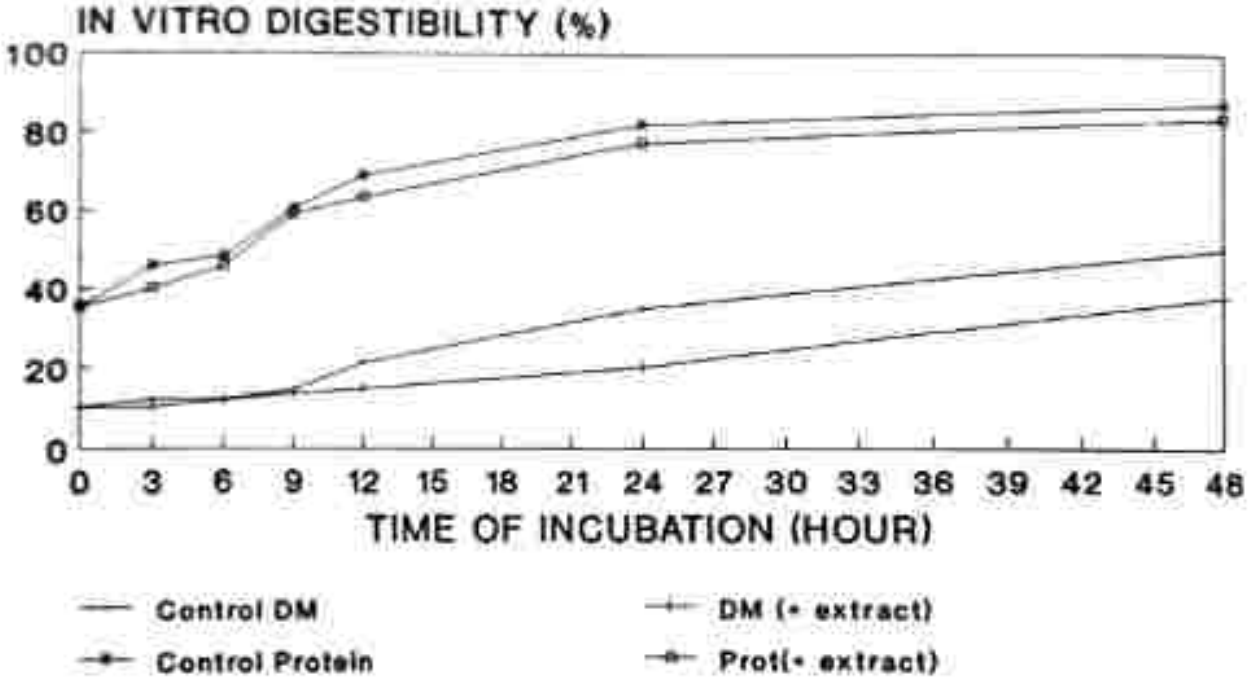

Figure 1. Effect of methanol extract of *Samanea saman* on the dry matter digestibility of elephant grass and protein digestibility of casein during *in vitro* fermentation

TABLE 3. EFFECT FROM THE VOLUME OF ABSOLUTE METHANOL EXTRACT OF *ACACIA VILLOSA* ON *IN VITRO* DRY MATTER DIGESTIBILITY OF ELEPHANT GRASS USING RUMEN LIQUOR AND PEPSIN-CELLULASE AND CELLULOSE CONCENTRATION IN THE RESIDUE

Methanol extract		Dry matter digestibility		Cellulose content in the residue	
volume	amount	rumen liquor	pepsin-cellulase	rumen liquor	pepsin-cellulase
(ml)	(mg/tube)	%			
0.1	0	48.15	38.60	27.48	40.75
0.5	1.03	12.45	19.40	40.49	42.34
1.0	2.06	6.80	16.20	44.01	48.15
1.5	3.09	3.12	8.10	46.00	52.49
2.0	4.12	1.00	-	49.18	-

TABLE 4. EFFECT FROM THE VOLUME OF ABSOLUTE METHANOL EXTRACT OF *CALLIANDRA CALOTHYRSUS* ON *IN VITRO* DRY MATTER DIGESTIBILITY OF ELEPHANT GRASS USING RUMEN LIQUOR AND PEPSIN-CELLULASE AND CELLULOSE CONCENTRATION IN THE RESIDUE

Methanol extract		Dry matter digestibility		Cellulose content in the residue	
volume	amount	rumen liquor	pepsin-cellulase	rumen liquor	pepsin-cellulase
(ml)	(mg/tube)	%			
0	0	48.15	38.60	27.48	40.75
0.5	2.80	20.49	24.42	39.08	41.49
1.0	5.60	10.02	16.63	42.87	42.15
1.5	8.40	4.52	9.81	46.28	44.00
2.0	11.20	2.29	-	48.12	-

Effect of Volume of Methanol Extract on in vitro Protein Digestibility. Adding the methanol extract of acacia and calliandra to the *in vitro* tube using casein as a protein substrate, resulted in a reduction of protein digestibility (Table 5 and 6). Even with increasing volume of extract, the reduction was not as drastic as for IVDMD, which shows that the effect of methanol extract on cellulolytic was more pronouced than on proteolytic rumen microbes. The end product of casein fermentation, which is ammonia, was analyzed in the supernatant. The ammonia concentration dropped drastically when 0.5 ml of methanol extract was introduced. However, when the volume of methanol extract was increased, the ammonia concentration started to increase slowly. This phenomenon cannot be explained since ammonia is very volatile. However, Tagari et al. (1965) reported that ammonia production remained unchanged even though the extract of carob pods in their study inhibited proteolytic activity and microbial synthesis.

TABLE 5. EFFECT OF VOLUME OF ABSOLUTE METHANOL EXTRACT OF *ACACIA VILLOSA* ON *IN VITRO* PROTEIN DIGESTIBILITY OF CASEIN AND AMMONIA PRODUCTION IN THE SUPERNATANT

Methanol extract		Protein digestibility rumen liquor	Ammonia in supernatant
volume	amount		
(ml)	(mg/tube)	(%)	(mg/100 ml)
0	0	89.91	15.30
0.5	1.03	79.43	4.90
1.0	2.06	77.56	7.00
1.5	3.09	75.31	7.40
2.0	4.12	71.20	12.20

TABLE 6. EFFECT OF VOLUME OF METHANOL EXTRACT OF *CALLIANDRA CALOTHYRSUS* ON *IN VITRO* PROTEIN DIGESTIBILITY OF CASEIN AND AMMONIA PRODUCTION IN THE SUPERNATANT

Methanol extract		Protein digestibility rumen liquor	Ammonia in supernatant
volume	amount		
(ml)	(mg/tube)	(%)	(mg/100 ml)
0	0	89.91	15.30
0.5	2.80	82.42	6.20
1.0	5.60	76.06	7.40
1.5	8.40	72.69	7.80
2.0	11.20	63.34	10.20

Tannin Concentration in Plant Extracts. In comparing the tannin concentration in all extracts from different legumes (Table 7), calliandra had the highest tannin level followed by *Leucaena diversifolia* and *Acacia villosa*. The big reduction in IVDMD caused by calliandra, leuacena or acacia might be related to the tannin level in the extract. The tannin fraction affects digestibility, however, in the present study, not all of the inhibition was related to tannin. In the case of acacia, the inhibition was stronger than that caused by calliandra. There must be other secondary compounds beside tannin which contributed to this stronger inhibition since the tannin concentration of acacia extract was not as high as that of calliandra. Non-protein amino acids have been detected in acacia (Wina et al., 1993b), and these compounds are not degraded by rumen microorganisms. Feeding fresh *Acacia villosa* to sheep as a sole diet was detrimental and caused liver damage (Tangendjaja, unpublished). Therefore, elucidation of these compounds is necessary, and technology to overcome this toxicity needs to be developed if acacia is to be established as an alternative legume to leucaena.

TABLE 7. TANNIN CONCENTRATION OF ABSOLUTE METHANOL, 50% METHANOL AND WATER EXTRACTS

Legume extracted	Tannin concentration		
	MeOH	50% MeOH	H_2O
	(mg/ml)		
Acacia villosa	2.06	1.30	0.35
Calliandra calothyrsus	5.6	4.2	1.35
Leucaena diversifolia	2.30	2.20	1.30
Albizzia falcataria	0	0.26	0.07
Flemingia congesta	0.50	0.58	0.17
Gliricidia sepium	0.17	0.11	0.05
Samanea saman	0.11	0.14	0.04
Sesbania grandiflora	0.27	0.07	0.04

In the case of *Samanea saman*, the inhibitory factors in the methanol extract may not be tannins as it contains only small amounts. However, to prove that tannin fraction really has an important role in reducing digestibility, the crude tannins from calliandra were isolated using gel chromatography.

Effect of Tannin Isolate on IVDMD. Increased volumes of tannin solution was added to the *in vitro* tube containing elephant grass as a substrate (Table 8). The three concentrations were equivalent to tannin quantities of 0.172, 0.344 and 0.516 mg in the tubes. With increasing tannin in the tube, IVDMD was reduced. The effect on IVDMD measured by rumen liquor was greater than those measured by pepsin-cellulase. This indicates that tannin affected rumen microorganisms more than cellulose degrading enzymes. The inhibition to rumen microorganisms, specifically cellulolytic bacteria has also been shown by tannin fractions isolated from carob pods (Henis et al., 1964). These workers claimed that tannins may affect bacteria by absorption to their surfaces or by affecting the cell membrane or cytoplasmic membrane. Tannins, therefore, can be a bacteriostat or a bactericide. The interference with the action of digestive enzymes was expected in view of the general protein binding properties of tannin. This was also reported by Windham et al. (1990) who found that a lower cellulose digestibility was due to the effects of tannin fraction from Sericea (*Lespedeza cuneata*) on ruminal cellulase enzyme.

TABLE 8. EFFECT PF CRUDE TANNIN ISOLATE FROM *CALLIANDRA CALOTHYRSUS* ON *IN VITRO* DRY MATTER DIGESTIBILITY OF ELEPHANT GRASS USING RUMEN LIQUOR AND PEPSIN-CELLULASE AND CELLULOSE CONCENTRATION IN THE RESIDUE

Isolated tannin		Dry matter digestibility		Cellulose content in the residue	
volume	amount	rumen liquor	pepsin-cellulase	rumen liquor	pepsin-cellulase
(ml)	(mg/tube)	%			
0	0	48.15	38.60	27.48	40.75
0.5	0.172	28.75	36.38	28.59	42.84
1.0	0.344	26.65	35.75	29.15	44.75
1.5	0.516	14.29	33.48	30.29	48.90

Although a similar effect was shown for both the methanol extract and the crude tannin from calliandra, it was difficult to conclude whether tannin was the only compound in the methanol extract that was responsible for the inhibition. The IVDMD values from the pepsin-cellulase assay of the methanol extract and crude tannin (Table 4), show that the methanol extract caused a stronger inhibition to cellulase enzymes than the crude tannin. Comparing the cellulose concentration in the residue after rumen fermentation (Tables 4 and 8) shows that a stronger inhibition resulted from increasing volume of the methanol extract as higher cellulose concentration occurred in the residue, whereas only a very small increase was rated by increasing the volume of crude tannin. Note that the concentration of tannin measured in the methanol extract and tannin solutions added to the *in vitro* fermentation were very different (5.6 mg vs 0.344 mg/ml, respectively). From these results, it is difficult to say that tannin is the only compound in the methanol extract that is responsible for the inhibition to digestibility. There are many secondary compounds in the methanol extract of tree legumes that may also influence rumen function. Bearing in mind the toxicity, some animals can also tolerate plant toxins by developing specific microorganism to destroy certain toxicants such as mimosine in leucaena (Tangendjaja, 1983).

In conclusion, the methanol extract of all legumes tested in this experiment showed the strongest inhibition of IVDMD of elephant grass compared to a 50% methanol or a water extract. The effect on IVDMD was more pronounced than on protein digestibility. Tannin can be a major inhibitory factor for microorganisms in the rumen. However, some other secondary components may also affect rumen function. Therefore, further studies are necessary to elucidate the secondary compounds in tree legumes and to find out ways to overcome them.

Acknowledgement

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COUMARIN IN *GLIRICIDIA SEPIUM*: THE EFFECT OF DRYING, ITS *IN VITRO* DEGRADATION AND ITS EFFECT ON *IN VITRO* DIGESTIBILITY

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ABSTRACT

The effect of drying on coumarin concentration was studied on *Gliricidia sepium* leaves. The influence of coumarin on the digestibility of grass and its degradation during incubation were also studied *in vitro*. Coumarin was analyzed by high performance liquid chromatography. Fresh leaves of gliricidia contain up to 7000 ppm of coumarin; this is decreased by drying. Sun drying reduced almost 70% of coumarin concentration. Coumarin was degraded by rumen microorganisms and totally disappeared after 48 hours of *in vitro* incubation. The digestibility of elephant grass was reduced when 300 mg coumarin was added to 100 ml of rumen liquor. Methanol extract from gliricidia caused a reduction in digestibility and this is partly attributed to coumarin. From this experiment, it is suggested that coumarin in gliricidia can be metabolized by rumen liquor. At high levels coumarin reduces digestibility but other substances may also contribute to this reduction.

Introduction

Gliricidia sepium is a perennial leguminous tree which has its origin in South America and is widely grown in Indonesia. It has versatile usages such as firewood, shade, living fence, green manure etc. Several feeding trials with gliricidia have shown that gliricidia supplements do not cause any negative effect but actually increase body weight gains of sheep (Rangkuti et al., 1984; Chadhokar, 1982; Wina and Syahgiar, 1991). The average daily gain of sheep fed with gliricidia as a supplement was similar to those fed other legumes such as leucaena and calliandra (Wina, 1992). It is now recommended that Indonesian villagers feed their livestock with gliricidia as a supplement. But the adaption is quite slow as some farmers say that their livestock refuse to eat gliricidia. Others say that their livestock consume wilted gliricidia but refuse to eat fresh gliricidia as the fresh leaves produce a strong odour. One of the compounds that causes the strong odour in gliricidia is coumarin. Coumarin is a secondary compound, and its role in gliricidia is still not known. Similar compounds have been reported in sweet clover (*Melilotus alba*), and when sweet clover spoiles, coumarin is changed to dicoumarol which is very toxic to animals and can cause

haemorrhages (Alstad et al., 1985). This problem has never been reported for animals that consume gliricidia.

The objective of the work described in this paper was to determine the coumarin concentration in *Gliricidia sepium*. Because coumarin is volatile, the drying effect on coumarin level in the gliricidia leaves was also observed as were the degradation in rumen and its effect to digestibility.

Materials and Methods

Materials. *Gliricidia sepium* was grown at Ciawi, West Java, Indonesia located at 500 m above sea level and with an annual rainfall of 4200 mm. The samples were taken from the first through the sixth leaf of each branch counted from the top. The leaflets were separated from the stem and rachis.

Methods of Drying. Fresh gliricidia leaves were divided into 2 groups. One group was put in a steamer for 5 minutes and the other was not. Both groups were then treated as followed:

- no treatment (control)
- freeze dried
- wilted under shade for 24 hours
- oven dried at 50°C for 24 hours
- sun dried for 6 hours

The moisture content of each treatment was determined from samples of the leaves.

Chemical Analysis. The coumarin in chopped leaves (1 g DM) was extracted by methanol (the concentration of methanol depending on the moisture content of sample) to make a volume of 24 ml. The mixture was blended using a sorval mixer for 2 minutes, then centrifuged. The supernatant was filtered through a Milipore 0.45 um filter. The clear solution was analysed by HPLC as follows:

> A Waters Ass HPLC machine (model 45) with UV detector and a recorder (Pharmacia Two-channel recorder REC-2) equipped with a Reverse Phase (RP) column, Alltech Sperisorb ODS 25um, 25 cm x 4.6 mm ID was used. An isocratic system using a mixture of methanol: 2% acetic acid solution (50:50 v/v) with a flow rate 1 ml/min was applied. The detection was at 280 nm and flow chart speed at 2 mm/min.

In vitro* Fermentation: Using Tilley and Terry Method.** ***Coumarin degradation in in-vitro fermentation. Three *in vitro* tubes containing 0.5 g milled elephant grass were prepared. The strained rumen liquor from sheep fed with

elephant grass was added, 10 ml per tube. Coumarin in buffer solution (0.6 mg/ml) was added so that the coumarin content in the tube was 12 mg. McDougall's buffer was added to make the volume up to 50 ml. The tubes were incubated for 48h in a shaking water bath at 39°C. After 3, 6, 9, 12, 24 and 48 hours incubation, 1 ml solution was taken from the *in vitro* tube. Before replacing the rubber stopper after taking each sample, CO_2 gas was blown into the tube. The sample solution was filtered through a 0.45um milipore filter and coumarin analysed by HPLC.

Preparation of Methanol Extract. Fresh gliricidia leaves (100g) were extracted with 500 ml methanol. The extract was concentrated to dryness by rotary evaporator, then redissolved with distilled water (100 ml). The extract in water was then ready to be used in the *in vitro* fermentation. This extract was analysed for its coumarin content by HPLC. The residue, after methanol extraction, was freeze-dried and used as a substrate in the *in vitro* fermentation.

The Fermentation. Gliricidia residue (0.5 g) was weighed into the *in vitro* tube. Strained rumen liquor from sheep fed with elephant grass was added into the tube (10 ml). The volume was made up to 50 ml by adding McDougall's buffer solution taking into account the volume of gliricidia extract added to each tube (2.5, 5.0, 7.5 and 10 ml). Standard coumarin in buffer solution (0.6 mg/ml) was added into each tube so that the coumarin level in the tube was 3, 6, 9, or 12 mg. The tubes were incubated for 48h in a shaking water bath at 39°C. The residue after fermentation was filtered through sintered glass and weighed after drying overnight at 105°C.

Another set of fermentations using dried milled elephant grass as a substrate was conducted. Different levels of coumarin (15, 20, 25 and 30 mg) were added into separate tubes. The tubes were then incubated in a shaking water bath at 39°C for 48h.

Results and Discussion

Coumarin Analysis by HPLC. When the methanol extract of gliricidia was injected into HPLC, 3 major peaks were detected at the 280 nm wavelength (Figure 1). Coumarin was one of the major phenolic components as it was identified as the last major peak. The first two peaks were unidentified. They must be more polar than coumarin as they came out earlier. Based on the retention time, the first peak was similar to p-OH benzoic acid and the second peak was similar to salicylic acid. However, the maximum absorption of these two peaks was different from that of p-OH benzoic acid and salicylic acid. Further clarification is necessary to identify the two substances.

Analyzing the leaves of different provenances of gliricidia, gave coumarin levels of less than 500 ppm to more than 2%. Coumarin level in the local *Gliricidia sepium* was almost 3000 ppm. Coumarin level may also be affected by age, season and location. This needs to be studied further.

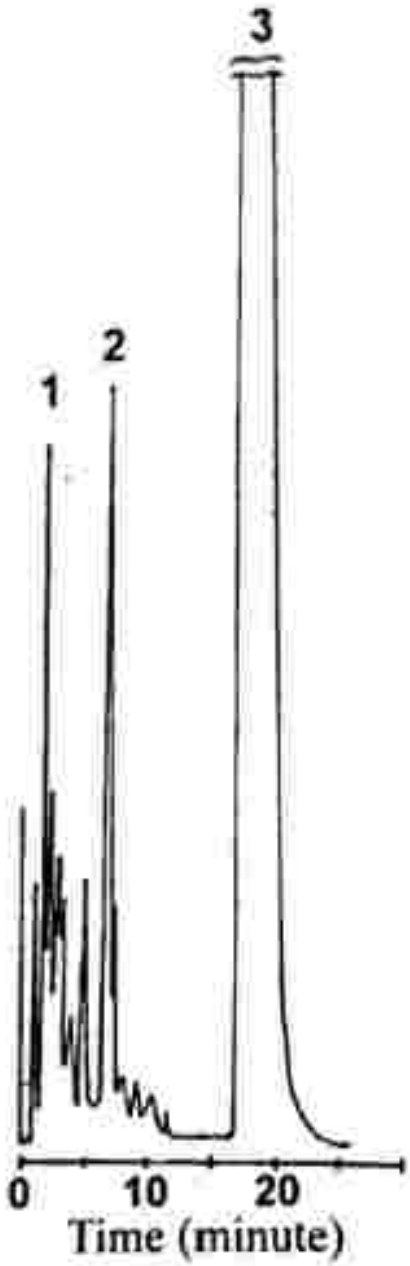

Figure 1. A chromatogram of phenolic compounds in *Gliricidia sepium* leaves

Effect of Drying on Coumarin Level. The drying effect on coumarin level in gliricidia leaves is shown in Table 1. Steaming was carried out before drying to inactivate the oxidative enzymes or peroxidases in the leaves. Steaming caused hardly any change in moisture concentration but it reduced coumarin levels to about 40%. Freeze drying slightly lowered the coumarin concentration. All other processes reduced the coumarin concentration, and sun drying drastically reduced the coumarin level to only one-third of the fresh sample.

TABLE 1. COUMARIN LEVEL IN GLIRICIDIA LEAVES AFTER DRYING

Treatment	Moisture level (%)		Coumarin level	
	Without steam	With steam	Without steam	With steam
	%		ppm	
Fresh	80.14	80.21	7468	1960
Freeze dried	8.26	12.08	7225	1748
Wilted for 24 h	29.32	30.41	6229	1386
Oven dried 50°C	0.60	0.64	4757	1272
Sun dried for 6h	16.17	20.36	2635	1161

This is in agreement with the report that coumarin is a volatile component. Sutikno (unpublished) using gas chromatography followed by identification by Mass spectra found that 95% of the volatile compounds in *Gliricidia sepium* was coumarin.

Degradation of Coumarin in In Vitro Fermentation. When coumarin itself was incubated for 48 h in *in vitro* fermentation, it was degraded completely (Figure 2). For the first 12 h incubation, the degradation was quite slow and only 30% of coumarin was lost. By 24 h the degradation was 50% and at the end of fermentation coumarin disappeared completely. The products of degradation of coumarin could not be detected by UV detector in HPLC as the ring structure of coumarin was possibly opened to become small molecules which could be utilized by microorganisms in the rumen.

The *in vitro* fermentation process was much slower than *in vivo* fermentation which means that in the sheep's rumen, coumarin can be degraded rapidly to become small molecules which cause no ill-effects. It has been reported that if coumarin is metabolised to o-hydroxy phenyl acetate in rats, it becomes a potent inhibitor of glucose 6-phosphate (Hall, 1973). The possibility of coumarin becoming its dimer "dicoumarol" is higher when fungal growth occurs in sweet clover during storage. In temperate countries, sweet clover is

harvested in the form of hay and made into bales for winter feed. Fungal growth is likely. These fungi change coumarin into dicoumarol and cause haemorrhages in animals which consume it regularly. In gliricidia the occurence of dicoumarol has not been reported. This may be due to gliricidia being fed fresh or wilted for only a few hours so that molding does not occur.

Effect of Coumarin on IVDMD. As coumarin was the major compound in the methanol extract of gliricidia, we closely looked at the effect of the methanol extract and coumarin in the *in vitro* fermentation analysis (Figure 3). The volume of the methanol extract added into the *in vitro* tube was 2.5, 5, 7.5 and 10 ml and the amount of coumarin added was equivalent to the amount of coumarin identified in the methanol extract, namely 2.98, 5.97, 8.93 and 11.93 mg. We found that there was an inhibition caused by the addition of the methanol extract. When the concentration of the methanol extract was doubled, the inhibition was 50% and when the concentration was quadrupled the inhibition reached 83%. The inhibition was only 10% when the concentration of coumarin was increased to 4 times. This indicates that the inhibition caused by coumarin was not as marked as that caused by methanol extract. In other words coumarin was not the only compound in the methanol extract that caused the inhibition and there must also be other compounds responsible for reducing digestibility.

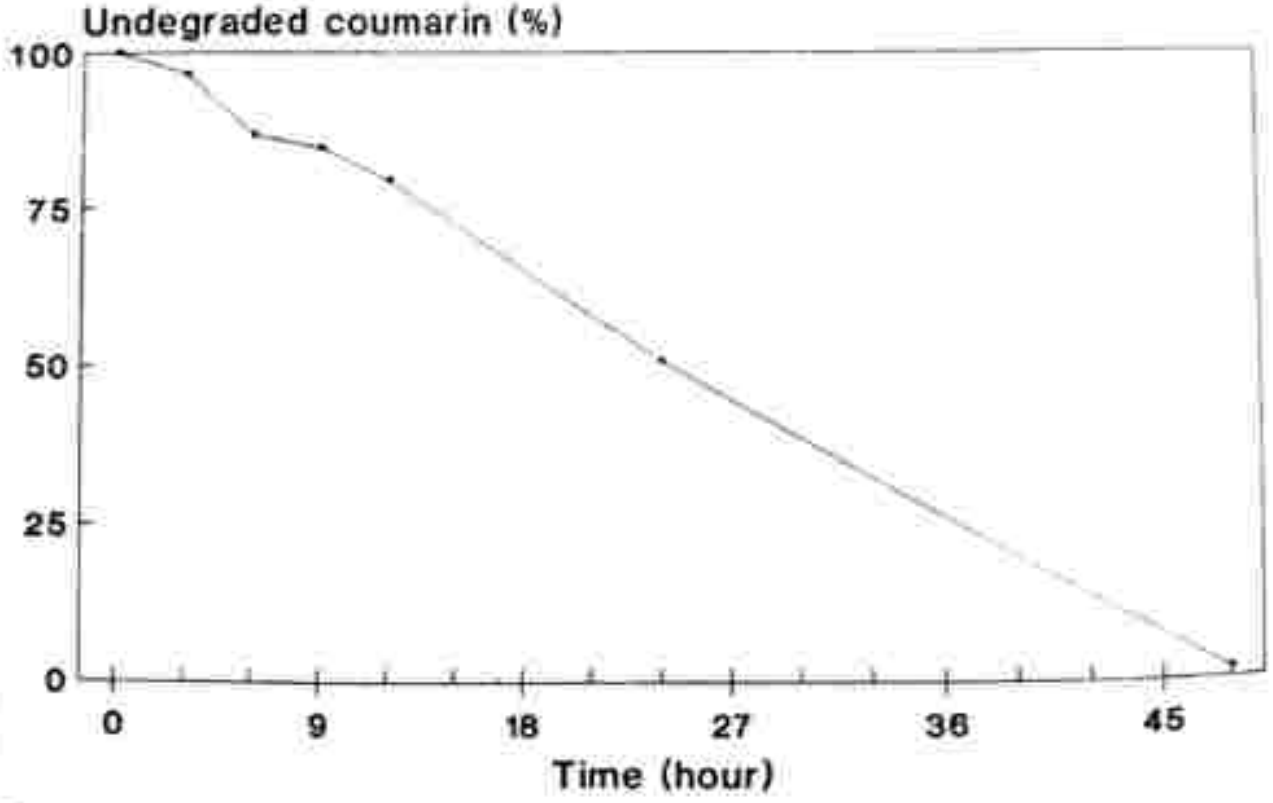

Figure 2. Coumarin degradation in *in vitro* fermentation

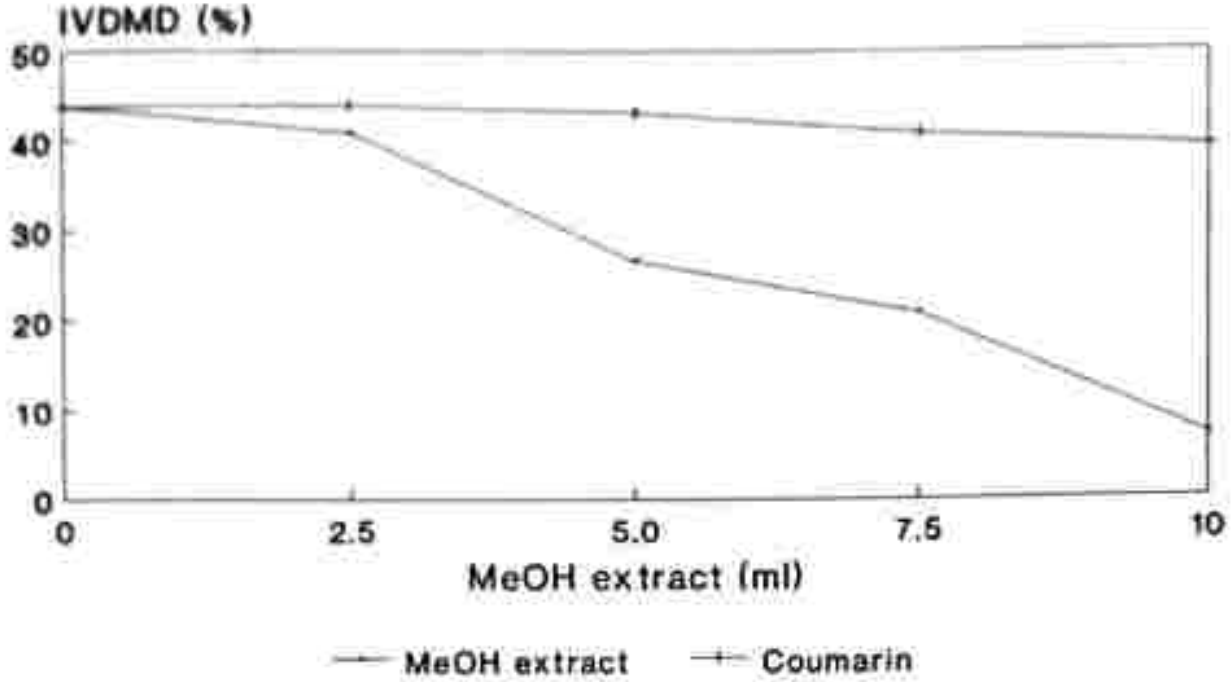

Figure 3. Effect of the methanol extract from gliricidia and coumarin on IVDMD of gliricidia residue after methanol extraction

Besides coumarin, gliricidia also contains flavonol glycosides, in this case kaemferol diglycoside (Lowry, personal communication). This compound can easily be extracted by hot water and the level can be up to 2% of the dry matter of leaves. However, the presence of pure kaemferol diglycoside in the *in vitro* fermentation up to 2% did not show any negative effect on the dry matter digestibility of elephant grass (Wina, unpublished). Therefore, further work needs to be done to identify the other component in the methanol extract of gliricidia which contributes inhibition of dry matter digestibility.

When coumarin level was increased from 15 to 30 mg in the *in vitro* tube, the dry matter digestibility of elephant grass was reduced by 53.68% (Figure 4). Thirty miligrams of coumarin in ten mililitres of rumen liquor in the *in vitro* tube was equivalent to 1.5% of coumarin in the leaves (g/100 g dry matter). Therefore, gliricidia has to be fed as a sole diet if the coumarin level is to be more than 1.5%, a level which would cause a significant effect on sheep. Feeding local gliricidia which contains only 0.3% of coumarin, will not affect rumen microorganism activity to any degree. From the small farmer stand point, when tree legumes are used as supplements at levels of 30-40% in the ration, or in mixed feed in a cut-and-carry system, it is unlikely that coumarin in gliricidia will cause a problem.

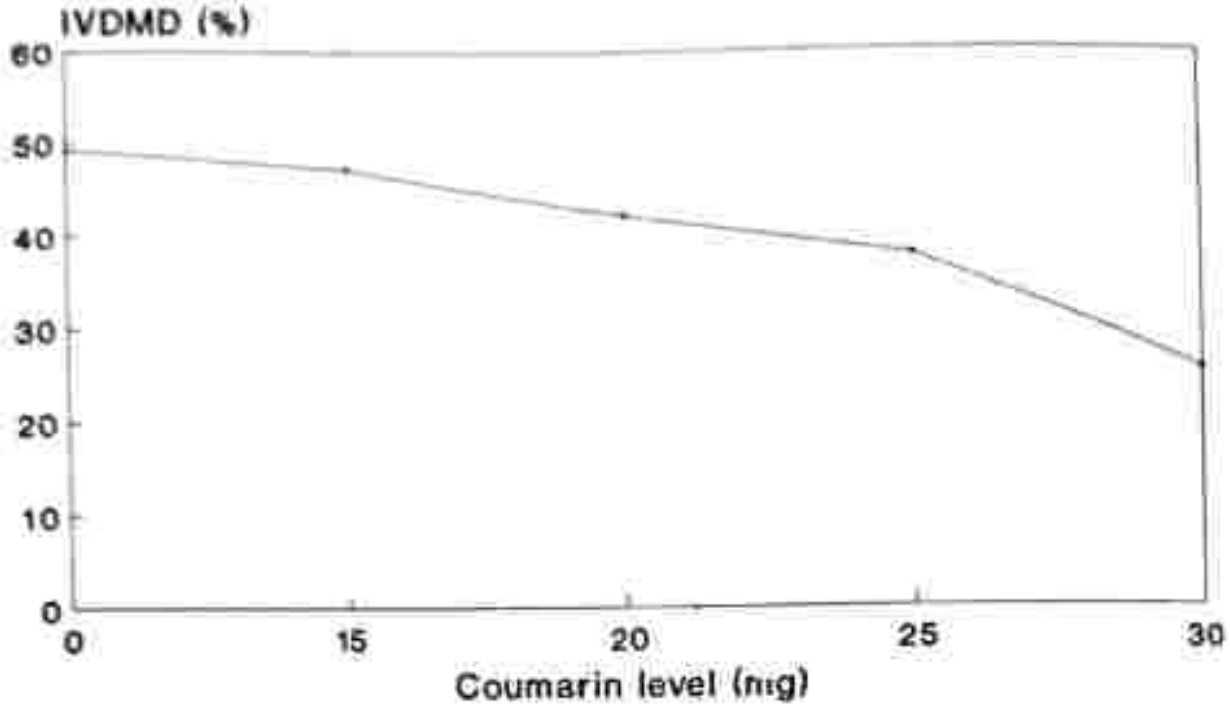

Figure 4. Effect of coumarin on *in vitro* dry matter digestibility of elephant grass

In conclusion, coumarin in *Gliricidia sepium* leaves is easily evaporated by drying. It can be degraded in rumen liquor and its effect on the dry matter digestibility of elephant grass is significant only when the concentration of coumarin is very high (1.5%). Further study is warranted to elucidate the other possible toxic substances in gliricidia.

Acknowledgement

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PROTECTED FAT: PREPARATION AND DIGESTIBILITY

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ABSTRACT

Providing energy to ruminants in the form of protected fat is thought to be better than unprotected fat since unprotected fat adversely affects rumen function. In this experiment, the technology of making protected fat was developed. Three different vegetable oils (coconut, palm and rice bran oils) were reacted with calcium to make soap. The best product was made from rice bran oil with calcium. Calcium chloride is a better source of calcium than calcium oxide. The product was incubated in a buffalo rumen for 48 hours and the degradation was 49.2% with 66.3% fat left in the residue. In the *in vitro* test, 10% unprotected fat in an elephant grass sample reduced the dry matter digestibility by 45.2% whereas with protected fat the reduction was only 15.4%. The maximum supplementation of protected fat was 10-11% from the *in vitro* study. The *in vivo* study showed that tha intakes of dry matter, organic matter and energy were higher with 10% protected fat in the diet than those with unprotected fat. So were the digestibilities of dry matter, organic matter and protein. The intakes and digestibilities of ADF, NDF and Calcium were not significantly different between the protected and unprotected fat. Concentrations of ammonia and volatile fatty acids in the rumen were also not significantly different between those two. In conclusion, protected fat can be produced from rice bran oil and this product showed higher digestibility than the unprotected fat.

Introduction

Several atternpts have been made to develop a feeding strategy for ruminants in the tropics, including feeding grain or molasses. Developing a feeding system based on a high energy diet sometimes becomes a necessity for the animal at a certain physiological stages such as lactation.

There is growing interest in feeding ruminants with fat as the energy density of fat is extremely high. In Indonesia, oil or fat production has increased significantly in the last few years due to the increase in area of oil palm plantation. Current palm oil production is estimated to be 400,000 mt/year and is expected to increase steadily in the next five years due to extensive plantation. Indonesia also produces a large quantity of rice bran. This product

contains considerable amounts of oil (approx 15%). Extracting oil from rice bran is an important industry in other rice producing countries such as Korea, Japan, Taiwan, whereas in Indonesia this industry has only recently been started.

Feeding fat or oil to animals especially poultry and pigs could become popular in the tropics due to its high energy density and low heat increment. However, feeding fat to ruminants is currently limited to developed countries. It has been reported, however, that feeding pure fat would impair fiber digestion, and probably there would be toxic effects of long chain fatty acids on ruminal bacteria which would depress appetite (Jenkins & Palmquist, 1984). Protecting the fat or fatty acids is an alternative way of feeding fat to ruminants. Two methods of protecting fat have been reported (Sutton et al., 1983; Jenkins and Palmquist, 1984). The most recent one is protecting fat in the form of calcium soap so that it cannot be degraded in the rumen but is degraded in the abomasum. Feeding this protected fat to dairy cows during low food intake could maintain the nutrient supply and produce more milk and milk solids.

The purpose of this experiment was to develop a technology of making protected fat from three different oils that are available in Indonesia, and to observe the effects of supplementation with protected fat on the digestibility of sheep diets.

Materials and Methods

Materials. Coconut oil which is usually used as cooking oil and crude palm oil were obtained from the local market. Crude rice bran oil was obtained from an oil-extraction plant. Calcium chloride, calcium oxide and sodium hydroxide were technical grade.

For *in sacco* evaluation, two fistulated buffaloes were used, and their rumen liquor was used for *in vitro* evaluation. For *in vivo* evaluation, eight Java Thin-tail sheep were used in metabolism cages.

Experiment I (Preparation of Protected Fat). Fifty grams of coconut, palm and rice bran oils were weighed separately into 2 l glass beakers and 10% sodium hydroxide solution was added (see Table 1). The mixtures were heated on the hot plate (90°C) and stirred until a precipitate of sodium soap was formed. The time required was between 4 to 10 minutes. Then calcium oxide which had been dissolved in HCl solution (1:1) was added to the beaker (see also Table 1). Again, the solution was heated and stirred for 5 minutes until calcium soap formed. This soap appeared at the bottom, although some floated on the top. The soap and the solution were transferred into centrifuge tubes and were centrifuged at 2500 rpm for 10 minutes. The supernatant was discarded and the

soap in the top layer and precipitate were transferred by spoon into a crucible and dried in the oven overnight at 105°C.

TABLE 1. THE AMOUNT OF SODIUM HYDROXIDE SOLUTION AND CALCIUM OXIDE AND HCl (1:1) USED IN MAKING CALCIUM SOAP WITH DIFFERENT OILS

Oils	10% NaoH (ml)	CaO (g)	HCl (1:1) (ml)
Coconut	1260	24.80	110
Palm	100	11.23	55
Rice bran	75	4.7	22

Experiment II. Calcium soap was made from rice bran oil using the same volume of sodium hydroxide solution as in experiment I (Table 1) and varying amounts of calcium chloride (18.8; 23.4; 28.1; 32.8 and 37.5 g) in water (20; 24; 27; 30 and 33 ml, respectively). The yield was weighed after drying in the oven. A low content of free fatty acids in the product is desirable. Therefore, free fatty acids in the product were checked by thin-layer chromatography. Half a gram of calcium soap was dissolved in 10 ml hexane in a 40 ml glass beaker. The solution was filtered using filter paper to get a clear solution. Then 25 μl of the clear solution was spotted on a Silica gel F_{254} plate (aluminum sheet, thickness 0.2 mm , 10 x 20 cm). The eluent was a mixture of petroleum spirit: diethylether: acetic acid (90:10:1). After elution, the plate was sprayed with sulfuric acid solution (1:1) and dried in the oven at 105°C for 10 minutes. Free fatty acids appeared as brown spots.

Experiment III (Preparation of Protected Fat on a Large Scale). Four kilograms of rice bran oil was placed in a big pile (layered by email). Six liters of 10% sodium hydroxide solution was added. The mixture was heated for 10 minutes with stirring, until sodium soap formed. Calcium chloride solution (1498.4 g in 1798 ml water) was added to the mixture which was then heated with stirring until a precipitate of calcium soap formed. The soap was transferred to a tray layered with aluminum foil and was heated overnight at 105°C. After drying, the calcium soap was ground using a Wiley mill without a screen. The soap was mixed with zeolite as a filler then was ground again with the Wiley mill, through a screen. This product (protected fat) is in powder form, and was used in the *in vitro* and *in sacco* experiments, and in the feed block for the *in vivo* experiment.

Experiment IV (In Sacco Test of Protected Fat). Twenty-seven nylon bags containing protected fat (5 g each) were placed into the rumen of a fistulated

buffalo fed rice straw and 3 kg of concentrate daily. After 0, 3, 6, 9, 12, 18, 24, 36 and 48 hours of incubation, three nylon bags were taken out from the rumen and washed under tap water for 1 minute. The bags then were dried in the oven at 60°C for 48 hours. The residues were weighed and dry matter digestibility was calculated. The fat content of the residue was determined as follows: 2 g of the residue was placed in a 40 ml glass beaker and 10 ml water was added. The beaker was heated with stirring for 5 minutes (till boiling). Then, while hot, 6 ml of HCl solution (1:1) was added and stirred for 10 minutes. The oil was floating above the aqueous phase. Petroleum spirit was added, and the oil dissolved in petroleum spirit formed the upper layer. This layer was transferred to a 50 ml test tube. Again, petroleum spirit was added several times (total volume of petroleum spirit was 10 ml). The top layer was removed and mixed with the previous petroleum spirit. The test tube containing the solution in petroleum spirit was placed in a water bath to evaporate the petroleum spirit. The fat residue was dried in the oven at 105°C for 24 hours. The fat content of the residue from *in sacco* test could then be calculated.

Experiment V (In vitro Test of Mixture of Protected Fat and Elephant Grass). One gram of a mixture of protected fat and elephant grass was placed in a 125 ml test tube. A mixture of rumen liquor and McDougall's buffer Ph 6.9 (1:4 v/v) (40ml) was added to it. The tube was incubated in a water bath at 39°C for 48 hours. After incubation, the residue was filtered through a sintered glass disc and dried in the oven at 105°C for 24 hours. The residue on the sintered glass was weighed and the dry matter digestibility calculated. The filtrate was kept in the freezer until analyzed for ammonia and total volatile fatty acid contents. The residue in the sintered glass was then dipped in HCl solution (Ph 2.6) at 39°C for 2 hours. The sintered glass was washed with 40 ml warm water and put in the oven at 105°C for 24 hours and weighed afterwards. The dry matter digestibility after rumen and HCl incubation could be calculated. Ammonia in the filtrate was determined by the Conway-diffusion method and total volatile fatty acids by distillation.

Experiment VI (In vivo Test of Protected Fat in Feed Blocks). Feed blocks containing protected and unprotected fat were made from ingredients as shown in Table 2. All the ingredients except the molasses were mixed thoroughly. Molasses was heated to make it less viscous, then 200g was added to 800g of the dry mixture and mixed thoroughly. The mixture was pressed to form a block.

TABLE 2. FEED COMPOSITION OF FEED BLOCKS CONTAINING PROTECTED AND UNPROTECTED FAT

Ingredient	Control (C)	Protected Fat (PF)
Rice bran	41.00	0.00
Wheat pollard	0.00	31.21
Leucaena leaf meal	16.50	18.12
Molasses	20.00	20.00
Soybean meal	5.27	5.66
Protected Fat (from rice bran oil)	0.00	10.00
Dried elephant grass	15.00	15.00
Calcium Carbonate	2.23	0.00
Urea + salt + MgO	3.00	3.00
Chemical composition		
Moisture	12.30	11.10
Protein	16.30	14.80
Fat	7.90	12.10
NDF	35.30	31.0
ADF	19.0	17.20
Ca	1.90	1.30

Eight Javanese thin-tail sheep (average body weight 25 kg) were placed in metabolism cages. For 14 days adaptation four sheep were fed with feed blocks containing protected fat and the rest fed with feed blocks containing unprotected fat as control. The feed blocks and water were offered *ad libitum*. The collection period was from day 15 to day 21. During that period, refusals and faeces were collected in big plastic bags. At the end of the collection period, these food residues and faeces were weighed and sampled for dry matter content. The rumen liquor was collected at the end of experiment and analyzed for its ammonia and volatile fatty acid contents. Ammonia was analyzed by the Conway-diffusion method and volatile fatty acids by gas chromatography. Body weight was recorded before and after the collection period. Organic matter, protein, fat, calcium, NDF and ADF were analyzed from feed, refusals and faeces.

Results and Discussion

Technology of Making Protected Fat. Protected fat was produced from oil or fat in the form of calcium soaps. The oil was reacted to produce sodium

soap which was then transformed to calcium soap. Table 3 shows that the amount of sodium hydroxide added to oil varied according to oil type. Coconut oil required a much larger amount of sodium hydroxide. Calcium oxide cannot be used directly to make calcium soap since it is not soluble in water. Therefore it was dissolved in hydrochloric acid solution (5 times). From Table 3, it can be seen that the crude palm oil produced the lowest yield of protected fat. However, this product was actually not calcium soap but a precipitate of calcium. Similarly coconut oil which had the highest yield produced not calcium soap but rather sodium soap. Sodium soap was slippery whereas calcium soap was a white precipitate. The true product of calcium soap was obtained only from rice bran oil, which produced 61 g of product from 50 g of oil. The successful reaction between calcium with rice bran oil seems to be related to the free fatty acid content in the oil. For calcium reaction, triglyceride has to be hydrolysed to free fatty acids (FFA). In rice bran oil, the FFA content was almost 70%. Coconut or palm oils contain mostly triglycerides and relatively small amounts of free fatty acids. Therefore, rice bran oil was chosen to make calcium soap.

TABLE 3. YIELD OF PROTECTED FAT
FROM DIFFERENT TYPES OF VEGETABLE OIL

Oil	Chemicals Used				Yield of Product
	oil (g)	10% NaOH (ml)	CaO (g)	HCl (1:1) (ml)	(g)
Coconut oil	50	1260	24.8	110	231
Crude Palm oil	50	100	11.2	55	10
Rice bran oil	50	75	4.7	22	61

Although it is possible to make calcium soap using calcium oxide after dissolving in hydrochloric acid solution (1:1), the use of calcium chloride is much easier since it easily dissolves in water. Also the yield of Ca soap from rice bran oil using calcium oxide was lower than that using calcium chloride (61 vs 68 g); therefore calcium chloride was chosen for making calcium soap. The optimum level of calcium chloride in making calcium soap was checked by reacting different amounts of calcium chloride with the same amount of rice bran oil.

TABLE 4. YIELD OF PROTECTED FAT FROM RICE BRAN OIL AND DIFFERENT AMOUNTS OF $CaCl_2$

No.	$CaCl_2$ added (g)	H_2O (ml)	Yield of Product (g)
0	18.75	20	68.1
1	23.41	24	68.2
2	28.09	27	69.1
3	32.78	30	69.0
4	37.46	33	70.5

Table 4 shows the yield of calcium soap produced using different amounts of calcium chloride. When calcium chloride increased from 18.75 g to 37.46 g, the yield of calcium soap increased only very little which indicates that there is no further reaction with the fatty acids in rice bran.

The quality of the product was checked by thin layer chromatography. By this system (Figure 1), the amount of free fatty acid left in the product could be qualitatively determined by the appearance of the brown spot. It shows that compared with the control, very few free fatty acids were left in the product.

However, when 37.46 g of calcium chloride was used in the reaction, the spot became wider which showed that more free fatty acids were left in the product. So, the maximum production of free fatty acids was seen when 32.78g calcium chloride used with 50 g of rice bran oil. Since the yield of Ca soap was very little different using 18.75g or 32.78 g of calcium chloride, it was decided to use only 18.75 g of calcium chloride for 50 g of rice bran oil.

Degradability of Protected Fat in the Rumen. For the *in vitro*, *in sacco* and *in vivo* tests, the protected fat was mixed with zeolite in the proportion of 9:1. Zeolite was used as a free flowing agent so that the product was in the form of dried powder.

The degradability of protected fat during incubation in the rumen is presented in Figure 2. Protected fat was degraded quickly in the first three hours of incubation. Then, the degradation continued slowly until 49% of the product had disappeared after 48h incubation in the rumen. This indicates that protected fat in the form of calcium soap is still degraded to certain degree in the rumen. The fat content in the residue after incubation ranged from 56 to 69.9%, whereas the fat content in the calcium soap itself was 70%. Thus the fat content before and after incubation were almost the same, which means that both calcium and fatty acids were removed from the nylon bag at the same time.

Figure 1. TLC of free fatty acids left in the Ca soaps using different levels of calcium chloride (0,1,2,3,4) and rice bran oil (C).

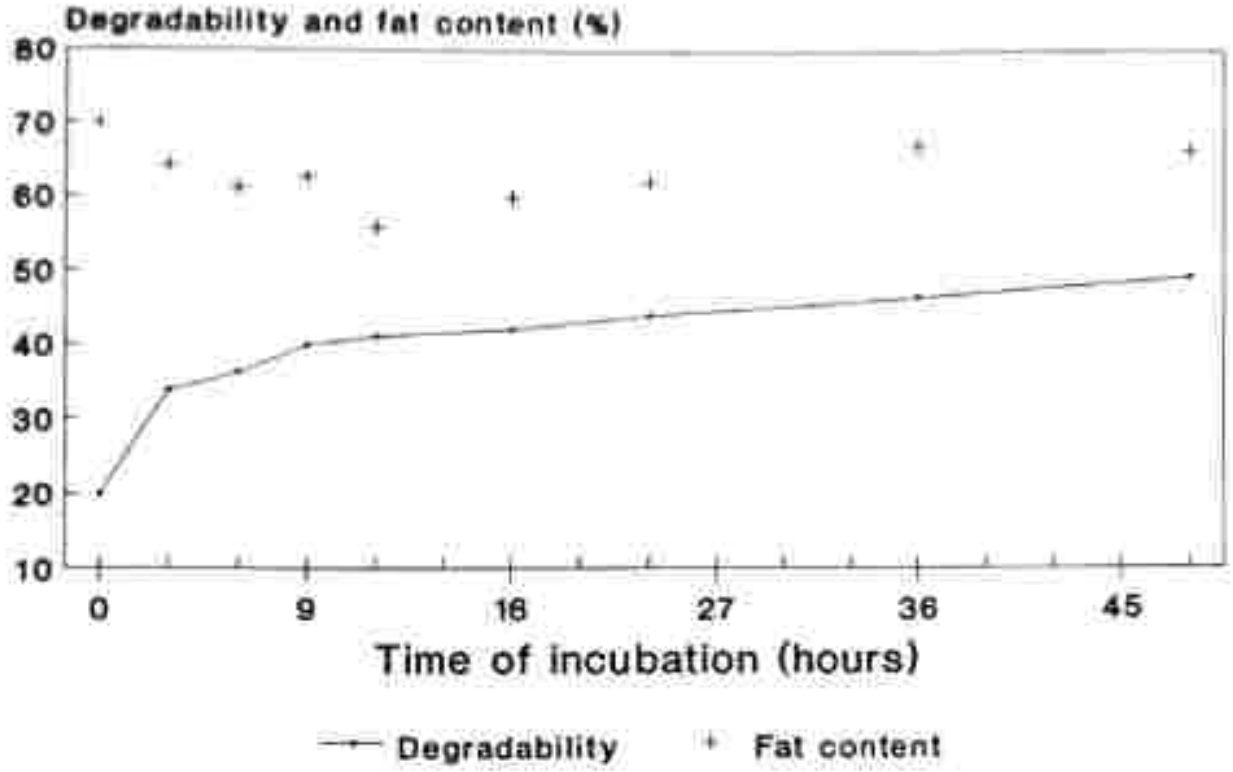

Figure 2. Degradability of protected fat as Ca soap in the rumen and its fat content in the residue.

Effect of Protected Fat on IVDMD. The influence of unprotected fat and protected fat in affecting the *in vitro* dry matter digestibility of elephant grass is presented in Table 5. Ten percent of both unprotected fat and protected fat were included in an elephant grass ration and incubated with rumen liquor for 48 h. After being filtered and dried, the residue was dipped in HCl solution for 2 hours. The dry matter digestibility of elephant grass reduced significantly with the addition of either protected or unprotected fat. However, the effect of unprotected fat was greater (45% reduction) than the protected fat (only 16% reduction). Jenkins and Palmquist (1982) reported that 10% tallow markedly

depressed *in vitro* cell wall digestibility. This reduction may be due to the physical presence of the fat coating the particles of elephant grass. But it is also possible that fat could influence the activity of fiber-degrading microbes by reducing the availability of calcium and magnesium in the rumen (Devendra and Lewis, 1974). When the residue after rumen fermentation was dipped in hydrochloric solution for 2 hours, some fractions of the sample were dissolved. About 1% of elephant grass was dissolved and about 3% of the sample either containing protected and unprotected fat was dissolved. This indicates that rice bran oil which contains a high proportion of free fatty acids and calcium soap can be dissolved in acidic conditions such as in the abomasum.

Unprotected fat significantly reduced the ammonia and VFA contents in the supernatant after rumen fermentation. Whereas, the reduction by protected fat to ammonia was not significant and to VFA was smaller than that by unprotected fat (Table 5).

TABLE 5. *IN VITRO* DRY MATTER DIGESTIBILITY OF ELEPHANT GRASS SUPPLEMENTED WITH PROTECTED FAT (PF)

	Elephant Grass (EG)	EG + 10%PF	EG + 10%UPF
Dry matter digestibility (%)			
rumen liquor 48h	42.6[a]	35.6[b]	23.3[c]
rumen liquor 48h + HCl	43.7[a]	39.0[b]	27.1[c]
Ammonia (mg/l)	56.7[a]	48.6[ab]	32.4[b]
Volatile Fatty Acid (as acetic acid mg/l)	6134[a]	5157[b]	3605[c]

[a] different letter in a row shows significant difference.

This result is in agreement with Chalupa et al. (1984) who reported that long chain fatty acids in fat decrease VFA production in rumen fermentation *in vitro* but as calcium salts, long chain fatty acids cause only small changes.

The effect of level of protected fat on the digestibility of elephant grass is shown in Table 6. Increasing the level of protected fat up to 21% in the elephant grass significantly reduced the *in vitro* dry matter digestibility. Reduction in digestibility was very low when the inclusion rate was 9% or less.

TABLE 6. MEAN OF *IN VITRO* DRY MATTER DIGESTIBILITY OF MIXTURES OF ELEPHANT GRASS (EG) AND PROTECTED FAT (PF) AT DIFFERENT LEVELS FROM 0-21%

Mixture	Dry matter digestibility (%)	
	Rumen Liquor	Rumen Liquor +HCl
EG 100%	46.12[a*]	47.47[a]
EG 94% + PF 6%	43.43[b]	45.98[ab]
EG 91% + PF 9%	41.62[b]	44.77[bc]
EG 88% + PF 12%	39.04[c]	42.82[c]
EG 85% + PF 15%	38.50[c]	42.81[c]
EG 82% + PF 18%	38.51[c]	42.92[c]
EG 79% + PF 21%	35.44[d]	40.45[d]
SE of mean	0.79	0.76

* different letter in a column shows significant difference.

Protected fat reduced digestibility significantly when the inclusion rate was more than 9%. This is in agreement with the recommendation of Fallon et al. (1986) that the inclusion of calcium soaps should be not more than 10% for young calves since it reduced consumption resulting in reduced energy intake and nitrogen retention.

Effect of Protected Fat on In Vivo Digestibility. From the *in vitro* result, the use of 10% protected fat in the ration was used in the *in vivo* trial. As a control, instead of using rice bran oil as unprotected fat, we used full fat rice bran oil. The result of the *in vivo* trial was shown in Table 7. The daily consumption of sheep fed with protected fat was markedly higher than those eating unprotected fat in the form of full fat rice bran. The dry matter, organic matter, fat and protein intakes in terms of grams/day increased by 59; 65; 79 and 44% respectively. The lower intake of the control was perhaps due to the hardness of the control feed blocks compared with those containing protected fat. The increase in dry matter intake was in contrast to the report by Fallon et al. (1986) that the dry matter intake declined significantly with increasing fat in the diet. Ngidi et al. (1990) also reported that protected fat reduced the dry matter intake of a corn-soybean diet for steers. The higheat increase was in fat consumption which meant that the sheep fed protected fat had a much increased energy intake.

Not only intake, but also dry matter, organic matter, fat and protein digestibilities were significantly different between the control and protected fat diets. Diets containing protected fat had more digestible dry matter, organic

matter, fat and protein. However, the digestibilities of ADF, NDF and Ca were not significantly different. Increasing level of free oil or fat reduced total digestion of fiber, organic matter and ADF and N of finishing diet for steers (Zinn, 1989). Addition of Ca soaps to diets for young calves improved digestibilities of fiber and N (Fallon et al., 1986). Addition of 4.5% protected fat, however, did not affect DM, OM, CP and energy digestibilities when supplemented to corn-barley diets for beef cattle (Hill and West, 1991) and did not affect DM and N digestion when supplemented to lactating cows (Schneider et al., 1988). Ngidi et al. (1990) found that NDF and ADF digestibilities linearly increased as the protected fat level increased in beef finishing diets. The results on digestibilities seemed very variable and may depend on the type of diet to which protected fat is added.

The daily gain was recorded only in the week of sample collecting which is too short a period to give an accurate estimate of growth rate. The control showed negative growth, and with protected fat the growth was 171 g/day. The rumen ammonia content of sheep fed with protected fat tended to be higher although the difference was not significant. This result is in agreement with Fallon et al. (1986) although they found that ammonia concentration increased significantly as level of protected fat increased. The ruminal total VFA of sheep fed protected fat also tended to be higher than the control which also supports the result of Hill and West (1991).

In conclusion, the technology of making protected fat was best developed with rice bran oil containing a high percentage of free fatty acids and calcium chloride as the source of calcium. However, it is suggested that other fatty acids could also be made into calcium soap. This product proved to be satisfactory in reducing the effect of unprotected fat on *in vitro* rumen activity. The maximum supplementation of protected fat in the diet was 10% and the *in vivo* trial showed that the supplementation of protected fat improved intakes and digestibilities of DM, OM, CP and fat.

TABLE 7. VOLUNTARY INTAKES, DIGESTIBILITIES AND DAILY GAINS OF SHEEP FED PROTECTED FAT (PF) AT 10% LEVEL IN METABOLISM CAGES

	Control	PF	SE for mean
Intake			
Dry Matter (g/day)	665 [a*]	1059 [b]	93
(g/kg $W^{0.75}$)	58.4[a]	87.3[b]	6.8
Organic Matter (g/day)	570 [a]	942 [b]	82
(g/kg $W^{0.75}$)	50.3[a]	77.6[b]	6.0
Fat (g/day)	52.5[a]	94.1[b]	8.1
(g/kg $W^{0.75}$)	4.6[a]	7.8[b]	0.6
Protein (g/day)	108.8[a]	156.4[b]	13.9
(g/kg $W^{0.75}$)	9.6[a]	12.9[b]	1.0
Digestibility (%)			
Dry Matter	57.2[a]	64.1[b]	0.8
Organic Matter	61.2[a]	66.3[b]	0.9
Fat	78.2[a]	86.3[b]	0.9
Protein	78.3[a]	81.8[b]	0.6
NDF	38.7[a]	40.8[a]	1.9
ADF	11.5[a]	12.9[a]	2.8
Calcium	20.2[a]	24.0[a]	0.8
Ammonia (mg/l)	216	261	29
Volatile Fatty Acid (mg/l)			
Total	249	343	70

* different letter in a row shows significant difference.

Acknowledgement

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EFFECT OF CREEP FEEDING ON THE GROWTH OF PRE-WEANING LAMBS

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ABSTRACT

One hundred and nine Javanese thin-tailed (JTT) ewes rearing new-born lambs were used to evaluate the effects of creep feeding on the growth of the young lambs. Ewes were grouped into three, i.e., those rearing (1) single (2) twin and (3) three or more lambs. The ewes were fed napier grass *ad libitum* and supplemented with commercial concentrate at approximately 2 percent of body weight per day. Creep feed was offered to the respective groups in separate feeding troughs after the lambs were 2-weeks of age and the amount given was gradually increased. The control groups were supplemented with commercial concentrate similar to that given to the ewes. The lambs were weighed every two weeks. Growth rate was calculated as the slope of the regression line of weight on age. Results indicated a slightly faster growth rate in the lambs supplemented with creep feed (119 g/d) compared to the unsupplemented lambs (108 g/d), especially for the males (128 versus 115 g/d) while the growth rates for the females were similar (102 versus 101 g/d). The difference in growth rates was greater in the lambs reared as singles (144 g/d) than those reared as twins (102 g/d) and triplets or more (88 g/d) regardless of creep feeding treatment. Milk availability during pre-weaning period is important and warrants further investigation in addition to creep feed formulation.

Introduction

Sheep production is determined by reproduction capacity, survivability of lambs and growth characteristics. Javanese thin-tailed (JTT) sheep are prolific animals and can produce three or more lambs in every parturition. Milk availability for the lambs becomes a limiting factor to rear more than three lambs. The nutritional status of the ewe is therefore important in supporting adequate milk supply for the young lambs. Supplementing the young lambs with high quality feed could also enhance growth. Creep feeding allows the provision of nutrient rich diets to lambs. Creep feed should preferably be rapidly fermented and not lead to accumulation of indigestible fibrous material in the stomach (NRC, 1985). Better growth of lambs receiving creep feeds during pre-weaning period is expected.

The present paper reports a preliminary study of providing creep feed on the pre-weaning growth of lambs of different birth types.

Materials and Methods

One hundred and nine JTT ewes in late-gestation period were used in this study. After parturition, ewes were divided into three groups, i.e., those rearing (1) single, (2) twin, and (3) three or more lambs. The ewes were fed napier grass (*Pennisetum purpureum*) *ad libitum*, supplemented with commercial concentrate (16% crude protein and 68% TDN) at 2 per cent of body weight, in a group feeding system. Creep feed was formulated from corn (54%), wheat pollard (22%), soybean meal (23%), premixed-minerals (0.7%) and salt (0.3%). The chemical composition of the creep feed (dry matter basis) was 22.4% crude protein, 2.8% fat and 3048 kcal equivalent Digestible Energy (DE) per kg. The creep feed was offered to the treated groups separate from ewes in feeder troughs after the lambs were approximately 2 weeks old and the amount of feed was gradually increased from 25 g/head/d to 100 g/head/d. The control group lambs were supplemented with similar commercial concentrate given to the ewes, in separate feeding troughs at a gradual increased from 25 g/head/d to 100 g/head/d as well. The lambs were weighed bi-weekly. Growth rate was estimated as the slope of the regression line of weight on age. Data were analyzed statistically as a factorial experiment with creep feeding, number of lambs reared, and sex as the main factors (SAS, 1987).

Results and Discussion

Birth weights of single born lambs were significantly higher (3.09 kg) than twins (2.35 kg), triplets (1.85 kg) and quadruplets (1.70 kg). The growth rate of lambs (Table 1) was affected by creep feeding, number of lambs reared, and sex. No significant two- or three-factor interactions were observed.

The lambs receiving creep feed showed 10.6% faster growth than the unsupplemented group, indicating that creep feeding was necessary. However, the response was relatively low partly due to the difference between males and females (Figure 1). Male lambs grew 19% faster than female lambs regardless of creep feed treatment (122 vs 101 g/d). Within the creep fed group, growth of male lambs was 25% faster than that of female lambs (128 vs 102 g/d). Similarly for single-reared lambs (34%; 167 vs. 124 g/d, see Table 1). This indicates that there are probably differences in milk supply. In addition male lambs are usually more aggressive in suckling (Figure 1) hence the different growth response.

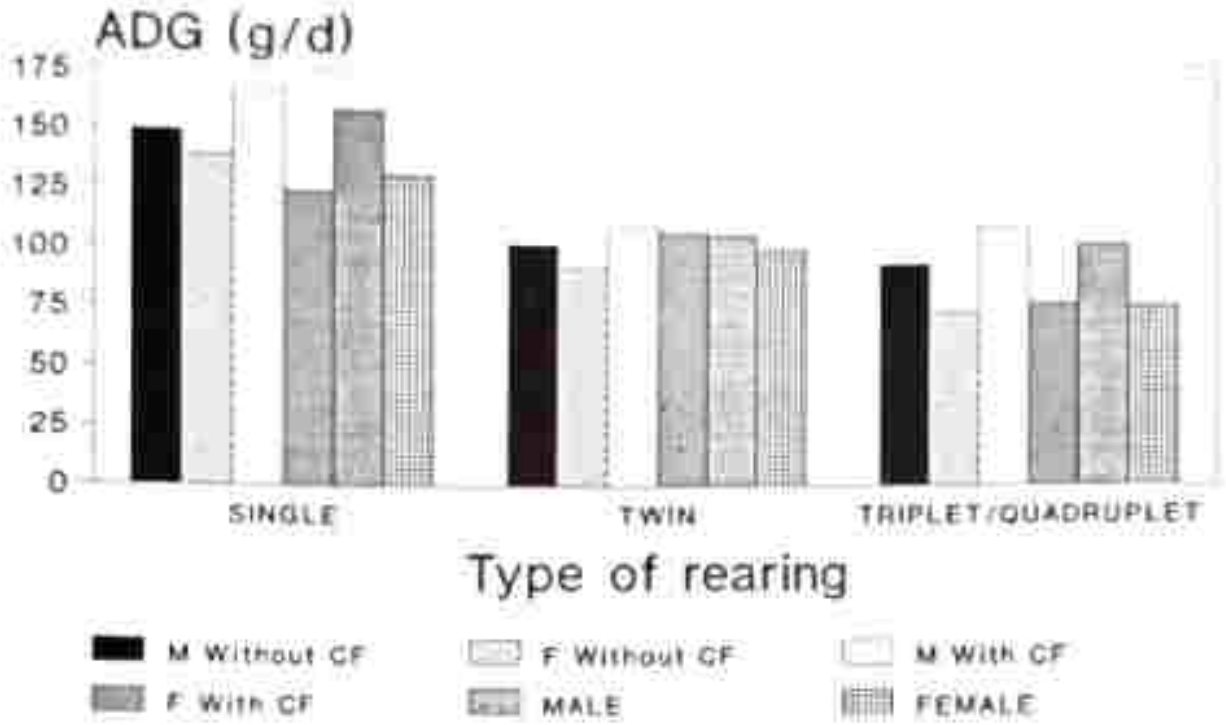

Figure 1 Growth response of young lambs to creep feeding (CF)

TABLE 1. GROWTH RESPONSE OF LAMBS TO CREEP FEEDING (g/d)

	Without creep feed		With creep feed	
Type of rearing	Males	Females	Males	Females
1	149	139	167	124
2	102	92	109	107
3 or more	93	73	109	76

Significant difference were observed for the main effect of creep feeding ($P<0.05$), type of rearing ($P<0.01$) and sex ($P<0.01$).

Table 2 indicates the average coefficient of determination (R-square) and residual mean square of the regression equation between weight and age of lambs. The R-square describes the closeness of the relationship between weight and age and hence the average daily gain. The residual mean square of the regression equation indicates the estimate of variance of the predicted variable. The smaller the residual mean square, the better the model for predicting dependent variable.The variation of R-square was not significantly affected by creep feeding ($P > 0.1$).

TABLE 2. AVERAGE COEFFICIENT OF DETERMINATION AND RESIDUAL MEAN SQUARE OF THE REGRESSION EQUATION BETWEEN WEIGHT AND AGE OF THE LAMBS

Type of rearing	Without creep feed		With creep feed	
	Males	Females	Males	Females
1	0.75(4.8)	0.92(1.1)	0.88(2.3)	0.75(2.8)
2	0.91(0.8)	0.87(0.9)	0.83(1.4)	0.88(1.0)
3 or more	0.82(1.1)	0.70(1.5)	0.85(1.3)	0.66(1.9)

() Residual mean square.

The R-square of single, twin and triplet lamb weights on age (0.83; 0.87 and 0.76, respectively) were significantly different ($P<0.01$). Similarly for the main effect of sex (0.84 versus 0.80 for the males and females, respectively; $P<0.01$). Interactions between creep feeding and sex; type of rearing and sex; and creep feeding, type of rearing and sex were found significant ($P<0.01$). Unlike the R-square, the residual mean square were only significantly different due to type of rearing (2.7; 1.0 and 1.5 for single, twin and triplet or more rearing type, respectively; $P<0.01$), interaction between creep feeding and sex ($P<0.05$), and interaction between creep feeding, type of rearing and sex ($P<0.05$). These interactions indicate that the variability in growth rate of young lambs was determined synergically by, at least, three main factors (creep feeding, type of rearing and sex). Sex, however, appeared to be a dominant factor compared to the others.

A growth rate of 170 g/d for the single-reared lambs and 73 g/d for the triple-reared lambs (Inounu et al., 1991) during the first 55-day period when concentrate feed was supplemented to the ewes was also obtained. The response to creep feeding of young lambs, was not observed by Sanchez and Boer (1990) which may be related to palatability of the creep feed and other environmental factors such as eating habit.

Conclusion and Recommendation

The response of young lambs to creep feeding was related to sex of lambs and type of rearing. The results suggest that creep feeding of lambs of prolific sheep warrants further investigations.

Acknowledgement

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SMALL RUMINANT MINERAL NUTRITION IN INDONESIA

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ABSTRACT

Data relating to small ruminant mineral nutrition in Indonesia were compiled and critically evaluated to determine the presence of mineral deficiencies and to identify information gaps and research needs. An attempt to obtain information through the membership of the Indonesian Small Ruminant Network was not very successful, indicating a need to make the Network more interactive. Several elements, including P, Na, Cu, Zn and I appear to be deficient. The status of Se is not clear. There is no evidence for deficiency of Fe and Mo. Little or no information was found for many provinces, likely reflecting both a real lack of data as well as a failure to access all existing information.

Introduction

Mineral deficiencies are a major cause of poor production and disease in ruminants in developing tropical countries where livestock rely entirely on forages to supply nutrient requirements (McDowell, 1985). Mineral deficiencies are poorly understood in Indonesia since local studies are often not comprehensive, not reported in conventional scientific literature or simply not appreciated locally. However, local information must be obtained and evaluated before research needs can be identified; information on mineral deficiencies in other countries has no relevance to Indonesia with its distinct soils, weather and farming systems.

The Indonesian Small Ruminant Network (ISRN) was established in 1988 to facilitate information exchange between entities concerned with small ruminant production in Indonesia (Djajanegara and Rangkuti, 1991). In 1990, ISRN published a directory identifying key personnel involved in small ruminant production, research and training.

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In this project, the ISRN was utilized and assessed as a source of information on small ruminant mineral nutrition. Information accessed via ISRN and from other sources was compiled, cross-indexed and finally evaluated element by element to determine the likelihood of deficiency, information gaps and research priorities for small ruminant mineral nutrition.

Materials and Methods

Document Accession. A questionnaire (in Indonesian) was mailed to every person listed in the Indonesia Small Ruminants Directory 1990, with the exception of those located outside Indonesia. The questionnaire explained the objectives of the project and requested a list of titles of documents available and the number of pages. A stamped, addressed envelope was enclosed to encourage respondents. After receipt of the list of available documents, those appearing relevant were selected and requested from the respondent. At the same time, money (twice photocopy cost plus estimated postage) was sent to encourage respondents. The same questionnaire was sent to all universities with faculties of agriculture.

The AGRIS database (1970-1990) was searched on two keywords **mineral + Indonesia** at the National Library of Agricultural Science, Bogor. A number of scientific journals, semi popular periodicals and theses were scanned in Bogor libraries.

The reference list in each document received was checked to ensure that all relevant citations had also been obtained.

Document Processing. Documents were given sequential accession numbers and bound in volumes of 800+ pages. Information, filed in the Notebook II text database program, included keywords, document type, source, number of references and the number required, as well as the standard citation material. A detailed subject index, biased towards its intended use for assessing mineral deficiency, was maintained.

Data Evaluation. For this report, data were evaluated after 149 accessions were received. A list of accessions was compiled for each element from the Subject Index and then each document was assessed alongside all other documents on the same subject to determine the weight of the evidence regarding mineral deficiency, information gaps and research needs.

Results and Discussion

Document Accession. The questionnaire was sent to 144 names in the ISRN Directory but only 8 responded (Table 1). One reason for this poor response is that key authors on small ruminant mineral nutrition (e.g., Prabowo, Panggabean, Darmono) are not listed in the Directory.

TABLE 1. ISRN QUESTIONNAIRE RECIPIENTS AND RESPONDENTS

Province	# Recipients	# Respondents
Bali	7	0
W. Java	65	1
C. Java	22	1
E. Java	18	1
Jakarta	8	3
Yogyakarta	15	2
N. Sumatra	6	0
S. Sumatra	3	0
Total	144	8

The computer search of the AGRIS database yielded 336 titles of which only 22 were considered useful. This database is not comprehensive for Indonesian ruminant mineral nutrition information.

Some key information was contained in theses and not encountered elsewhere, for example, Batubara (1988) and Hardijanto (1989) contained good data not encountered in scientific publication or cited by any accessions.

Although additional relevant documents were found continually, the document and mineral data analyses presented here are based on accessions #1 to 149. Documents accessed after this cut-off are appended in Volume 5 but they have not been processed in any way, i.e., they do not appear in the Accession List, Subject Index or Data Analysis. However, they constitute an initial step towards updating and refining this database.

Document Processing. The documents obtained have been characterized by type of document (Figure 1), language (Figure 2), year of publication (Figure 3), document size (Figure 4) and number of citations (Figure 5).

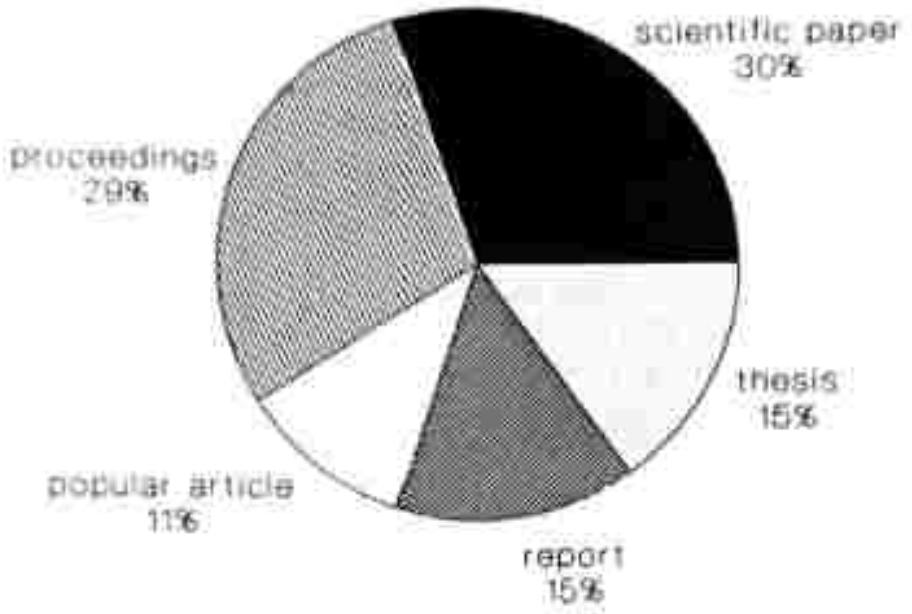

Figure 1. Document type (accessions 1-147)

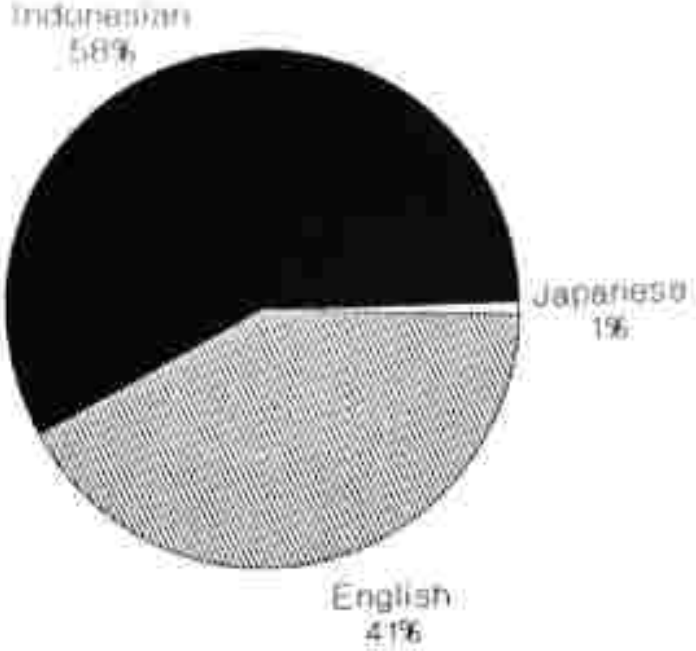

Figure 2. Document language (accessions 1-147)

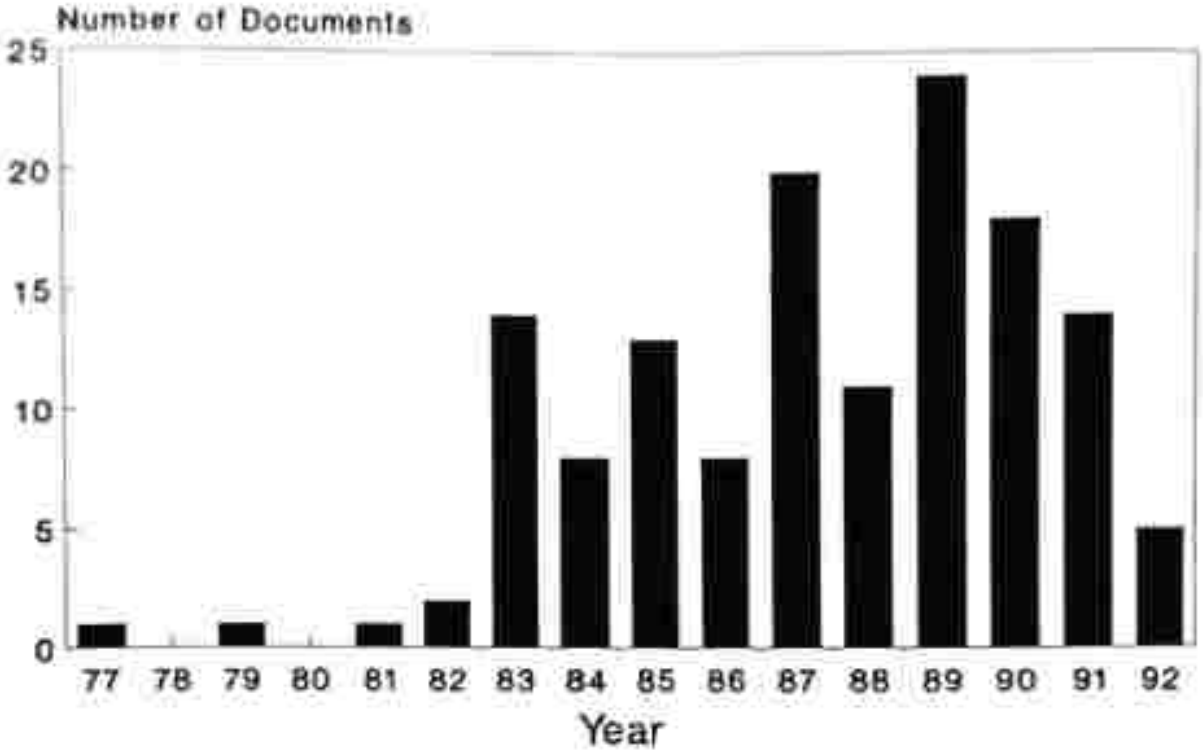

Figure 3. Publication date (accessions 1-147)

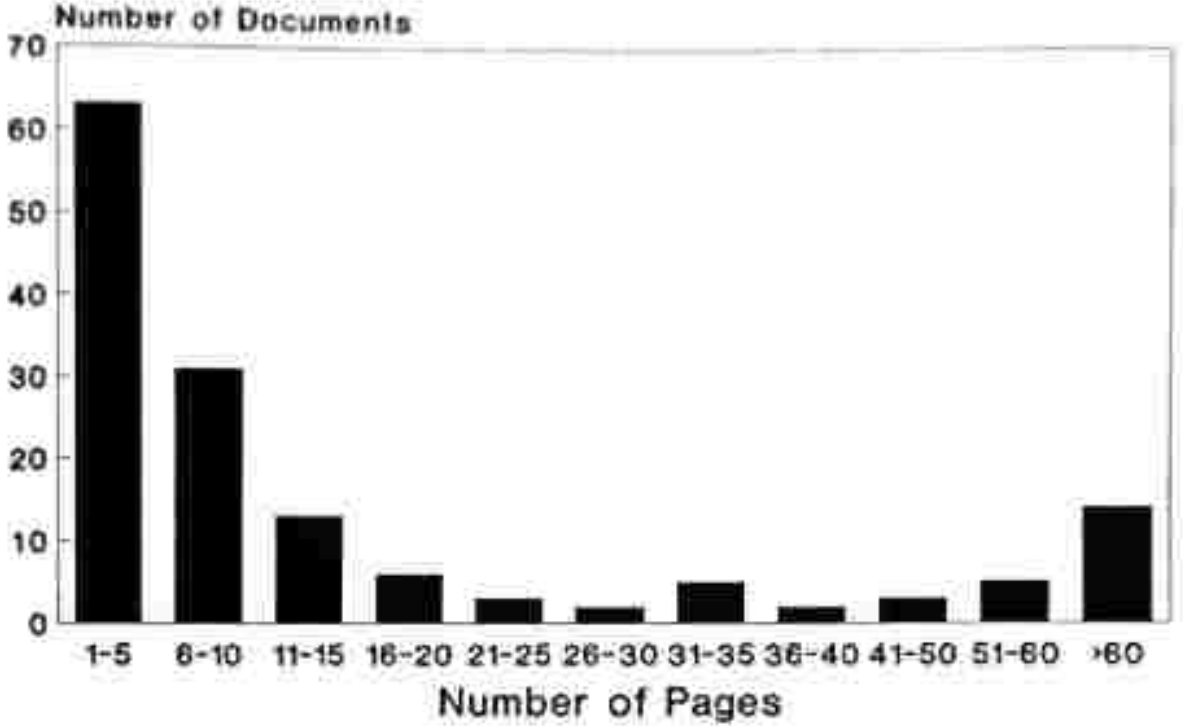

Figure 4. Document size (accessions 1-147)

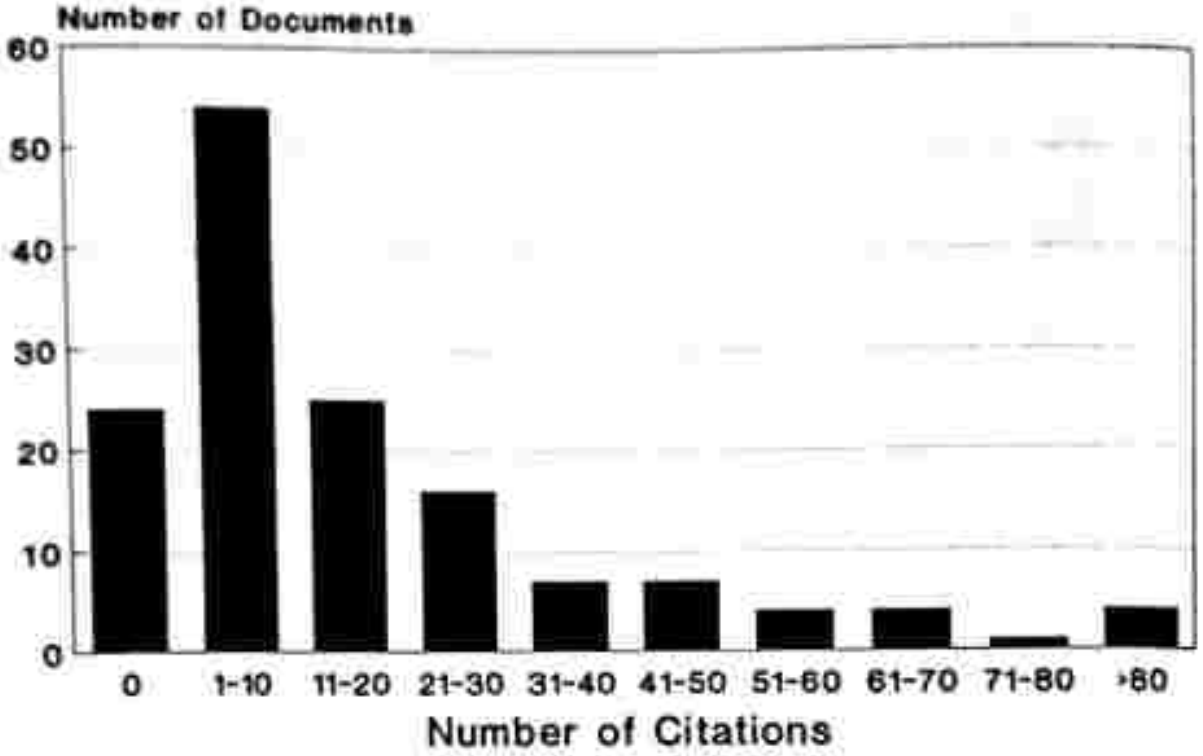

Figure 5. Size of bibliography (accessions 1-147)

Only 30% of accessions are scientific journal papers, indicating that much information remains in the realm of grey literature. Popular articles are included because they are part of the information flow from specialists to potential users. One example of a popular publication, i.e., one not aimed at scientists, is the book "Penyakit Kekurangan Mineral Pada Sapi" (Nugroho, 1986) which contains a detailed description of mineral deficiencies but absolutely no hint of what elements were known to be (or might be) deficient in Indonesia. This is unfortunately typical of popular articles.

The high proportion (41%) of English language accessions is likely due to the influence of foreign aid projects at key institutes. The use of English language may be a constraint to information sharing.

The notable increase in publishing activity in 1983 is only partly due to foreign aid projects. Publications in 1983 originated from a variety of universities and research institutes.

Document size and the size of the bibliography follow a similar distribution, except for the zero citation accessions which are popular articles. At the high end are theses, with maxima of 164 pages and 142 citations. In general, the theses cited few papers relevant to mineral nutrition in Indonesia.

Data Evaluation. Table 2 presents an example of the organization of documents and the format for data evaluation for copper, molybdenum and sulfur which were evaluated jointly, taking into account interactions. This standard format was modified slightly as appropriate for certain elements, e.g., iodine.

Components termed "ancillary information" were not exhaustively sought. Only representative articles on soil levels, plant nutrition, etc., were included where they might conceivably have some bearing on ruminant nutrition. Information on peat and acid sulfate problem soils is included since ruminant introduction schemes have been initiated on such marginal lands.

Components termed "direct information" include intake through both forage and water, although information on the latter was limited, tissue levels, seasonal variation, supplementation studies, association with disease and integrated studies correlating several of the above components. Information on large ruminant mineral nutrition is included since it is directly relevant to small ruminants.

Mineral intake from drinking water may be significant in acid sulfate soil areas where elements interfering with copper can occur at toxic levels in groundwater (Subagyono et al., 1990).

TABLE 2. COPPER, MOLYBDENUM AND SULFUR ACCESSIONS* BY SUBJECT

ancillary information	
1. soil levels	5,33,40,42,45,54,65,66,67,69,85,99,121, 125
2. plant nutrition	49,83,84,85,86,99,100,148
3. human nutrition	
4. interactions/interference	2,19
direct information	
5. water levels	86,99,100,101,102,103
6. forage content	2,3,5,7,10,19,21,32,33,38,40,45,46,51,56, 57,63,64,72,73,74,75,80,111,119,127,136
7. blood levels	
- buffalo	31,33,39,91,127
- cattle	1,5,7,29,31,32,33,39,40,52,56,91,119,127, 140
- goats	79
- sheep	17,38,43,57,74,79
8. kidney levels	
- buffalo	81
- cattle	81
- goats	
- sheep	38,131
9. liver levels	
- buffalo	33
- cattle	1,5,31,32,33,35,41,45,77
- goats	79
- sheep	38,74,79,111,131
10. seasonal variation	1,5,17,21,32,33,38,72,111,119
11. supplementation	22,24,27,37,43,73,74,80,133
12. disease association	7,19,54,56,140
13. integrated studies	5,7,19,32,33,38

* Accession number for documents in Data Relating To Small Ruminant Mineral Nutrition In Indonesia, Volumes 2-5.

TABLE 3. CALCIUM AND PHOSPHORUS FORAGE ACCESSIONS* BY REGION

Province	Ca <0.3%	Ca >0.3%	P <0.25%	P>0.25%
W. Java	46	3,10,21,38, 42,51,58,72, 73,74,76,92, 93,112,128	3,10,21,38, 42,46,58, 72,73,74, 92,93,112	51,76,128
C. Java		45	45	
E. Java		10,58,72	10,58,72	
S. Sulawesi	4,10,33, 57,119		4,10,33,57, 119	
W. Kalimantan		19	19	
C. Kalimantan		40	40	
N. Sumatra	127,142	10,64,108, 136	10,64,108, 127,136, 142	
W. Sumatra		63	63	
S. Sumatra		62,120,125	62,120	125
Jambi	7,56		7,56	
Riau	34		34	
Timor		10	10	
5 provinces		2	2	

* Accession number for documents in Data Relating To Small Ruminant Mineral Nutrition In Indonesia, Volumes 2-5.

TABLE 4. ZINC TISSUE LEVEL ACCESSIONS*

Province	Blood Zn		Liver Zn (dry weight)	
	<0.80ppm	>0.80ppm	<84ppm	>84ppm
W. Java				
buffalo	146	31	31	
cattle		26,29,45		31
goats		79**		79
sheep	17,38,146	74**,79**	38/111	74,79,131
C. Java				
cattle			35/45/77	
E. Java				
cattle		1**		
S. Sulawesi				
buffalo, wet	33			33
dry		33		33
cattle, wet		5/32,40		5/32,33
dry	5/32,40			5/32,33
sheep	57			
S. Kalimantan				
cattle	39/52			
C. Kalimantan				
cattle	40			
N. Sumatra				
buffalo		127**		
cattle		127**		
W. Sumatra				
buffalo		91**		
cattle		1**,91**		
Jambi				
cattle	7/56			

* Accession number for documents in Data Relating To Small Ruminant Mineral Nutrition In Indonesia, Volumes 2-5.

** Accessions with samples considered contaminated.

The forage data are usually presented to show regional distribution of reports indicating deficient and adequate mineral levels. Table 3, from the analysis of calcium and phosphorus, is presented as an example. In this format, regional information gaps and inadequacies are immediately apparent, and some conclusions are justified. The blood and tissue level data are presented similarly, as shown in Table 4 from the analysis of accessions on zinc.

TABLE 5. SUMMARY OF MINERAL STATUS OF INDONESIAN RUMINANTS

Province	Ca	P	Mg	Na	S	Cu	Co	Zn	Mn	I	Se
Aceh						-					
N. Sumatra	+	-	(?)	-	(+)	-	+	-	(-)		(-)
W. Sumatra	(+)	(-)	(-)		(-)	-			(+)		
Jambi	-	-	+	-	+	-	+	-	+		?
Riau	(-)	(-)									
Bengkulu											
South Sumatra	+	-									
Lampung											
D.K.I. Jakarta											
W. Java	+	-	+	-	+	+	+	-	+	-	+
C. Java	+	?	+	-		(+)		(-)	+		
D.I. Yogyakarta	(-)									-	+
E. Java	+	-	+		+	-	+	-	(+)	-	?
W. Kalimantan	(+)	(-)	(+)	(-)	(+)	-	(+)	(-)	(+)		(+)
C. Kalimantan	(+)	(-)	(-)			-		(-)			
S. Kalimantan	-	-				-		-			
E. Kalimantan											
N. Sulawesi					-						
C. Sulawesi											
S. Sulawesi	-	-	?	-	(+)	-	+	±	-		-
SE. Sulawesi											
Bali						-					
W. Nusa Tenggara											
E. Nusa Tenggara	+	-	+	-	+	-	?	-	+		-
Maluku											
Irian Jaya											
E. Timor	+	-	+	-	-	-	?	-			

+ = adequate; - = deficient; ± = seasonal variation; ( ) = limited data
? = contradictory data; = no data.

Several studies include data on wet versus dry seasons, but consistent seasonal variations are difficult to find. If samples are not taken near the end of the season, they might not fully represent that season. In many cases, sample variability and regional differences may mask seasonal variations. Several papers by Prabowo et al. (e.g., 1991) address these interactions.

Good mineral supplementation studies are difficult to design and conduct, and could be considered incomplete without a cost-benefit analysis. Most of the supplementation studies accessed could be faulted for a) no analysis of basal diet, b) failing to supplement all deficient elements, c) failing to consider interactions between minerals (e.g., S and Cu), and d) providing more of elements already overabundant in the diet (e.g., Fe). One important accession reports wide discrepancy between labelled contents of two commercial mineral supplements and the contents as determined by laboratory analysis (Darmono, 1989).

Table 5 is an attempt to summarize data from all accessions. Fe and Mo are not included as there is no evidence for deficiency of these elements. Several elements, including P, Na, Cu, Zn and I appear to be deficient. The status of Se is not clear. Little or no information was found for many provinces, likely reflecting both a real lack of data as well as a failure to access all existing information.

Project Output. Five bound volumes containing the actual accessions, the subject and author indexes and data evaluation, as well as the Notebook II program, manual and data files were placed in the ISRN office and in the libraries at Balai Penelitian Veteriner, Bogor and Balai Penelitian Ternak, Ciawi.

Summary and Recommendations

i) This database on ruminant mineral status should be maintained and updated, and conclusions disseminated particularly to educational institutes and livestock extension services by ISRN. A further attempt should be made to collect information not accessed here.

ii) ISRN members should be encouraged to use the network as an information source, perhaps via a column in the Newsletter where members can solicit information from colleagues. If not, the Network is only a mailing list for the Newsletter.

iii) Although certain mineral deficiencies are already well defined for certain areas, the status of other minerals and other regions remains unknown. Studies are required to fill in these gaps. In addition, good on-farm supplementation studies with an economic component are required, and could be supported or coordinated by SR-CRSP.

iv) An analysis of the mineral supplement industry should be undertaken to assist agencies responsible for certifying the quality of such products and regulating advertising ethics. Areas of interest should include a) label vs actual composition of all available products; b) advertising claims; and c) a

marketing survey to ascertain who buys mineral products and their reasons for doing so.

vi) The information on mineral nutrition compiled in this project should be exploited by planners of major ruminant livestock introduction schemes, especially in areas of marginal soil fertility.

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EVALUATION OF THE MINERAL STATUS OF GOATS IN SOUTH SULAWESI

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ABSTRACT

A study was conducted to evaluate the mineral status of goats in South Sulawesi. Samples of forage and animal tissue (blood, liver, bone) from slaughtered Kacang and Etawah grade (PE) goats in the regencies of Majene and Jeneponto were collected in June, 1992. Forages were found to be low to deficient in Se (< 0.1 mg/kg DM), P (< 0.16% DM) and Cu (< 7 mg/kg DM). Differences ($P<0.05$) due to the sampling location were observed for forage Fe. Additionally, crude protein concentrations in both locations were marginal (7 - 8% DM). The average blood mineral concentrations for Kacang and PE goats in both locations were above the critical levels but considerable numbers of samples were low in Cu (< 0.65 µg/ml). Kacang goats had lower ($P<0.01$) plasma Ca but higher ($P<0.05$) serum Zn than PE goats. Location variations ($P<0.10$) were observed for serum Se and variations due to the animal breed by location interaction were found for Cu ($P<0.10$), Se ($P<0.01$) and Zn ($P<0.01$) concentrations. Liver mineral analyses indicated that Kacang goats had higher Cu ($P<0.05$) and Zn ($P<0.05$) but lower Fe ($P<0.10$) concentrations than PE goats. Differences due to sampling location were found for liver Co ($P<0.05$), Cu ($P<0.10$) and Se ($P<0.05$). The incidence of liver mineral deficiencies, based on the suggested critical levels, for both breeds in both locations were low. Compared to the 11.5% critical level, high incidence of deficiencies were found for bone P. It is suggested that in addition to crude protein, the minerals most likely to limit goat production in South Sulawesi are P, Se, and Cu. The excessive Fe concentration (> 500 mg/kg DM) in forages may contribute to the situation. Variations in mineral status due to animal breed found in this study are probably of little significance practical values since the average concentration of these minerals were above the critical levels.

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Introduction

Livestock have traditionally been important in South Sulawesi agriculture. Goats are the predominant species of small ruminants which along with Bali cattle play an important role in the socio-economic life of small farmers. However, as a source of income goats are still placed under food-crops and cattle, which may due to their low productivity and the high mortality rate of kids (Abduh et al., 1992).

Goats are maintained largely on grass diets by letting them graze on pastures or pen-fed in a cut and carry feeding system supplemented with various tree leaves. Mineral supplementation, if any, is limited to common salt. In this situation, forages are the major source of essential nutrients. It has been reported that mineral imbalances, along with poor husbandry, frequently contribute to sub-clinical deficiencies in ruminants maintained on forage based diets (Conrad et al., 1980) and become a major limitation to productivity (McDowell, 1985).

Although more attention is being paid to mineral nutrition of Indonesian livestock in South Sulawesi, only a few studies on mineral status and supplementation have been conducted. Even fewer have been conducted with goats. Recent studies have indicated that there are mineral deficiencies in grazing cattle (Prabowo et al., 1991a; Prabowo et al., 1991b) and buffaloes (Prabowo et al., 1990) in South Sulawesi. One study also showed increased gains in goats receiving micromineral supplement (Pongsapan et al., 1992). The objective of this study was to evaluate the mineral status of goats in South Sulawesi.

Materials and Methods

Blood, liver and bone samples were collected from slaughtered goats during the "Idul Adha" Islamic Celebration on June 11, 1992 and three days thereafter in the regencies of Majene and Jeneponto. Those locations are considered as the goat producing center in the province of South Sulawesi. After tracing the origin of animals that were sampled, samples of forages commonly grazed by or fed to goats in the area were taken. The animals sampled were yearling male Kacang and Etawah grade (*Peranakan Etawah* = PE) goats, weighing in 25 to 40 kg. In each location, 18 forage and 30 blood, liver and rib bone samples for each of the animal breeds were obtained. A total of 36 forage and 120 blood, liver and bone samples were then prepared for mineral analyses following the methods described by Fick et al. (1979).

Forage samples were analyzed for macrominerals: Ca, K, Mg, Na and P; and microminerals: Co, Cu, Fe, Mn, Mo, Se and Zn. Blood plasma samples were

analyzed for Ca and P whereas serum were analyzed for Mg, Cu, Se and Zn. Liver samples were analyzed for Co, Cu, Fe, Mn, Mo, Se and Zn; and bone samples were analyzed for Ca, Mg and P.

Calcium, K, Mg, Na, Cu, Fe, Mn and Zn were determined by atomic absorption spectrophotometry (Perkin-Elmer Corp., 1982), while Co and Mo were determined by flameless atomic absorption spectrophotometry (Perkin-Elmer Corp., 1984). Phosphorus was analyzed using the calorimetric method of Harris and Popat (1954) and Se determination was carried out by a modified fluorometric technique (Whetter and Ulrey, 1978). Additionally, forage samples were also analyzed for crude protein (CP) by measuring total nitrogen following the method described by the Technicon Industrial Systems (1978); and for neutral detergent fiber (NDF) using the procedure of Goering and Van Soest (1970).

Data obtained in this study were analyzed statistically by least squares analysis of variance for the factorial experiment with breed and location (Snedecor and Cochran, 1980), using the General Linear Models (GLM) procedure of the SAS System (SAS, 1987).

Results and Discussion

Forage Analyses. It has been reported that the major component of goat diets in the study locations was grasses (Abduh et al., 1992). In Majene, goat diets consisted of 82.5% grasses, while those in Jeneponto consisted of up to 97.5% grasses. The predominant species of forages sampled in this study were *Cynodon dactylon, Paspalum conjugatum, Axonopus compressus, Drymaria cordata* and *Panicum* sp. Results of forage analyses as related to sampling location are presented in Table 1.

Location differences ($P<0.05$) were found for forage Fe, with concentrations in Jeneponto higher than those in Majene. In both locations, the average concentration for Ca, K, Mg, Na, Co, Fe, Mn and Zn were above the suggested critical levels for each element (McDowell, 1985), and the percentages of deficient samples were small. However, it is important to point out that the average Fe concentration in Jeneponto was higher than 500 mg/kg level suggested as the maximum tolerable level for sheep (NRC, 1985). It has been reported that high levels of Fe in diets may adversely affect utilization of other minerals such as Cu, P, Zn and Mn by lambs (Prabowo et al., 1988).

TABLE 1. FORAGE MINERAL, CRUDE PROTEIN AND NDF CONCENTRATIONS (DRY BASIS) AS RELATED TO SAMPLING LOCATION

Variable	Critical level[a]	Location				SE[d]	Significance[e]
		Majene		Jeneponto			
		Mean[b]	% Def[c]	Mean	% Def		
Ca, %	< 0.2	0.34	5.6	0.33	11.1	0.06	
K, %	< 0.5	1.56	0.0	1.38	5.6	0.07	
Mg, %	< 0.12	0.23	0.0	0.24	0.0	0.02	
Na, %	< 0.09	0.12	0.0	0.10	11.1	0.02	
P, %	< 0.16	0.18	33.3	0.16	55.6	0.03	
Co, mg/kg	< 0.1	0.34	0.0	0.32	0.0	0.01	
Cu, mg/kg	< 7	8	22.2	7	38.9	2	
Fe, mg/kg	< 30	433	0.0	532	0.0	39	L*
Mn, mg/kg	< 20	76	5.6	85	0.0	19	
Mo, mg/kg	> 10	0.46	0.0	0.32	0.0	0.05	
Se, mg/kg	< 0.1	0.11	44.4	0.09	61.1	0.03	
Zn, mg/kg	< 20	32	0.0	35	0.0	3	
CP, %	< 7	8.2	11.1	7.6	38.9	0.48	
NDF, %	-	64.4	-	68.2	-	4.4	

[a]Concentrations below which is deficient or above which, in the case of Mo, is excessive (Milford and Minson, 1966; McDowell, 1985), based on requirements of sheep (NRC, 1985).

[b]Means of 18 samples/location.

[c]Percentage of deficient samples.

[d]Standard error of means.

[e]L = location; * = $P<0.05$.

Similar to the result of previous studies (Prabowo et al., 1990; Prabowo et al., 1991a), P showed the highest incidence of deficiency among macrominerals analyzed in forages. Individual evaluation of samples based on the critical level of 16% (McDowell, 1985) indicated that forages were deficient in P at 55.6% in Jeneponto and at 33.3% in Majene.

Compared to the critical level of 7 mg/kg (McDowell, 1985), the average forage Cu concentrations were marginal for both locations. The percentages of forage samples below the critical level were 22.2% for Majene and 38.9% for Jeneponto. In both locations, however, none of forage samples analyzed showed

Mo concentrations above the 10 mg/kg level, regarded as excessive and detrimental to Cu metabolism (McDowell, 1985).

A high incidence of Se deficiency was found in forage in both locations. Compared to the critical level of 0.1 mg/kg (McDowell, 1985), the percentages of Se deficient forage samples were 44.4% in Majene and 61.1% in Jeneponto.

Crude protein and NDF concentrations were similar ($P>0.10$) in both locations. However, the percentage of forage samples below the crude protein value of 7%, regarded as critical for protein deficiency (Milford and Minson, 1966) was higher in Jeneponto than in Majene. The NDF values of forage samples analyzed in this study are within the 62.4 to 84.8% range reported by Prabowo and Salam (1992) for roughages in South Sulawesi. Moore (1980) suggested that mature forages having less than 7 to 8% crude protein are likely to show increased intake due to protein supplementation. Therefore, supplemental protein were may also be suggested for goats in South Sulawesi, that may increase voluntary forage intake, energy digestibility and animal performance.

Blood Analyses. Blood mineral concentrations as related to animal breed and sampling location are presented in Table 2. The average concentrations of blood minerals for both breeds in either location were above the suggested critical levels (McDowell, 1985) for each element.

Animal breed differences ($P<0.01$) were found for plasma Ca, with concentrations for PE goats higher than those for Kacang. For either breed, however, plasma Ca concentrations in Majene and Jeneponto were similar ($P>0.10$). Although plasma levels of Ca do not necessarily indicate the nutritional status of Ca, because of these levels are hormonally controlled, it is established that plasma Ca levels below the 8-9 mg/dl range indicate chronic low Ca intake and/or utilization (NRC, 1985). In this study, the percentages of blood samples below the critical level of 8 mg/dl for both locations were less than 17%.

No differences ($P>0.10$) were detected in serum Mg and plasma P due to the animal breed, location or their interaction. Despite the considerable number of forage samples found to be low in P, in both locations the percentages of blood samples below the critical level were small. Little et al. (1971) reported that hydrolysis of organically combined P, such as adenosine triphosphate, may increase the level of inorganic P in blood plasma. Additionally, blood P could also increase with some degree of stress (Gartner et al., 1965).

TABLE 2. BLOOD MINERAL CONCENTRATIONS AS RELATED TO ANIMAL BREED AND SAMPLING LOCATION

Variable[a]	Breed	Location						Significance[e]
		Majene			Jeneponto			
		Mean[b]	SE[c]	% Def[d]	Mean	SE	% Def	
Ca, mg/dl	Kacang	8.4	0.06	16.7	8.3	0.05	16.7	B**
	PE	8.7	0.06	3.3	8.7	0.04	6.7	
Mg, mg/dl	Kacang	2.3	0.02	13.3	2.4	0.02	6.7	
	PE	2.5	0.02	0.0	2.5	0.02	0.0	
P, mg/dl	Kacang	5.6	0.13	3.3	5.4	0.11	6.7	
	PE	5.2	0.13	6.7	5.0	0.10	10.0	
Cu, µg/ml	Kacang	0.77	0.03	26.7	0.86	0.03	16.7	BL+
	PE	0.66	0.03	40.0	0.70	0.02	30.0	
Se, µg/ml	Kacang	0.12	0.01	0.0	0.05	0.01	10.0	L+, BL**
	PE	0.10	0.01	6.7	0.06	0.01	26.7	
Zn, µg/ml	Kacang	1.00	0.06	0.0	0.97	0.05	0.0	B*, BL**
	PE	0.75	0.06	10.0	0.70	0.04	26.7	

[a]Plasma for Ca and P, and serum for Mg, Cu, Se and Zn.

[b]Least squares means of 30 samples/breed for each location.

[c]Standard error of least squares means.

[d]Percentage of deficient samples, based on the following critical levels: Ca, 8 mg/dl; Mg, 2 mg/dl; P, 4.5 mg/dl; Cu, 0.65 µg/ml; Se, 0.03 µg/ml; Zn, 0.6 µg/ml (McDowell, 1985).

[e]B = animal breed, L = location, BL = animal breed x location interaction; ** = $P<0.01$, * = $P<0.05$, + = $P<0.10$.

Similar concentrations of serum Cu were observed for Kacang and goats in both Majene and Jeneponto locations ($P>0.10$). Variations were found, due to the interaction of animal breed by location ($P<0.10$). However, considerable numbers of samples below the critical level of 0.65 µg/ml suggested by McDowell (1985) were found in both locations, with PE having higher percentage than Kacang goats.

Location differences ($P<0.10$) were observed for serum Se, with concentrations in Majene higher than those in Jeneponto and consequently, the

percentages of deficient samples were higher in Jeneponto than in Majene. This agreed with the results of forage analyses which showed a higher incidence of Se deficiency in Jeneponto than in Majene. Variations in serum Se concentrations also were found due to the interaction of animal breed by location ($P<0.01$).

Animal breed differences ($P<0.05$) also were found for serum Zn, with concentrations for Kacang goats higher than PE. Furthermore, none of the samples taken from Kacang goats in both locations indicated deficiency, while 10 and 26.7% of those from PE goats in Majene and Jeneponto, respectively, were below the suggested critical level of 0.6 μg/ml (McDowell, 1985). Variations due to the interaction of animal breed by location ($P<0.01$) were observed in serum Zn concentrations.

Liver Analyses. Liver mineral concentrations as related to animal breed and sampling location are shown in Table 3. Animal breed differences were observed for Cu ($P<0.05$), Fe ($P<0.10$) and Zn ($P<0.05$); while differences due to the sampling location were found for Co ($P<0.05$), Cu ($P<0.10$) and Se ($P<0.05$). Kacang goats had higher Cu and Zn but lower Fe concentrations than Pe goats. Liver samples taken from goats in Jeneponto had higher Co and Cu but lower Se compared to those in Majene.

None of the liver samples analyzed in this study was found below the critical level of 0.05 mg/kg for Co (McDowell, 1985). In agreement with previous study in cattle and buffaloes in South Sulawesi (Prabowo et al., 1990; Prabowo et al., 1991b), it seems that Co deficiency is not a problem in goats.

As the Kacang goats had higher ($P<0.05$) liver Cu than PE, and that Cu concentrations in Jeneponto were higher ($P<0.10$) than those in Majene, a smaller percentage of samples below the critical level of 75 mg/kg (McDowell, 1985) was found in Kacang than in PE goats, and also was found in Jeneponto than in Majene. The percentages for Kacang and PE goats, respectively were 10 and 26.7 in Majene, and 3.3 and 10 in Jeneponto.

There were no differences ($P>0.10$) in liver Mo concentrations due to the animal breed, location or their interaction. Individual evaluation of samples, based on the critical level of 4 mg/kg (McDowell, 1985) indicated that some of the liver samples were excessive. These conditions may indicate the negative interrelationship between Cu and Mo (Underwood, 1981). In this study, however, the average liver Cu concentrations also were found to be above the suggested critical level for a deficiency.

TABLE 3. LIVER MINERAL CONCENTRATIONS AS RELATED TO ANIMAL BREED AND SAMPLING LOCATION

Variable	Breed	Location						Significance[d]
		Majene			Jeneponto			
		Mean[a]	SE[b]	% Def[c]	Mean	SE	% Def	
Co, mg/kg	Kacang	0.36	0.03	0.0	0.43	0.02	0.0	L*
	PE	0.36	0.03	0.0	0.46	0.02	0.0	
Cu, mg/kg	Kacang	123	8	10.0	161	7	3.3	B*,L+
	PE	83	8	23.3	128	6	10.0	
Fe, mg/kg	Kacang	271	5	0.0	319	4	0.0	B+
	PE	301	5	0.0	367	4	0.0	
Mn, mg/kg	Kacang	8.0	0.18	10.0	7.8	0.15	16.7	
	PE	8.0	0.18	6.7	8.1	0.14	3.3	
Mo, mg/kg	Kacang	2.0	0.05	0.0	2.1	0.05	3.3	
	PE	2.3	0.05	6.7	2.4	0.04	10.0	
Se, mg/kg	Kacang	0.48	0.03	13.3	0.31	0.02	16.7	L*
	PE	0.44	0.03	16.7	0.28	0.02	26.7	
Zn, mg/kg	Kacang	114	1.7	0.0	113	1.4	0.0	B*
	PE	102	1.7	6.7	106	1.4	10.0	

[a]Least squares means of 30 samples/breed for each location.

[b]Standard error of least squares means.

[c]Percentage of deficient (excessive, in the case of Mo) samples, based on the following critical levels: Co, 0.05 mg/kg; Cu, 75 mg/kg; Fe, 180 mg/kg; Mn, 6 mg/kg; Mo, 4 mg/kg; Se, 0.25 mg/kg; Zn, 84 mg/kg (McDowell, 1985).

[d]B = animal breed, L = location; * = $P<0.05$, + = $P<0.10$.

Differences ($P<0.10$) were found for liver Fe due to the animal breed, with concentrations for Kacang goats higher than those for PE. However, the average liver Fe concentrations for both breeds in both locations were above the critical level of 180 mg/kg (McDowell, 1985), and none of the samples analyzed was deficient. As generally reported, nutritional Fe deficiency is not a problem for ruminants (Underwood, 1977).

Liver Mn concentrations were not different ($P>0.10$) between animal breeds and sampling locations. The average concentrations for both breeds and both locations were above the 6 mg/kg level indicating deficiency (McDowell,

1985). These results agreed with results of forage analyses. McDowell et al. (1978) suggested that Mn deficiency can best be detected when there is a combination of less than 6 mg/kg Mn in the liver and 20 mg/kg in the diet.

Location differences ($P<0.05$) were observed for liver Se, with concentrations in Majene higher than those in Jeneponto. However, the average liver Se concentrations for both breeds in both locations were above the critical level of 0.25 mg/kg (McDowell, 1985).

Kacang goats had higher ($P<0.05$) liver Zn than PE. In both locations, however, the incidence of deficiency for both breeds, based on the critical level of 84 mg/kg (McDowell, 1985) was low.

Bone Analyses. Results of bone mineral analyses as related to animal breed and sampling location were shown in Table 4. For all variables analyzed in bone samples, no differences ($P>0.10$) were found due to either animal breed, location or their interaction. The percentage of deficiencies for bone Ca and P, based on the critical levels suggested by Little (1972) in each animal breed and location were high. However, since bone breakage in live animals is not excessive, it is suggested that the critical levels may overestimate inadequacy of bone minerals.

Similar ($P>0.10$) bone Mg concentrations were found for both breeds in both locations. There was no critical level established for bone Mg in goats. The average concentration observed in this study, however, was above a value of 0.39 % reported by Prabowo et al. (1988) for bone Mg concentration in lambs fed a forage based diet.

The percentage of samples below the critical bone ash concentration suggested by McDowell (1985) was also high. Since the majority of components in bone ash are Ca and P (Maynard et al., 1979), the low content of bone ash may be attributed to the fact that bone Ca and P were found to be low.

TABLE 4. BONE MINERAL CONCENTRATIONS (DRY, FAT-FREE BASIS) AS RELATED TO ANIMAL BREED AND SAMPLING LOCATION

Variable	Breed	Location					
		Majene			Jeneponto		
		Mean[a]	SE[b]	% Def[c]	Mean	SE	% Def
Ca, %	Kacang	23.8	0.06	20.0	23.8	0.05	30.0
	PE	24.4	0.06	26.7	24.4	0.05	13.3
Mg, %	Kacang	0.47	0.01	-	0.47	0.01	-
	PE	0.42	0.01	-	0.42	0.01	-
P, %	Kacang	11.0	0.17	73.3	11.2	0.14	66.7
	PE	11.3	0.17	66.7	11.2	0.13	70.0
Ash, %	Kacang	65.3	0.63	86.7	65.8	0.53	83.3
	PE	66.3	0.63	63.3	66.0	0.47	70.0

[a]Least squares means of 30 samples/breed for each location.

[b]Standard error of least squares means.

[c]Percentage of deficient samples, based on the following critical levels: Ca, 24.5%; P, 11.5%; Ash, 66.8% (Little, 1972; McDowell, 1985).

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EFFECTS OF FEEDING MOLASSES-UREA BLOCKS ON GROWTH RATE AND ONSET OF PUBERTY IN ETTAWA-CROSS GOATS

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ABSTRACT

The effect of supplying Non-Protein Nitrogen in Molasses-Urea Blocks (MUB) on weight gain, date of first oestrus, kidding date and birthweight of kids, was studied in two groups of Ettawa cross pre-puberal does. Growth rate was not affected by the MUB supplement, probably because the grass was harvested from an area with plenty of moisture during the entire experimental period and it was sufficiently high in N. However, the onset of first oestrus was about 3 weeks earlier, kidding was earlier and birthweights of the kids born were heavier in the group supplemented with MUB.

Introduction

The authors are interested in developing feeding systems for small ruminants, which increase productivity, but which are affordable by smallholder farmers in Indonesia.

In the densely populated islands of Java and Bali, most ruminants are kept in sheds (*kandangs*) with their feed being brought to them using the so-called 'cut-and-carry' system. Thus, although they may be tethered or loose between harvest and planting, at least a large proportion (if not all) of the feed is harvested by the farmer and brought to the animals in the *kandang*. It is well known that native grasses in the tropics contain low protein and high fibre except when very young. They become mature quickly due to high environmental temperatures.

We thus got interested in the concepts of Preston and Leng (1987) who postulated that on high fibre, forage-based diets in the tropics, energy intake is never the primary factor limiting ruminant production. They believe that two systems have to be considered:

a. there must be sufficient ammonia in the rumen fluid for efficient microbial synthesis. Since protein sources are expensive, the cheaper non-protein nitrogen (NPN) can be used and be equally efficient;

b. for maximum production, feeding sufficient bypass protein which avoids the rumen and breakdown by the rumen microorganism and can be used directly by the animal itself, should be fed.

In this report, an experiment is described in which NPN in Molasses-Urea Blocks (MUB's) was provided to one experimental group and the effects of this supplementation on growth, onset of puberty and fertility of Ettawa-cross does were studied.

Materials and Methods

Animals. Ettawa-cross (Peranakan Ettawa or PE) goats were chosen because it has been the policy of the Indonesian government to cross the local Kacang with Ettawa, so that now in Bali it is difficult to find pure Kacang animals and most of the goats are indeed PE.

Thirty-two pre-puberal PE does eight to ten months old, and four PE bucks (three two-tooth and one about eight months old) were bought from one source near Klungkung. In addition, four similar bucks were fitted with rumen fistulae and used for the measurement of digestibility and of ammonia content in the rumen fluid.

All animals were treated for endoparasites and ectoparasites by injection with Ivomec soon after arrival and three weeks later. The smallest buck and the smallest doe died after the first injection. In addition, two does were found to be pregnant, kidding within two months after arrival and were excluded from the results.

Housing. Within the covered shed in which the goats lived, the raised pens were made of bamboo sides and floor slats. The feed trough faced towards the middle of the shed and the gates were on the outer side of the covered area.

Experimental Design and Treatments. Does were allocated by randomization (restricted by body weight) into two groups: group A fed cut grass *ad libitum*, while group B was fed the same ration, but received in addition Molasses-Urea Blocks (MUB) *ad libitum*. Unlimited water was available to all goats at all times. The composition of the MUB's is given in Table 1. The does were kept in group pens, with four animals per pen. Thus, a complete randomized block design was used with four replicates with four animals in each group.

TABLE 1. PERCENTAGE COMPOSITION OF THE MOLASSES UREA BLOCKS (MUB)

Component	%
Molasses	46
Urea	6
Rice polishings	25
Coconut meal	10
Vitamin premix	2
NaCl	5
CaO	6
Total	100

Measurements Made. Fresh grass was cut and fed to the goats at 8 am and 4 pm. Grass was cut from areas which never had grazing animals on them and could thus be considered free of parasites. Residues of grass, MUB and water were collected and measured before the morning feed to calculate daily intakes. Oestrus was checked daily with two bucks, and the goats were weighed once a week.

The determination of ammonia, in the rumen fluid using the fistulated bucks was carried out by the hypochlorite solution method (Leng et al., 1992) using a spectrophotometer. Digestibility was measured also using the fistulated bucks, by weighing nylon bags with the feed before and after incubation in the rumen fluid for 24 hours.

The experiment began on 26 May, 1992 and finished on 6 February 1993. Mean weekly body weights and feed as well as water intakes are given only for the first 16 weeks (until 15 September, 1992) because after that the increasing pregnancy of some goats complicated the results and made them meaningless.

Oestrus continued to be checked daily until the end of May when animals were sold. Kidding dates and birthweights were also recorded.

Results and Discussion

Intakes and Bodyweights. Figure 1 shows mean daily intake of grass (g) per goat for groups A and B, mean daily intake of MUB (g) per goat per day for group B, mean daily intake of water (ml) of both groups, and mean weekly bodyweights. Table 2 show analyses of body weights and body weight gains as well as of grass and water consumption during the first 16 weeks of the experiment.

TABLE 2. ANALYSIS OF BODYWEIGHT FEED AND WATER CONSUMPTION OF FEMALE GOATS FED GRASS ONLY (A) AND GRASS PLUS MUB (B) DURING THE FIRST 16 WEEKS' OBSERVATION (26 MAY TO 15 SEPTEMBER 1992)

	A	B
Initial body weight (kg)	14.5[a]	15.3[a]
Final body weight (kg)	17.9[a]	19.3[a]
Weight gain (kg)	3.5[a]	4.1[a]
Feed consumption/head		
- Grass (kg)	269[a]	279[a]
- UMB (kg)	-	6.7
Water consumption (liter)	6.8[a]	24.4[b]

Values in the same line with different letters are significantly different ($P < 0.05$).

It can be seen that grass intakes were similar in the two experimental groups. Goats in group B took a variable and relatively long time to start eating MUBs. It took them ten weeks before they were eating approximately 100g per goat per day. This long learning time could probably be much reduced if a 'teacher' goat (already eating MUB) could be included in each per as Chapple et al. (1987) found that the presence of a sheep already eating wheat hastened the acceptance of wheat of other animals.

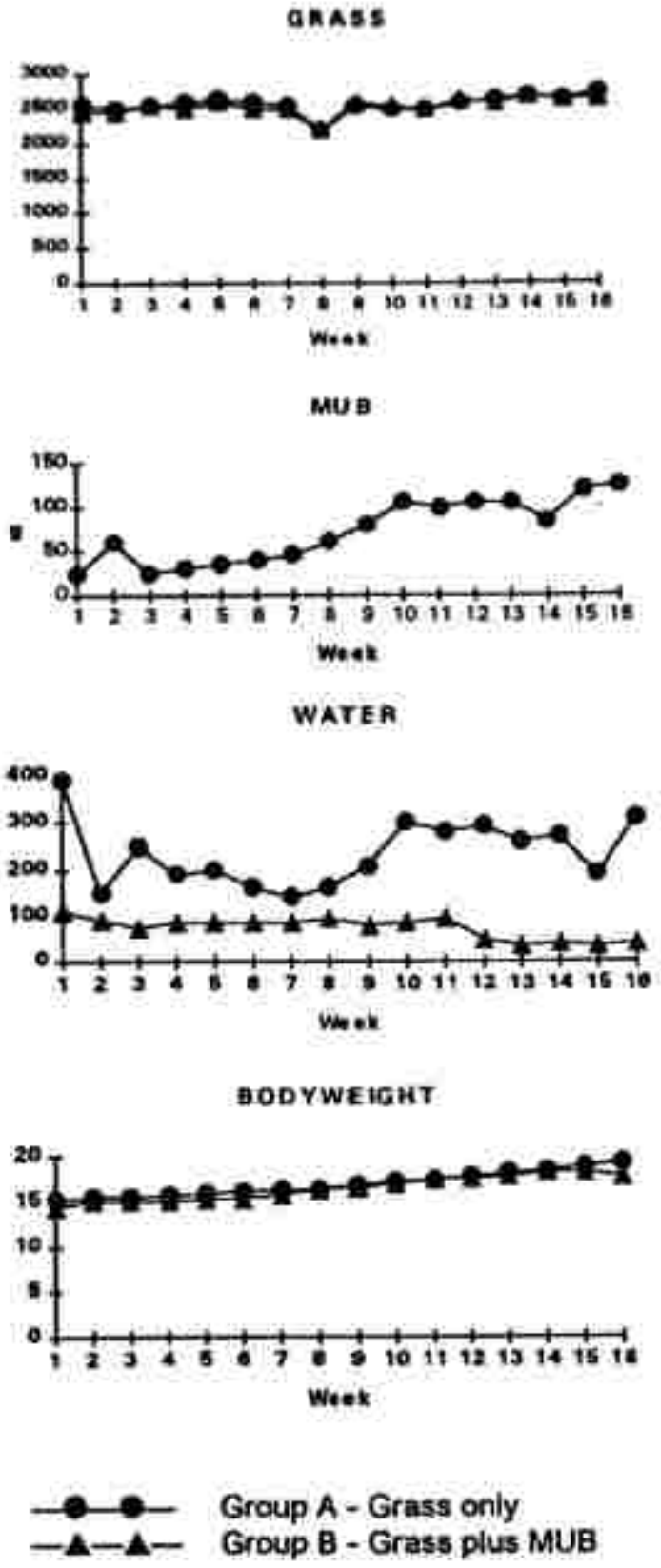

Figure 1. Intakes and bodyweights during the first 16 weeks

It can be seen that goats in the two groups showed similar increases in body weight. The mean bodyweight of group B was higher from the beginning of the experiment, due to the death of the smallest doe in group B after drenching and after randomization, but the slopes of the body weight curves are similar. The mean growth rates were 31 g/d for group A and 37 g/d for group B.

Significantly more water was drunk by animals in group B which were more thirsty, probably due to the high mineral content of the MUB.

The results from the fistulated animals were interesting. The total digestible intakes of the fistulated bucks on the two rations were not different enough to cause differences in total digestible intake. Perhaps unexpectedly, the levels of ammonia in the rumen fluid were similar and relatively high being 215mg per liter for the group A and 200mg per liter for the group B diets.

Thus the cut grass was sufficiently high in protein throughout the experiment. This was due to the fact that the area from where grass was cut is fertile and moist throughout the year producing unusually leafy, green grass. This would not be true of the grass grown during the dry season in other Eastern Islands, including large parts of Bali, and this experiment should be repeated in those drier parts where the supplementation with NPN in MUB would be expected to be more beneficial.

Onset of Oestrus, Conception, Fertility. Table 3 shows the mean incidence of first oestrus in the two groups, when the does kidded (during the experiment) and how many does were still cycling. Mean birthweights (as well as the range) are also given in this Table.

TABLE 3. SOME REPRODUCTIVE PARAMETERS

	A	B
No. of does	14	14
First oestrus*	73	53
Kidded by d 256*	4	7
Kidded by d 378*	5	10
Pregnant by d 378*	7	14
Still cycling at d 378*	7	0
Mean birthweights (kg)	1.9	2.3
Range (kg)	(1.6 - 2.3)	(1.7 - 2.5)

* Days after the beginning of the experiment.

It can be seen from Table 3 that the onset of puberty as evinced by first oestrus was 20 days earlier in the supplemented group B and kidding was earlier. All ewes from group B were obviously pregnant by day 378 (6 June, 1993), whereas 7 does from group A were still cycling and thus not yet pregnant

Finally it would also be useful in the future to have a group receiving also a bypass protein which would be expected to increase liveweight gains. Initially, fish meal (which is about 50% protected protein) could be used. Then, it would be of interest to treat locally available feeds including tree legumes, so that they would bypass the rumen and that amino acids would be absorbed from the abomasum. It would also be of interest to carry out experiments with younger, just weaned animals with a higher growth potential.

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Session V
Animal Health and Networking

SMALL RUMINANT HEALTH AND DISEASE RESEARCH AND DEVELOPMENT IN INDONESIA

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ABSTRACT

Sheep and goats, as small ruminants, are important animals for small holders in rural areas of Indonesia. The populations of both sheep and goats are low. One of the major constraints that is considered to influence growth rate is disease. A wide range of important diseases of sheep and goats have been reported but there is a lack of information on aetiology and epidemiology. Research was directed to identify missing information needed for disease prevention and control. The limited number of research staff working on small ruminant diseases and limited funding are considered to be major constraints to the development of research on small ruminant health and disease. Efforts for the development of small ruminant disease research in Indonesia are also discussed.

Introduction

Small ruminants, sheep and goats, are important animals for small holder farmers in rural areas of Indonesia. Although the animals are raised traditionally by farmers as a sideline to the main agricultural activities, they contribute from 14% to 25% of the total annual income of smallholders (Knipscheer et al., 1983). The populations of both sheep and goats are low at present at around 6 million and 11 million for sheep and goats respectively (Biro Pusat Statistik, 1991).

One of the major constraints to increasing sheep and goat production are disease and health problems. A range of small ruminant diseases and health problems has been reported since the Dutch occupation. However, most of them still need further research. Research activities on small ruminant health and diseases have made promising progress, and constraints to development have been identified.

This paper describes diseases of sheep and goats in Indonesia, research and development in veterinary science and previous and present research on small ruminant diseases carried out at the Research Institute for Veterinary Science (RIVS), Bogor.

Institutions Responsible for Research in Veterinary Science in Indonesia

The Research Institute for Veterinary Science (RIVS) or Balai Penelitian Veteriner (Balitvet) is the institution that has responsibility for research in veterinary science. The Institute also is a reference laboratory for veterinary laboratory diagnosis in Indonesia. Other institutes that carry out research in veterinary science are educational institutes which have a veterinary faculty. There are 5 such universities: Bogor Agricultural Institute, University of Syah Kuala, Gajah Mada, Airlangga and Udayana. However, most of them have limited facilities to study infectious diseases than RIVS. There are 7 Disease Investigation Centers (DIC) distributed throughout Indonesia. The DIC are responsible for disease monitoring, investigation and diagnosis, and they are the reference for the smaller veterinary laboratories in Indonesia. Research units may also be set up by the government for specific animal diseases, such as the Bali Cattle Disease Investigation Unit (BCDIU) for Jembrana disease in Bali Cattle. Although most of those laboratories do not conduct research, they contribute useful information on animal diseases.

Small Ruminant Diseases in Indonesia

A wide range of diseases of sheep and goats has been reported in Indonesia. These include viral, bacterial, and parasitic diseases. Only a few of the reported diseases are non-infectious diseases. Others are still of unknown cause. The information presented in this paper is from research findings or case reports published by the institutions mentioned above and from personal communication, up to early 1993.

Viral Diseases. One of the most common viral disease of sheep and goats is Contagious ecthyma (Orf). In Indonesia, Orf was reported first by Van Der Laan (1919). The disease may be a problem in susceptible sheep and goat populations with a morbidity of up to 100% and mortality as high as 20%, usually when the animals are stressed (Adjid, 1992). When infected animals are sold, the price is reduced by up to 80% (Adjid et al., 1989b). At present the disease is widely distributed in areas where sheep and goats are raised.

Another viral disease is blue tongue (BT). Blue tongue with severe clinical signs has been identified only in imported sheep (Sudana and Malole, 1982a). Although Sendow et al. (1986) in a serological study reported the prevalence of

BT viral antibodies in local sheep and goats, no clinical cases of the disease have been reported up to the present. The role of sheep in carrying malignant catarrhal fever (MCF) viral agents has been observed (Wiyono, 1993, personal communication). Indonesia has been free of Foot and Mouth Disease since 1984 (Direktorat Jenderal Peternakan, 1985), and the disease is now exotic for Indonesia. There are no reports of other viral diseases of sheep and goats up to present.

Bacterial Diseases. Sudana and Malole (1982b) reported foot rot in goats caused by *Sphaerophorus necrophorus* (Fusobacterium necroporum). Worral et al. (1987) isolated *Clostridium novyi* from the liver of healthy sheep and goats. This agent potentially causes black disease of sheep and goats when the animals suffer from fascioliasis. Poernomo et al. (1986) reported the isolation of *Salmonella spp.* from sheep. Caseous lymphadenitis has been reported only in imported sheep (Sudarisman, 1990, personal communication). Hastiono (1993) stated that prevalence of Chlamydial infection in sheep was 14.2% as detected by a serological test. However, no clinical cases of abortion were observed.

Parasitic Diseases. Parasitic diseases are the most common cause of disease in sheep and goats in Indonesia. A range of intestinal parasites has been reported including *Haemonchus sp., Strongyloides sp., Ostetargia sp., Bunostomum sp., Oesophagostomum sp., Trichostrongylus sp., Cooperia sp., Fasciola sp., Paramphistomum sp.,* and *Eimeria sp.* (Peranginangin and Heryanto, 1985; Beriajaya, 1984; Kusumamihardja, 1988). Arasu et al. (1991) reported pancreatic fluke in sheep. Soesilo et al. (1988) reported coccidiosis in goats. The role of infestation of paramphistome fluke (*G. explanatum*) in sheep was also studied (Wiedosari, 1989).

For external parasites, scabies is the primary disease of goats (Manurung, 1988) causing economic loss. Soesilo et al. (1988) reported that *Damalinia ovis* infestation was also common in small ruminants. Infestation of a blow fly larvae (maggots) sometime causes health problems in injured animals (Adjid et al., 1989a).

Non-infectious Diseases. Soesilo et al. (1988) reported plant poisoning caused by *Leucaena sp.* Cyanide poisoning in sheep that fed Sorghum spp. was reported by Bahri et al.(1985). Kusumamihardja (1979), and Zahari et al. (1984) reported facial eczema cases of sheep. Ronohardjo (1981) also reported a skin problem in sheep characterized by symmetrical dermatitis caused by photosensitization (Bahri, 1988). Neonatal mortality of sheep in relation to T4 hormone deficiency was also reported (Bahri, 1983). Cases of goiter in goats was reported by Bahri et al. (1987). The mycotoxin of fusarium deoxynivalenol was reported by Bahri et al. (1990b) as a primary cause of death in a flock of sheep. Darmono et al. (1988) reported that zinc deficiency may be a problem in small ruminants in Indonesia. Bahri et al. (1990a) also reported a possible sodium deficiency in the sheep population.

Others (Unidentified Aetiology). Histopathologically, the most common conditions were pneumonia (31%), enteritis (12%), and hepatitis (4%) (Iskandar et al., 1984). Adjid et.al. (1989a) reported that clinically the most common problem of sheep was diarrhoea and a high neonatal mortality rate. Soesilo et al. (1988) reported the occurrence of clinical signs of the following disease of goats: cachexia, tympany, dystocia, mastitis, infectious conjunctivitis, and abscesses.

Small Ruminant Diseases Research at the RIVS

1. ***Previous Research Activities (1992-1993) and Research Findings.*** Research on small ruminant diseases conducted at the Research Institute for Veterinary Science for the period 1992-1993 revealed the following:

Contagious ecthyma (Orf). Orf is the most common viral disease of sheep and goats in Indonesia. It is reported frequently especially when after the transportation of sheep and goats. Prevention by vaccination is not used due to the lack of available vaccine in Indonesia. The virus is considered to have more than one strain. For the period 1992/1993 study of the disease was directed to identify strain variation by looking at genomic variation among the Orf viral isolates. It was shown from the three isolates tested, that there was genomic variation among the isolates, suggesting more than one orf virus strain is present in Indonesia.

Scabies. Scabies is the most common skin disease of goats. The disease causes considerable economic loss. Effective medicine is available for treating the disease. However, smallholder farmers could not afford to buy the medicine and it is not easily obtained by farmers in rural areas. Research was conducted to find out an effective medicine from materials available in villages. The study showed promising results when 2,5% sulfur in vaseline or 0.75% detergent (soap) plus 1.5% sulfur were used for scabies treatment. However, further studies were needed to identify the effectiveness of the medicine when applied in field condition, and to investigate factors affecting successful treatment.

Nematodiasis. Nematode infestation is the most common health problem of sheep and goats. The disease is wide spread and considered to be the most important parasitic disease of sheep and goats in Indonesia. The study was carried out to identify the epidemiology and the prevention of the disease in sheep raised by smallholder farmers. The study is incomplete but available results show that monthly anthelmintic treatment was not sufficient to reduce nematodiasis to the safety level (epg less than 1000) in sheep raised under rubber plantation areas. There was a reduction of the growth rate in untreated animals aged 6 to 12 months.

Coccidiosis. Coccidiosis is an intestinal disorder cased by *Eimeria sp.* It causes problems predominantly in lambs. However there is a lack of information on the disease in Indonesian small ruminants. A preliminary study was directed to isolate and identified *Eimeria sp.* in sheep and goats in Indonesia. It showed that the prevalence of coccidiosis was 58,3% with mixed infection of *E. parva, E. pallida, E. crandalis, E. ovina* and *E. granulosa.*

Chlamydiasis. Chlamydiasis may cause abortion in sheep and goats. So far, there have been no reports of the disease in Indonesia. A serological study was carried out to identify the presence of reactors in sheep and goats in Indonesia. Of 649 sheep sera tested, 14.2% contained antibodies to Chlamydia, and no antibodies were detected from 6 goats sera using the CF test. No agent was isolated and no cases of abortion were found.

Abortion and Neonatal Mortality. Neonatal mortality is frequently found on traditional sheep farms. However, the primary causes and the conditions which cause the problems are still unclear. A preliminary study showed that the mortality rate was 16.4% with prevalence from 4%-25%. Around 80% of the dead animals were from twins and triplets, not single. The aged 0-24 hours was considered to be a critical time. From 2 dead new born lambs, no specific lesions were found when examined by gross and histopathology. Isolation of bacterial agents from intestinal organs was unsuccessful. The study failed to identify the primary cause of the death, but sheep production management was considered to have a major effect leading to starvation. Infectious diseases was still thought to be involved in neonatal mortality. Further integrated studies are needed to identify the cause of the problem.

Pesticide. One of the commonest pesticides used in soybean and sugar cane farms is Thiodan. It contains endosulfan. Because small ruminants are also grazed around plantation areas and usually soybean leaf and sugar cane leafs are given by farmers, it is important to study the effect of endosulfan on sheep and goats. Research was directed to study the kinetics of endosulfan in goats kept under laboratory conditions. The study showed that conjugation peroses with glucuronide acid reduced the toxicity of endosulfan.

Traditional Medicine for Small Ruminant Health Problems. The availability of traditional medicine may help and encourage farmers to increase sheep and goats productions in rural areas. In this period research was directed to the study of traditional medicine for the control of secondary bacterial infections associated with contagious ecthyma (Orf) or scabies. The effectivity of *Usnea app* extract on bacterial agents isolated from the case of Orf was studied *in vitro*. This showed that *Usnea app.* extract inhibited the growth of bacterial agents isolated from Orf and scabies cases. It was suggested that the study be continued to ascertain its application in field condition.

Tympany. Tympany is a non infectious health problem of sheep and goats frequently found in field. It frequently causes death. A preliminary study was carried out to identify plants and other condition that cause the problem. The study showed that under field conditions the mortality rate was 3.4% within a period of 3 months. Fresh cassava leafs/wet leafs were identified as the cause of the problem in sheep and goats that do not usually feed an on the leafs. The use of coconut oil results in 80% recovery. It was suggested that deaths due to tympany were not identified by the farmer because the tympany probably occurred during the night. Laboratory work showed that tympany was caused by plants containing a high content of nitrate given in the morning when leafs was still wet. Feeding with fresh cassava leafs given in the morning and fasting or stress conditions produce tympany.

2. ***Present Research Activities (1993-1994).*** Research activities for the period 1993-1994 are shown in Table 1. Most of the research activities during this period are a continuation from previous research activities.

Twelve research activities on small ruminant health problems were conducted at the RIVS. They include viral, bacterial and parasitic diseases, poisonous plants, neonatal mortality and traditional medicine. These activities are conducted by 11 research scientists. Most of the projects are preliminary studies.

Development of Small Ruminant Disease Research at the RIVS

To increase the capability of the Institute to do research on small ruminant diseases, several initiatives have been made over the past ten years. They include education, training, and purchasing more advanced equipments. Post graduate study and training are carried out to increase the scientific capability and abilities to carry out research. At present 2 research staff have completed PhDs, and 3 are expecting PhD. Providing more advanced equipment allows the research staff to develop more sensitive, accurate and faster diagnostic tests for defining health problem and developing new technologies.

TABLE 1. PRESENT RESEARCH ACTIVITIES (1993/94)
ON SMALL RUMINANTS CARRIED OUT
AT THE RESEARCH INSTITUTE FOR VETERINARY SCIENCE (RIVS)

Diseases		Aspect
Viral		
	Orf	Development of vaccine
Parasitic		
	Nematodiasis	Control of nematodiasis using anthelmintic combined with mineral supplementation
		Effectiveness of *Carica papaya L* seed for controlling *Haemonchus contortus* infestation
	Scabies	Control of scabies using traditional medicine (plants) in *vitro*
		Effect of *Anona squamosa L* extract on bacterial agents isolated from scabies cases in *vitro*
Bacterial		
	Brucellosis	Characterization of *B. abortus* causing abortion in goats
Poisonous Plants		
		Effect of poisonous plants on milk production
		Toxic effect of pyrolizidin on small ruminants
		Epidemiology of alkaloidosis in small ruminants
		Plants as heavy metal accumulator and it effect on animal production
		Plants containing nitrate/nitrite and their effect on production
Others		
	Neonatal mortality	
		Epidemiology of neonatal mortality in sheep

Constraints in Research and Development at the RIVS

The limited number of research scientists is considered to be the major constraint in small ruminant research and development at the Institute. In addition not all research staff trained on small ruminants are now working on that topic. Last year only 6% of a total 67 research staff were working on small ruminant health problems. Efforts have been made to invite research staff at the Institute to work on small ruminant diseases research. Another constraint is lack of funds provided by the government. These conditions do not maximize the ability and capability of the research staff to do a research. Additional funds from other funding agencies must be forth coming. Another important consideration is a communication network among scientists working on small ruminant diseases in Indonesia. This regional network will encourage and help other scientist to do research on small ruminant diseases and to avoid duplication. An international network would also be useful for Indonesian scientist. However, this forum is not yet established.

Conclusion and Recommendations

Present research on small ruminant disease and health problem in Indonesia is inadequate. There is a need for more research staff conducting research on small ruminants diseases. The important health problems of unknown aetiology need more attention and integrated research involving many disciplines including, health, epidemiology, nutrition, breeding, genetics and management. Additional funds from other funding bodies is expected to stimulate and accelerate research on small ruminants diseases. A communication network should be established among scientists working on small ruminant diseases in Indonesia. An international communication network with other institutions working on similar problems would also give additional benefits for Indonesian scientists.

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PANCREATIC FLUKE: PROBLEM AND SOLUTION

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ABSTRACT

In the last three years, it has been reported that most sheep which have been routinely slaughtered or have died naturally at Sungai Putih, North Sumatra were infected with pancreatic fluke, *Eurytrema pancreaticum*. No significant clinical symptoms were seen in those animals except inappetence and loss of weight, and most of animals were apparently healthy. At the present, little is known on the species of intermediate hosts, land snails and grasshoppers, which play an important role in the magnitude of infection in Indonesian sheep. There have also been relatively few studies on the chemotherapy of this fluke and most chemicals tested were not effective. Further research is recommended to reduce the magnitude of infection of *E. pancreaticum* associated with sheep grazed in rubber plantations.

Introduction

Disease caused by pancreatic fluke is recently recognized as a problem in sheep grazing in rubber plantations in North Sumatra (Gatenby et al., 1992). Post mortem examinations have confirmed severe infections of pancreatic fluke in the pancreas of sheep which died naturally. Affected sheep showed a syndrome of progressive wasting and weakness, emaciation, recumbency and eventually death in adult Sumatran Thin-tail (indigenous) and St. Croix (introduced) sheep grazed in a rubber plantation (Graydon et al., 1992).

It has also been reported that heavy infections with pancreatic fluke caused a loss of weight in sheep in Russia (Vsevelodov, 1937). Apart from inappetence and loss of weight, no other clinal symptoms were shown. This paper reviews current knowledge of infections with pancreatic fluke and some possible solutions to solve the problem especially with sheep grazed in a rubber plantation in North Sumatra.

The Species of Fluke

The species of fluke is *Eurytrema pancreaticum* (Jansen, 1889) which is found in the pancreatic ducts and sometimes in the bile ducts and the duodenum of sheep, goats, cattle and buffaloes in Eastern Asia and Brazil and humans in China (Soulsby, 1982) and Japan (Ishii et al., 1983; Takaoka et al., 1983). The fluke measures 8-16 by 5-8.5 mm. The body is thick and armed with spines, which are often lost in the adult stage. The eggs measure 40-50 by 23-34 microns.

Two other species, *E. ovis* and *E. coelomaticum* have been described from domestic and other ruminants but it is not clear whether these are all distinct species. *E. ovis* occurs in the perirectal fat of sheep in the Philippines and *E. coelomaticum* is common in the pancreatic ducts of sheep and cattle in Brazil and other parts of South America, Europe and Asia (Soulsby, 1982).

Life Cycle

The life cycle of the pancreatic fluke is like that of other digenetic trematodes. This species requires two intermediate hosts. Tang (1950) found that the two land snails, *Bradybaena similaris* and *Cathaica ravida sieboldtiana*, belonging to the family Fruiticoidolidae, serve as first intermediate hosts. The hermaphroditic adult worm produces eggs which are passed out with the feces of the host. These eggs do not hatch until eaten by the land snail. Two generations of sporocysts occur in the snails. The second generation produces cercariae about 5 months after infection. The mature daughter sporocysts are passed out through the respiratory aperture of the snail and are deposited upon vegetation. Cercariae are extruded onto herbage and are eaten by grasshoppers, *Conocephalus maculatus*, and three crickets, *Oecanthus longicaudus*, which serve as secondary intermediate hosts in Malaysia (Basch, 1966) and the USSR.

Basch (1966) reported that in Malaysia the infection rate of the land snail, *Bradybaena similaris*, was approximately 6% of 2,114 examined, and in the grasshopper, *Conocephalus maculatus*, 3.8% of 1,036 specimens contained metacercaria, with an average of 210 per infected insect. In China, *Ganesella virgo* was reported as the first intermediate host and the meadow grasshopper, *Conocephalus chinensis*, as the second intermediate host (Gu et al., 1990). Moreover, Gu et al. (1990) reported the rate of larval infection was 6.18% and 2.8% respectively from Daxinganling Mountain and the foot of mountain.

In Indonesia, little is known on the species of land snail and the grasshopper which can act as intermediate hosts. In North Sumatra, long-horned green grasshoppers of the family Tettigonidae have been confirmed as the second intermediate host (Arasu et al., 1991).

In this host the individual cercariae penetrate the wall of the intestine and form a pearly cyst. Metacercaria occur in the haemocoele becoming infective 3 weeks after infection of the grasshopper. Sheep and goats are infected by inadvertently eating infected grasshoppers, the immature flukes migrating via the pancreatic duct. The prepatent period in goats is 7 weeks and in sheep and cattle is 80-100 days (Nadykto, 1973). All transmission of this trematode is passive, and each stage must be eaten by the next host to develop. This life cycle is like that of the related liver fluke, *Dicrocoelium dendriticum* which involves a land snail and an insect (ant).

Pathogenesis

Soulsby (1982) stated that a few flukes cause little change in the pancreas but usually there is catarrhal inflammation with destruction of duct epithelium. Eggs may penetrate into the wall of ducts causing inflammatory foci and granulomata in which plasma cells and eosinophils predominate. Severe fibrosis may occur producing atrophy of the pancreas but the remaining parenchyma is normal, but no other clinical signs have been definitely ascribed to these parasites.

Wilson (1992) reported that the pathogenesis of *Eurytrema pancreaticum* can be categorized into three stages. First, marked fibrosis around the pancreatic ducts caused by invasion of immature fluke which subsequently become mature to the egg-laying stage. In Sungai Putih it was found that 91 percent of all infected animals showed fibrosis of the pancreatic ducts. Second, destruction of the islets of Langerhans (which produce insulin) and glandular tissue (which produces digestive enzymes) is thought to be due to the movement of eggs into tissue. This stage is associated with massive inter-lobular and intra-lobular fibrosis and general necrosis of all parts of the pancreas. In long-standing cases involving emaciated, recumbent sheep, Graydon et al. (1992) found large periodic acid Schiff positive vacuoles in the pancreatic islet cells. Lastly, development of toxic changes in the liver as a direct result of metabolic disturbances caused by the destruction of the islets of Langerhans. This stage leads to widespread degenerative changes in the hepatocytes of the liver, beginning with centro-lobular fatty degeneration and ending with generalized necrosis and hepatic failure. Nephrosis was also found in severe cases. Gatenby et al. (1992) reported that 9 percent of all infected animals showed some necrosis in the liver confirming that infection was at an early stage. Sheep with such severe lesions had marked glycosuria (>500 mg/ml). Graydon et al. (1992) postulated that the animals were suffering from terminal diabetes mellitus, preceded by gradual development of chronic pancreatitis and pancreas enzyme insufficiency.

Treatment

A variety of anthelmintics including hexachloroparaxylene, hexachloroethane, chlorophos, bithionol, niclofolan and thiabendazole have been tried without success (Soulsby, 1982). However, several authors reported that nitroxynil may be effective against *E. pancreaticum* in Korean native goats (Suh, 1983) and *E. coelomaticum* in cattle (Kono et al., 1981).

Li et al. (1983) also reported that praziquantel in an oral dose of 50-70 mg/kg was very effective for the treatment of sheep heavily infected with pancreatic fluke. Gatenby et al. (1992) carried out an experiment to test the efficacy of nitroxynil, praziquantel and albendazole in the control of pancreatic fluke in sheep at Sub-Balai Penelitian Ternak Sungai Putih, Medan. Although albendazole and praziquantel significantly reduced the level of infection of pancreatic fluke, neither drug reduced the infection to a negligible level. They suggested that more frequent doses of the drugs or higher dose rates may be more effective but are unlikely to be of economic benefit.

The effect of phenasal (niclosamide) at 0.25 g/kg body weight on the genital system of *E. pancreaticum* was studied by Nacheva and Grebenshchikov (1983). They found the anthelmintic affected gametogenesis and the development of vitelline cells, prevented the formation of ova, destroyed the prostate shell glands and reduced the amounts of glycogen and protein in the trematode tissue. Substituted salicylanides (preparations G-937 and G-1026) and of Oksinid (a bisphenol derivative) on the carbohydrate metabolism and some key enzymes of *E. pancreaticum* were tested in vitro (Vykhrestyuk et al., 1984). All three anthelmintic compounds killed *E. pancreaticum* in 24 h (at 5.10-5M/litre medium) and affected the composition of the final products of carbohydrate metabolism in both aerobic and anaerobic conditions. All three compounds reduced the activities of hexokinase, fumarate reductase and malate dehydrogenase (Oksinid fully inhibited hexokinase). G-937 and G-1026 inhibited pyruvate kinase activity. Oksinid had no effect on pyruvate kinase or phosphopyruvate carboxylase activities.

Problem and Solution

A large proportion of sheep in North Sumatra appear to be infected with pancreatic fluke. Arasu et al. (1991) reported that 4 out of 10 Sumatran Thin Tail sheep slaughtered in Medan were infected with pancreatic fluke. However, Partoutomo et al. (1976) who carried out abbatoir surveys in Sumatra reported that pancreatic flukes were recovered only from 3.12 percent of cattle and 0.06 percent of buffaloes slaughtered, and none were found in sheep and goats. As the pancreas is diffuse in the mesenterium, it is likely that this organ is not observed during quick slaughter in the abbatoir. This situation has been

experienced by the author when examining sheep slaughtered for the drug trial in Sungai Putih near Medan. Another possibility is that the system of grazing sheep under rubber plantations was not yet introduced at that time. Surveys are needed to determine the prevalence of infection, geographical distribution of the fluke and other related factors, and to answer the question whether pancreatic fluke are restricted to sheep grazing in rubber plantations.

This parasite has two intermediate hosts. Only limited reports are available in Indonesia to confirm that land snails and grasshoppers can serve as a intermediate hosts. Sheep are infected by eating grasshoppers. Gatenby et al. (1992) postulate that it is unlikely that healthy grasshoppers would allow themselves to be eaten, but those infected with metacercaria of fluke are probably sick and do not jump away from the mouth of sheep. Basch (1966) reported that during the dissections of field grasshoppers it was noticed that some individuals were hosts for Mermithidae or other nematode parasites; and in other grasshoppers, the viscera were necrotic or of a caseous texture presumably because of a virus infection. Thorough long-term studies on the population dynamics, population density and the rate of infection of intermediate hosts and other factors related to the life span of intermediate hosts may increase our understanding of the life cycle of the pancreatic fluke, determine the period that the final development stage remains infective in grasshoppers and seasonal patterns of infection of grasshoppers and sheep in rubber plantations.

Pancreatic fluke appear to be causing morbidity and also contributing to mortality. Those infected animals which have died naturally were emaciated. Post-mortem examinations suggest that in seven out of nineteen adult sheep at Sungai Putih in 1991, pancreatic fluke contributed towards death (Gatenby et al., 1992). Studies with sheep artificially infected may also help to determine the clinical pathology and pathogenesis of disease and establish the life cycle of *Eurytrema* spp. (Carmichael, 1991).

There is not yet a recognized chemical for the treatment of pancreatic fluke. Relatively few studies on the chemotherapy of pancreatic flukes have been carried out, and more studies are needed to find a chemical which is highly effective against immature and mature fluke.

Management systems for preventing nematode infections such as spelling pastures or preventing faecal contamination on pasture may help to control pancreatic fluke. This issue has to be tested based on the epidemiology of infections with *E. pancreaticum* and factors related to the breeding habit of infected intermediate hosts. In China, measures for treating infected sheep, killing intermediate hosts, grazing on designated regions and establishing *E. pancreaticum*-free flocks were carried out during 1981-1984 (Shu et al., 1987). The results showed that the infection rate on the farm decreased from 37.4% to 1.8%, and the body condition and production performance of the sheep improved greatly.

A situation involving at least five factors: the trematode in its various developmental stages, the snail and grasshopper as the two intermediate hosts, the mammalian host for the adult trematode and the microsporidian disease of the worm may make control strategies complex. In addition, diseases resembling viral polyhidrosis may also make the grasshopper unsuitable and therefore suppress dissemination of the pancreatic fluke. This fact may help to introduce a means of biological control of the grasshoppers. Basch (1966) suggested that matters such as total number of sporocysts produced in an infected snail, periodicity of shedding of sporocysts, relationships of snail and grasshopper to specific vegetation, breeding habits and life history of both intermediate hosts, and the influence of climate on transmission must be further studied.

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NETWORKING IN SMALL RUMINANTS

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ABSTRACT

One may consider that the present production systems of small ruminants in Asia may well be the most sustainable, since many technology transfer efforts have not been very successful. It is foreseen that rapid global change may force different approaches to be implemented. A network, considered as a powerful mechanism in exchanging knowledge and a tool for communication and information delivery, can contribute to the development of production systems through research activities. Characteristics of a network along with the problems and specifically the outlook in the future are discussed in this paper to stimulate education and research activities aimed at improving small ruminant production systems.

Introduction

Small ruminant (sheep and goat) production in most developing countries in Asia has remained traditional with little change over the past two decades. This is in spite of the large efforts in research and development (R&D) that have produced tremendous results. Relatively few research findings have been applied by farmers due to unsupporting conditions in the field and farmers' poor socio-economic status. It should be emphasized that an important role of small ruminants is their contribution to family welfare. Most farmers raise small ruminants as a living savings account for survival against sudden cash needs and income fluctuations based on production of food crops. No visible improvement has been made in developing the small ruminant industry, probably because of lack of urgency, poor investment in R&D leading to low development priority for small ruminants compared to other commodities.

State of Art

In Asia, the number of sheep and goats has increased by 2-3% per annum with large populations in China and India of 200 million and 150 million, respectively (An Min and Xiu Yufeng, 1990; Acharya, 1990). In most countries in Asia goats represent a higher proportion of the small ruminant population than

sheep. However, most R&D activities have concentrated on sheep rather than goats.

A very large number of small ruminant breeds are found in Asia and the diverse genetic resources have not been fully utilized. Information on small ruminant breeds in Asia remains obscure and so far little has been gained in breeding efforts that can improve the small ruminant industry. The special qualities of tropical small ruminant breeds which include non-seasonal breeding and prolificacy, among others, have not been fully exploited. Prolificacy, for instance, can be regarded as an advantage in terms of production, however, it will be necessary to apply good management practices in order to maintain the offspring, otherwise the genetic quality will not be expressed. This may be a constraint under the present situation.

Crossbreeding with temperate breeds has often been regarded as the main approach to improve productivity. This may produce offspring of better performance. However, in order to obtain the heterosis effect, it will be necessary to maintain pure lines of the parent breeds. This could be another burden and probably is still not feasible under present economic conditions where the price of breeding stock is similar to that of the final stock. Specialized production systems exist at present that rely on specific breeds, e.g., the production of animals having special genetic qualities like the Garut sheep in Indonesia. As for goats, cross breeds between the Kacang goat and German fawn has been produced in Malaysia.

In feeding and nutrition, many research activities have produced excellent information on feed quality and its utilization. The results are readily applicable under conditions where the feedstuffs are accessible and within farmers' economic capacity. Most often feeds for small ruminant are not specially produced, hence, small ruminants rely heavily on what is freely available to the farmer. Any new technology that requires financial input may have little advantage to the farmer who is not in the position to provide additional cash input.

Management of animals is often reported as traditional, and has withstood the changing environment over centuries. One may consider that the present production systems may well be the most sustainable. While this in part may be true, rapid global change may force different approaches to be implemented. In order to utilize the available information that is often scattered, we need a mechanism of exchanging knowledge, and one important tool is networking.

Characteristics of Networks

Networks should have well-defined objectives and participants are consulted in planning network activities. A committee is generally available to provide guidance and direction to the network coordinator in decision making and implementing collaborative action. The participating individuals or contact persons in the different countries/locations should preferably have national standing, be well known, and actively involved. This is not easy to obtain, since these persons are often overloaded with administrative responsibilities.

The network coordinator resides in one of the collaborating institutions. Depending upon the type of network the participating individuals may represent an institution or the individual themselves. This aspect of membership depends upon the interests and support of the individual. Preferably the individual could represent his or her institution and country. It is important that the existing manpower is used.

A regular exchange of information is a must, otherwise the network will not be fully functioning. This is often a problem and neglected. Generally meetings, workshops, monitoring tours and visits are organized. In addition, the production of a newsletter is regarded as essential. Information should come from participating parties, otherwise the information provided will only duplicate what has been published elsewhere. These activities, however, are becoming more and more expensive and may not fully achieve the objectives of the network. As most individuals in the network have not the luxury to obtain/subscribe to recent publications, it is desirable that the newsletter increases the available information. The topics covered in the newsletter are sometimes different from what is needed.

Networking Problems

In order for a network to function effectively, the area of collaboration must be wide. This is important for each participant to benefit from and hence provide support to the network. It is most important that collaborators commit part of their time and own resources, i.e., manpower, facilities and also operational costs and support. It is most desirable that additional funding is available to carry out the network activities, particularly initial funding. Hopefully in the future, funds can be generated following achievements of the network.

Many problems are faced in networking.

1. The fundamental problem faced is time; often there is slow feed-back from those involved. This could be related to:

   - No real interest in promoting the networking.
   - Individual's responsibility within the job is the first priority.
   - Limited facilities/support to maintain regular communication links, and
   - Bureaucratic barriers, etc.

2. In research activities of the network, decisions are often slow and undertaken by a few selected scientists. Considerable time is needed, particularly if relying on the postal service. There are limitations during workshops and meetings to properly discuss details of research projects.

3. Skills are needed to collaborate with people at various levels. Leadership is usually a problem in conjunction with the institution, especially if several institutions are involved. Leaders are often administrators who are overloaded with other activities.

4. An effective medium for communication is a newsletter. However, in developing countries exchange of information is often limited due to limited capacity to send and distribute information.

5. Funding is always a problem.

Future Outlook

The recognition to small ruminant networks relies on the network progress. One may arouse the interests of others through the network. An evaluation of how/what the network could do is difficult, since this is not one person's responsibility, but, obviously includes all its members.

Group dynamics should be activated if there is a mechanism that keeps interest in the network. One aspect of a research network is the provision of small research grants. The SR-CRSP has a small grant scheme that has kept links with various parties. This is advantageous in producing scientific information; the question, however, is whether it is also of interest to members of different backgrounds. Provision of research grants to individuals through their institutions will be in line with national interests rather than the individual's interests and while this may induce some delays, it is foreseen that the national priority settings will be enhanced in the future.

For sustainable production of a newsletter the printing and postal costs will have to be overcome. Those participants that have the capacity to give financial support could assist those that have not. The request for subscription fee at the level of minimal postal costs could offset the ever increasing postal costs. This may not be popular, but it is essential to maintain the information exchange.

In the organization of meetings, network events can be planned to coincide with other meetings in which most network participants are present. This is apparently cost efficient but is often difficult to organize. Otherwise, discussions and decisions have to be carried out by mail which takes considerable time.

Conclusion

The need to communicate is not argued, but the forum for effective communication is of interest. Meetings/workshops may have to be limited due to escalating expenses. Networking relies on several parties that are willing to communicate, hence, it would be desirable that everyone is actively involved.

There is a need to study the interests of various parties that are involved in small ruminants in order to prioritized network activities.

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GENERAL DISCUSSION

Following the presentations of papers, a general discussion was held to generate conclusions and recommendations of the various disciplines involved, the small grant scheme and networking.

The general discussion was firstly organized in subgroups to discuss each subject, followed by a plenary session. This was chaired and summarized by Dr. Ruth M. Gatenby, Program Representative of SR-CRSP for Indonesia.

Socio-Economics

Indonesia has a policy of poverty alleviation through the introduction of sheep and goats to poor farmers. Several studies have shown the benefits of this, but few have compared small ruminants to other options for poverty alleviation, such as growing cash crops.

The economic viability of new technologies should always be assessed before they are recommended to farmers. At the very least this should involve estimating the costs of the new technology and estimating the benefits it will give to farmers.

Several participants felt that sometimes socio-economic research consists solely of studies which have no practical benefit. Socio-economic studies must therefore be carefully planned and the results must be applicable. For small farmers, it was recognized that non-monetary benefits are often as important as monetary benefits, and these must be considered in socio-economic and other studies.

Specific information is needed on market demand, quality and handling of products required, and the potential of the international market for sheep and goats.

Breeding

Breeding research usually requires a long-term research program, and if this type of research is to be undertaken long-term funding must be guaranteed. There is a need to match breeds of sheep and goats to the available feed resources and farming system. We cannot expect one or two breeds to be the best for the whole of Indonesia. More work is needed on the performance of goats, particularly, in eastern Indonesia.

If we are to set up breeding centers which produce superior animals for distribution to farmers, this must be undertaken in collaboration with Dinas Peternakan.

Forage and Nutrition

Most efforts in nutrition research have produced information and technologies that are applicable in semi-intensive and commercial production systems. Relatively few technologies have been adopted by extensive and smallholder systems.

Feed resources in Indonesia vary widely according to location and farming system, so research must vary according to area. In eastern Indonesia (in contrast to western parts) the major factor limiting small ruminant production is shortage of forage in the later part of the long dry season and at the beginning of the wet season. Very little research on feeding and nutrition of small ruminants in the dry areas of eastern Indonesia has been carried out.

Research on strategic supplementation of sheep and goats in relation to season and physiological status (e.g., early lactation) is needed. Would it be beneficial to change the season of lambing and kidding in eastern Indonesia to make better use of the seasonally available feed supply?

In western Indonesia, more information on the carrying capacity of grazing land, particularly in plantations is needed. It is apparent, that stocking capacity affects production of vegetation, hence, importantly to control stocking rate. Particularly in areas where it is difficult to enhance the production of grass and ground legumes, the use of tree legumes deserves more attention.

Mineral deficiencies are difficult to identify, as they are often associated with general symptoms such as poor growth rate which are also associated with other problems such as inadequate dietary energy and protein, and infection with parasites.

In studies of mineral deficiencies and toxicities, it is necessary to have a complete study which should include the major interactions between minerals because mineral problems rarely arise in isolation.

Animal Health

There is a close relation between feeding and animal health. An underfed animal is much more likely to be sick than a well-fed animal. Studies of disease should include nutrition aspects where appropriate.

Pre-weaning mortality of lambs and kids is a big problem, and research is needed to identify causes of death and to rectify the problem. Some respondents suggested that more information is needed on the deaths of young lambs with infected navels. Is this a seasonal problem? Is it the result of infection by flies, and could the fly population be reduced by better disposal of wastes from factories?

Parasites are recognized to be a major factor limiting productivity in the wetter parts of Indonesia in grazed flocks and herds. Research is needed to study the epidemiology of parasite infection and methods of alleviation.

Scabby mouth or orf can be a major problem, and is reported to cause substantial mortality in lambs and kids. Some participants suggested that research on orf control is needed.

Networking

Currently two networks on small ruminants are organized from Bogor. These are (i) ISRN, the Indonesian Small Ruminant Network, and (ii) SRUPNA, the Small Ruminant Production Network for Asia. Most discussion centered around the newsletters produced by these networks.

The newsletters should be a developed to become a forum for the exchange of ideas between persons working with small ruminants. The addition of a letters section or a question-and-answer page would be appropriate. Thus a scientist working on a particular topic could write to the newsletter stating what he or she is doing and ask for information from others working in related areas.

Currently much research conducted in Indonesia is either not published, or is published in a form which is not widely distributed (grey literature). The transfer of information from research workers to interested persons needs to be improved. Summaries of PhD and MSc theses produced in Indonesian universities could be regularly published in the newsletters. Also relevant research conducted in Indonesia and elsewhere should be summarized to produce readable accounts relevant to readers. Information in the newsletters on future meetings and seminars is appreciated and should be continued.

It was recommended by the meeting that the ISRN newsletter should not be only in the English language, but that English articles with a summary in Indonesian, and Indonesian articles with a summary in English should be accepted.

It was suggested that there should be closer links between our small ruminant networks and those in Africa, Europe and Latin America, and that use of modern techniques such as electronic mail should be considered in the future.

It was noted that the cost of maintaining the small ruminant networks is substantial, and the long-term future of these networks depends on obtaining continued funding.

In general, it was concluded that more communication between scientists working in similar fields is needed to avoid duplication of effort and to speed up research progress. The small ruminant networks, ISRN and SRUPNA, have the mandate to encourage transfer of information within Indonesia and Asia, respectively.

Problems encountered with animal production in Indonesia are often regional, and results in one location may not be directly applicable in another. An example is the identification of mineral deficiencies, hence a region-specific approach is often needed.

Small Grants

In general the participants felt that the Small Grants program of the SR-CRSP is good. It is hoped that this program will continue in years to come. Some suggestions for improvements were made.

Information advertising Small Grants should be made more widely available throughout Indonesia, not only to scientists, but also to extension and development personnel (such as staff of Dinas Peternakan) working with small ruminants. It was suggested that advertisement in the local newspaper i.e., Sinar Tani should be encouraged.

To make Small Grants available to persons who have had little contact with foreign aid projects, it was recommended that applications in bahasa Indonesia with a comprehensive English summary are accepted.

Some topics require more study, and it was suggested that preferentially small grants be given to study (i) goats rather than sheep, (ii) feeding strategies using village resources, and (iii) the economic impact of disease. Perhaps the SR-CRSP should specify the topics for which Small Grants will be awarded. However, grants for preferential topics can be awarded only if quality applications of these topics are submitted.

Current projects supported by Small Grants tend to be narrow in scope, and a wider approach involving team effort should be encouraged. Funding for

more than one year would allow research to be conducted on a wider range of topics, and would shift the emphasis away from short-term studies. Research funded by Small Grants should be in line with national scope and the objectives of the applicant's institution. It was recommended that the number of grants and amount of funding should be increased.