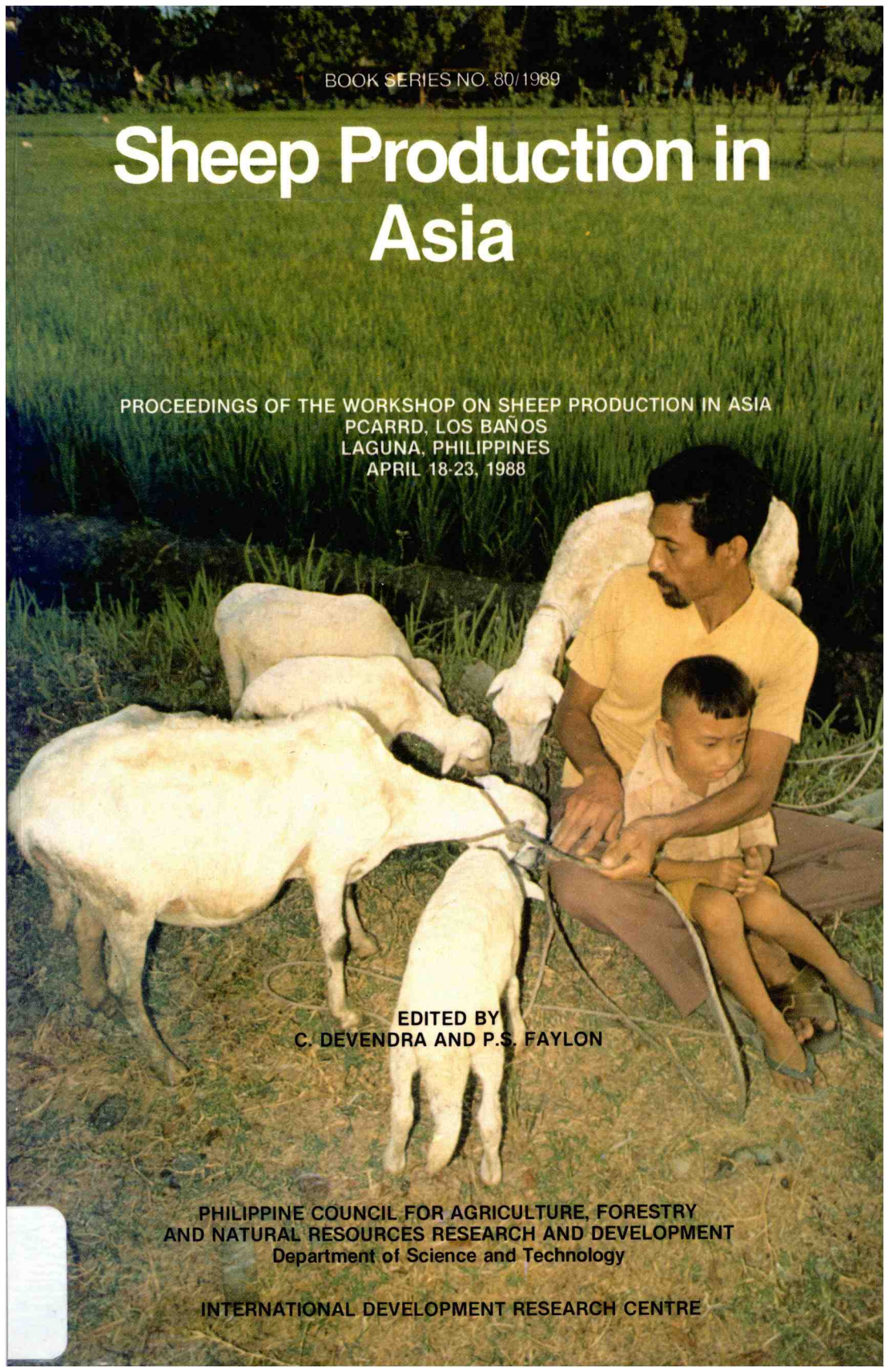
BOOK SERIES NO. 80/1989

Sheep Production in Asia

PROCEEDINGS OF THE WORKSHOP ON SHEEP PRODUCTION IN ASIA
PCARRD, LOS BAÑOS
LAGUNA, PHILIPPINES
APRIL 18-23, 1988



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PHILIPPINE COUNCIL FOR AGRICULTURE, FORESTRY
AND NATURAL RESOURCES RESEARCH AND DEVELOPMENT
Department of Science and Technology

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

OFFICE OF THE EXECUTIVE DIRECTOR

To Our Valued Reader:

This publication, **Sheep Production in Asia,** highlights the status of sheep production in the Asian Region.

The resource and country papers presented in this volume emphasize the principles of sheep production and management, as well as the constraints and some possible solutions to problems besetting the sheep industry in Asia.

We hope that this publication will pave the way for the development of innovative production and management techniques for the small ruminants, especially sheep in Asia and the whole world.

Sincerely yours,

RAMON V. VALMAYOR
Executive Director

PHILIPPINE COUNCIL FOR AGRICULTURE, FORESTRY AND NATURAL RESOURCES RESEARCH & DEVELOPMENT

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Volume Editors: Edwin C. Villar, Livestock Research Division; Fulgencio DL. Mojica, Applied Communication Division

Foreword

Asia, as a whole, accounts for almost 30% of the world's sheep population. The south and southeast of the continent, the region of primary concern in this workshop, is home to more than half of this figure, a number estimated to be in excess of 175 million head. Sheep are widely reared in small farm systems where they are an important source of food and income; as live "bank", they contribute to family security.

In spite of their importance, it is perhaps surprising that there has never been a meeting specific to sheep in south and southeast Asia. It was the first time that researchers interested in the species have come together specifically to take a broad look at the array of different agro-ecological conditions and production systems to be found in the region, and to try to learn from each other's experiences. It is reported, for example, that there are about 58 different breeds, and the potential of many of these, as well as of many of the local production systems, remain largely unknown.

Recognizing the importance of sheep in the Philippines and the region, the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) and the International Development Research Centre (IDRC) were pleased to have been able to sponsor the Workshop on Sheep Production in Asia held on 18-23 April 1988 at the PCARRD Headquarters in Los Baños, Laguna, Philippines.

The Crops and Animal Production Systems Program within the Agriculture, Food and Nutrition Sciences Division of IDRC gives high priority to supporting research on small ruminant production because of their comparative neglect by many, if not most, research institutions. Special emphasis is given to research conducted in the context of the whole farming system, in an attempt to ensure a rapid livelihood and well-being of the rural poor.

The worskhop was set out to critically assess the current status within the national programs in an attempt to identify priority problems and opportunities on which to focus future attention. It was also aimed to provide a forum for the exchange of information and ideas. It is clear from the five backgrounds and nine country papers that resource allocation for and progress within individual national program is very variable. However, in all countries, very good opportunities exist for substantially increasing sheep productivity.

It is hoped that the conclusions and recommendations generated from the workshop will be useful to national research programs, regional and international programs, and donor agencies. The meeting clearly provided a useful occasion for the presentation and discussion of technical information and ideas. If, in addition to this, it helps to stimulate wider support for research on sheep, the workshop will have amply fulfilled its objectives.

G.C. HAWTIN
Director
Division of Agriculture, Food and Nutrition Sciences, IDRC

R.V. VALMAYOR
Executive Director
PCARRD

Acknowledgment

The International Development Research Centre (IDRC) wishes to thank Dr. Ramon V. Valmayor, Executive Director of the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) and Dr. Patricio S. Faylon, Director, Livestock Research Division, PCARRD for hosting the meeting and organizing local arrangements.

Special thanks are extended to several scientists and institutions who participated in the workshop and contributed to this publication.

Appreciation is due Lacson Farm, Pampanga; Tarlac Breeding Station; Baguio Dairy Farm; and Pangasinan sheep raisers. We also wish to thank Dr. P.S. Faylon, Dr. L.T. Trung, Dr. B.C. Patnayak, Dr. C. Sevilla, and Dr. A. Wahid for chairing the individual sessions, and Prof. I.E. Coop for the workshop synthesis.

The overall coordination of Dr. Teresa H. Stuart, PCARRD Applied Communication Division (ACD) Director, for the production of this publication is also acknowledged. The indefatigable efforts and assistance of Ms. C.P. Bejosano and Mr. A.A. Alejar, both PCARRD-ACD staff under the supervision of Ms. P.J. Lastimosa, Print Media Head, PCARRD-ACD; and the hardwork and patience of Mr. E.C. Villar, PCARRD-LRD and Mr. F. DL. Mojica, PCARRD-ACD, for painstakingly editing the manuscript and managing the production of this publication, are highly commended.

Contents

Abstract

This publication presents the results of a meeting held at the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) Los Baños, Laguna, Philippines on 18-22 April 1988. It focuses specifically on the status of sheep production in Asia. Both the resource and country papers highlighted principles of production, variations in management, problems, and possible solutions. The country case studies presented prevailing patterns of production, existing issues, and policies. These promoted much discussions, including those on specific issues such as marketing and international movement of the sheep. The conclusions and recommendations were considered across systems to encourage multidisciplinary work and integration of effort in the context of mixed farm systems. Specific recommendations were made on breeding, feed resources, feeding systems, nutrient requirements, management, marketing, methodology, and terminology. These recommendations enabled a definition of the priority problems and opportunities to focus future research and development action.

Welcome Address

R.V. Valmayor
Executive Director
Philippine Council for Agriculture,
Forestry and Natural Resources
Research and Development (PCARRD)
Los Baños, Laguna
Philippines

On behalf of PCARRD, allow me to extend my profound greetings.

It is with great pride and honor that I welcome the guests and participants to this regional workshop on sheep production — a gathering which, I consider, marks an interlocking of efforts of multitude entities to effectively harness the collective potential of the participants towards the promotion of sheep production in the whole of Asia.

The current role of sheep in developing countries ranges from being very minor in level of production in some countries in the wet tropics to being the principal source of animal protein in certain North African and Middle East nations. In most cases, however, the lack of understanding of the important role of sheep has generally resulted in their being ignored as part of the sustenance and development cycle of smallhold farmers.

PCARRD and the IDRC initiated this workshop in recognition of the need for a better understanding of the contributions of sheep and the realization of its great potential.

Sheep has a long history in the Philippines. Various literature have shown that sheep was introduced to the country from Mexico by the Spaniards through the galleon trade.

I for one, can speak of the prominent presence of sheep in our farms in Negros. As far as I can remember, sheep production has ever since been part of our farm operations.

It is quite unfortunate, therefore, that only a meager 33 research projects involving sheep were implemented and documented in the Philippines for the last 50 years (1936-1987). It has only been in recent years that serious attention has been given to sheep research.

In a country, like ours, characterized by a rapid rate in population increase where 70% is trapped below the poverty line, sheep production is a sound alternative source of income, employment,

and nutrition. The integration of sheep with crop farming could not only provide employment and income, but likewise promote optimum utilization of farm resources, thereby minimizing risk of monocrop farming.

In a sense, the absence of major research efforts on sheep provides us a unique opportunity — the opportunity and challenge to bolster our efforts towards the furtherance of sheep production development, and eventually, the identification of priority areas for future R and D activities in Asia.

In our bid to boost sheep production research and development, we are beset with several problems. How we will go about overcoming these problems remains to be uncovered from the ideas and discussions we are going to share with each other in this workshop.

A great task lies ahead, but the job can be done. We should, therefore, look forward to the meaningful and substantive deliberations from this timely affair.

Again, our sincere appreciation for your cooperation in promoting sheep production.

Opening Remarks

R.N. Alcasid
Director
Bureau of Animal Industry
Department of Agriculture
Philippines

We are glad to be a part of this regional workshop on sheep production, as it is very appropriate and timely. Given the current situation characterized by declining cattle and carabao populations and the prohibitive prices of pork and poultry products because of high production cost, the need to look for other sources to provide our needs for animal protein is of urgency.

It is estimated that by the end of the century, the country's human population will reach to almost 75 million from the present 57 million. This will mean a tremendous increase in the demand for meat, milk, eggs, and other animal products.

In order to fill the demand gap, our best option would be the small ruminants, goats, and sheep, as they grow and multiply fast and are not dependent for survival on expensive feeds.

Throughout the country, about 3.5 million ha are planted to coconut. Several rubber and palm oil tree plantations are also present in Mindanao. The grasses and legumes that grow under these trees could be utilized to support sheep and goats. Meanwhile, in sugar producing areas, sugar cane by-products such as cane tops, bagasse, and mud press can be fed to ruminants.

In 1979, we at the Bureau of Animal Industry (BAI) launched an intensive program to raise the goat population, backed with a supervised credit program made available through the rural banking system. This resulted in the dramatic increase in the number of goats in the country. Hence, we need to do something similar in the case of sheep.

Sheep are multipurpose animals. They are good sources of meat and milk, as well as wool and skins. An increase in the sheep population and the eventual establishment of a sheep industry would provide us with an inexpensive substitute for beef, carabeef, pork, and poultry products which we envision to become short in supply in proportion to the human population growth if conditions affecting their production do not improve.

There is a tremendous potential for sheep raising in the country. There is land and there are by-products that can be utilized for the purpose.

Sheep, however, are not yet popular compared to the goat as a source of meat in the Philippines. Thus, there is a need to develop the market for mutton and lamb. We at BAI have the capability to do this as our food technologists at the Animal Products and By-products Training Center which is a UNDP/FAO-assisted project located at Marulas, Valenzuela, Metro Manila, can standardize recipes utilizing these meats. By holding food processing demonstrations and taste tests, we can help in promoting acceptance of these products. The same is true for sheep's milk. Meanwhile, our tanners will have more raw materials out of sheep skins. If we decide to wool sheep, this would mean another potential industry, particularly for countryside development.

The ASEAN Goat and Sheep Center in Zamboanga del Sur has been a good start. You can learn more about this project through Dr. Oscar Parawan who is, incidentally, also participant in this workshop. Having established regional satellites of this project particularly in strategic areas, we are confident that in doing so, we will be hastening the development of the sheep and goat industries in the country.

It is quite obvious why this regional workshop is most welcome to us. It will give us the chance to share ideas and experiences with our neighbors in Asia, some of whom have already established viable sheep industries. Likewise, it will enable us to continue working with them in the spirit of regional friendship and cooperation towards establishing our very own sheep industry in the Philippines.

In closing, may I congratulate the organizers of this workshop for making this very worthwhile project a reality, as well as for making the excellent arrangements. Also, I wish the participants a most rewarding workshop experience and memorable stay in our country.

Thank you very much and good day to all.

Session I: Resource Papers

Sheep Production and Development in Asia

I.E. Coop
132A Hamilton Avenue
Christchurch, New Zealand

ABSTRACT

Improvement in nutrition, disease control, and management yields short-term gains. By comparison, breed improvement creates permanent gains. This paper concentrates on breeding. It elaborates on breeding season, seasonal variation in ovulation rate, time and frequency of breeding, and controlled versus noncontrolled breeding. The main emphasis of this paper is on genetic improvement through selection. The arguments for and against selection within indigenous breeds and in crossbreeding are discussed. To date, indigenous breed improvement has been very limited; success has been unmeasured. Crossbreeding using imported temperate breeds had many failures but likewise had some notable successes. Successes have been achieved on breeds that yield wool such as the Merino type (including the Rambouillet) sheep, and on breeds that come from cool or temperate climate as in the grasslands or mountains of China, India, and Pakistan. In the hot arid regions, less Merino-type blood can be introduced but some new breeds have already been developed from the half-breds. In the humid tropics, growth rate, not wool, is wanted. Along this line, crossbreeding has yet to be tried. There is a continuing need for improvement through selection and for the development of large scale multiplication and distribution of superior sires be it pure, indigenous or new composite breed.

Small ruminants such as sheep and goats significantly contribute to the livelihood of several villages in Asia, and form a valuable livestock resource that continue to increase through time. Currently, Asia holds 30% of all the sheep and 50% of the goats in the world. Table 1 shows the number of sheep in Asia and the annual increase in number and sheep meat production. In both features, Asia leads all the other continents.

Despite the continuing growth of sheep production in Asia, sheep research and development (R & D) must be reviewed and

Table 1. Sheep population and annual increase. [a]

Area	Population (million)		Annual Increase (%)	Sheep Meat Annual Increase (%)
	1960-62	1980-82		
World	1,015	1,134	0.65	1.02
Asia	238	333	2.23	4.25

[a]Source: Terrill 1986.

examined critically. There is an increasing realization that both sheep and goats in most underdeveloped countries have not received their rightful share of attention in comparison with cattle and crop production. Likewise, there is a growing recognition of the many failures in spite of the successes in sheep R & D activities.

The increasing interest in sheep and goats is reflected in the number of conferences and workshops which have been held in recent years. However, some of the causes of failure in R & D are political, social, and economic which are beyond the scope of these workshops. Others meanwhile are in the nature of livestock research where progress is slow. But at the technical level, which refers to the actual research programs on research stations and universities, activities are focused on the sheep's relevance to the needs of the owner and the industry.

Two meetings relevant to the development of sheep were just recently conducted. These are the FAO Expert Consultation on Small Ruminants in Developing Countries held in Sofia, Bulgaria in 1985 and the International Development Research Centre (IDRC) Workshop on Small Ruminant Production Systems held in Bogor, Indonesia in 1986.

This paper makes several references to the papers in the proceedings of the said meetings. Several recommendations are likewise presented in this paper. The underlying message of this discussion lies in giving priority and investment to the small ruminant R & D in developing countries.

It is important that coordination and linkages be established between research centers within the region and between developed and developing countries, and that R & D become more systems-research oriented. In the latter respect, the three basic elements must be: identification of problems and objectives, research station experimentation, and on-farm research to validate experimental station results.

At this point, it is worthy to note the existing sheep population distribution in the different regions (Table 2). China and India, being the highest producers of sheep, must be looked upon for major research resources and leadership. For those countries with less than a million sheep, the animal must be given priority.

Table 2. Sheep population in the Region.[a]

Countries	Population (million)
China	95
India	41
Pakistan	25
Indonesia	5
Nepal	2
Bangladesh	1
Burma	0.4
Malaysia	0.065
Thailand	0.045
Sri Lanka	0.03
Philippines	0.03

[a]Source: FAO Production Yearbook, Vol. 39, 1985.

At the suggestion of Dr. Devendra, this paper would cover breeding and Dr. Parawan's would cover animal health. This deal primarily with sheep breeding since three introductory papers would precede the country-by-country papers. To put things into perspective, the author would like to express the view that rectifying some of the obvious husbandry and management deficiencies in a practical way would be the quickest way to improve production. Examples of these deficiencies are lack of control of sheep nutrition while grazing, lack of control of mating and lambing periods, common loss of 10-20% of bodyweight of ewes during pregnancy, slow recognition of incipient trouble, and a general level of performance so much below the potential of the sheep. These are important issues that must be considered in this gathering.

The harsh reality is that sheep are relegated to the deserts and mountains that are unsuitable for cropping and cattle, or are raised in small village flocks as scavengers and converters of crop residues. Flocks are small in size, thus many of the technologies from developed countries cannot be applied for this animal because of these conditions though some can be adapted.

REPRODUCTION

Reproduction is the nongenetic or the environmental aspect of breeding. Despite the fact that tropical sheep are, in general, inherently as fertile as temperate zone sheep, lambing percentages are low. Part of this is due to the nature of the environment and part is due to lack of good management, the most important of which is the lack of control of nutrition and mating. In a flock, the sheep are run together all year round; the different classes of sheep, rams, pregnant ewes, suckling ewes, dry ewes, and weaned lambs are not fed according to their respective needs.

Likewise, the rams and ewes, rather than the raisers, often decide when mating and lambing should take place. Apart from these difficult problems, there are several areas with very meager information; therefore, research in these areas should be intensified. These include the determination of the true breeding season of the breeds and seasonal variation in ovulation rate, controlled restricted mating compared with uncontrolled mating, optimum periods and frequency of lambing, and variation in ewe performance with age.

From the little information available, it seems that some breeds have a fairly constant ovulation rate, while others have much higher values at certain periods of the year. It is important to know this so that the optimum time of mating can be ascertained. Research is also needed on the effects of controlled restricted breeding at the optimum time once a year, compared with breeding three times in two years and with the present uncontrolled breeding all year through. With this knowledge, it would be possible to devise an improved management system on a whole flock or a whole farm on a whole year basis.

The key word is control. It would be easier if cooperation between smallholders would be extended so that enlarged cooperatives could make more efficient use of resources and could begin to justify the introduction of improved facilities and the adoption of new technologies. There should be a discussion in this meeting on how to achieve control of nutrition and breeding, and what research is needed to facilitate control.

BREED IMPROVEMENT WITHIN INDIGENOUS BREEDS

Sheep breeding in underdeveloped countries has often resulted into arguments as to the relative merits of improving the local indigenous breeds through selection or crossbreeding using imported temperate zone breeds. The arguments are fairly well known (Acharya 1986; Bradford et al. 1987) and need not be repeated here. Breed improvement schemes involving selection and culling in a central flock and distribution of superior rams to the villages have been in operation in State or Provincial Departments of Animal Husbandry in India (Acharya 1986) and in Pakistan and China (Coop 1987). Though highly commendable, the efficiency of the selection process and the measure of village flock improvement or total national improvement may be questioned. The author is not aware of similar schemes in other countries.

Crossbreeding proved to be a popular venture among scientists despite many failures. There are several reasons for the relative lack of interest in local breed improvement through selec-

tion. The main reason is the slow rate of genetic progress that can be made — approximately 1 to 2% per year for any one character such as fertility, wool weight, and growth rate or 1% if all three are selected simultaneously. In a country of many breeds, as in the Merino in Australia or the Romney in New Zealand breed, which would be improved? Further, since a control flock is usually not kept, there is no measure of the improvement actually achieved; also, the improved sheep and their progeny are usually indistinguishable from the nonimproved and so villagers cannot be sure of what they have got. Finally, since this type of breeding program is long-term, it would require a long-term personal and professional dedication by the scientist which is not highly probable.

The situation is better now than it was. A 1% per annum genetic improvement projected for a 10 to 20-year period is in fact a very good rate. The limitation is really on how this rate can be extended to the whole population, i.e. the logistics of ram supply and distribution. Secondly, there are new breeds in China and India developed by crossbreeding which can now be called indigenous and in which selection must continue and sheep population be multiplied. Thirdly, geneticists are looking for outstanding individual sheep which may have single gene inheritance for a production character. These can only be found by having populations of recorded sheep. It is highly probable that one such gene for high fertility has already been found recently in the Javanese Thin Tail breed in Indonesia (Bradford 1987).

Lastly, the development of large scale "screening" for high producing sheep in Australia and New Zealand has shown the way for future programs to begin with. In one stroke, this screening process can yield a genetic improvement equivalent to 10 years within flock selection. Here in Asia, where flocks are small and the number of sheep performance recorded is low, screening will be more difficult but certainly not impossible. Screening can start with visual assessment together with information on birth rank, number of lambs weaned and mothering ability which can be provided by the flock owner.

Selection within indigenous breeds and crossbreeding should not be regarded as in opposition. Rather, within-breed selection based on performance should be considered as the end result of both avenues.

CROSSBREEDING

Results of crossbreeding become visually apparent in a fairly short period of time. It would, however, take five years or more to be able to undertake a thorough assessment, including any on-

farm trial. Results are usually spectacular if the crossbreeds are reasonably adapted to the local environment; nevertheless, at some instances, imported sheep die out. Over the past years, many attempts to improve the local sheep through crossing with imported temperate zone sheep have failed, primarily because of a genuine lack of adaptability and tolerance by the sheep, aggravated by a lack of understanding and management. On the other hand, in the more temperate regions of Asia such as in the mountains and hills, imported temperate zone sheep have survived and have left high producing progeny.

It is proposed that an examination of crossbreeding in three different Asian environments namely: mountain and hill regions, hot arid and semi-arid regions, and humid tropical regions be undertaken.

Mountains and Hills

The north and western plateau regions of China have a continental climate with severe winters. The Himalayas of Nepal, India, and Pakistan have the same climate of varying altitude. As far as the sheep is concerned, these areas are really temperate since the sheep migrate between the lowlands in winter and the mountains in summer.

Temperate zone sheep do not suffer from heat stress, which is the main worry in the humid tropics; consequently, at least climatically, sheep adjust satisfactorily. This is especially true of the hardier breeds more accustomed to living on low nutritional levels of nutrition. These are primarily the Merino types such as the Australian Merino, Soviet Merino, US Rambouillet, French Merino d'Arles, and to a lesser extent, those containing 50% or more Merino such as the Polwarth and Corriedale. Other breeds adjust less-satisfactorily. All breeds are subjected to varying challenges such as long period of housing in some places, winter nutrition, and the vigors of migration or transhumance.

The indigenous sheep of these regions are mostly coarse carpet-wooled breeds, some are fat-tailed while others are thin-tailed mostly clipping a relatively low fleece weight of about 1 kg greasy wool. Fortunately, the Merino types are not only relatively hardy but are the best fine wool producers in the world. Crossing the indigenous breeds with the Rambouillet or Merino immediately gives a spectacular change to a 30 micron fleece. Further crossings yield fairly typical Merino type fleeces of 20 to 25 microns of apparel wool. Fleece weights are increased substantially, often by several folds. In China, several new fine-woolled breeds like Zinjiang Fine Wool, North East Fine Wool, and Gansu Alpine Fine Wool have been produced from the Mongolian and Tibetan ewes and Soviet Merino and Rambouillet rams (Chang 1984; Foote 1980).

Rambouillet was introduced to India and Pakistan in the 1950's. In Kashmir, these breeds were crossed over the local sheep and over Australian Merino x local crosses, to produce what is now known as the Kashmir Merino which has been distributed throughout the area. In the North-West Frontier Province of Pakistan, the crossbreds are mostly still F2-F4 (75-95% Rambouillet). Interbreeding has not yet been commenced though 100 crossbred rams are distributed each year. The crossbreds are larger, clip more wool than the indigenous sheep, and appear to survive the transhumance management (Coop 1987). In Nepal, lamb losses in the transhumance systems appear to be high (Pradhan 1987).

Crossbreeding in these areas has been very successful because of the importance of wool (Merino-type sheep are greatly superior in wool weight and quality), and the temperate climate where problems of heat stress and adaptation are minimized.

There are certain hilly areas that carry sheep at 1,000 to 2,000 m elevation in Southern China; at 1,000 to 1,500 m in Northern Thailand; and at 1,500 to 2,000 m in Sri Lanka and Southern India near the equator. Corriedales and some Romneys were introduced into Guizhou Province, South China from New Zealand in the 1930s, again in the 1950s, and recently in 1987. A large proportion of the sheep in the plateau region of Western Guizhou are now mostly Corriedale (Brougham et al. 1988) derived from the original Tibetan Valley carpet-wool sheep. The Corriedale is therefore successfully replacing the original breed, with substantial improvements in wool production.

In Northern Thailand, the picture is much less optimistic. Dorset cross halfbreds can survive but incentive and marketing problems prevail (Falvey 1984). In Sri Lanka and the Nilgiri hills of Southern India, the climate is more or less temperate but temperate zone animals are less adaptable to the constant dark/light ratio and less resistant to local diseases and parasites. Dorset, Wiltshire Horn, Romney, and Southdown breeds have been imported into these areas several years ago and have more or less survived. The crossbred lambs grow faster than the pure indigenous sheep. Even lambs (25% Dorset or Wiltshire) by first cross rams show over 10% increase in weight in six months (Goonewardene et al. 1983).

However, there seems to have little expansion of the industry. In the highlands of Africa at 2,000 m on the equator, Corriedale and Romney sheep have survived well, while in the highlands of Papua New Guinea, Corriedale and Perendale are barely surviving but crosses over the local Priangan sheep perform well (New Zealand Ministry of Foreign Affairs 1987).

Theoretically, crossbreds with 50:50 exotic:indigenous should do well in these hill environments. In Guizhou, such crossbreds perform well. Hence, their nonexpansion in Sri Lanka and the Nilgiris may be because of the areas' nearness to the

equator and their not having any cold period or any photoperiodism.

Hot Arid and Semi-Arid Regions

These regions refer to Rajasthan, Sind, and Baluchistan at 20-25 N. These regions have a very high summer temperature. The local sheep in these areas are very hardy carpet-wool sheep; wool is an important source of income. The Central Sheep and Wool Research Institute of India is in Rajasthan. Much research has been done there which has given direction to sheep production in the region. Dr. Patnayak could speak more authoritatively on this subject.

All temperate breeds, including the Merino types, suffer greatly from heat stress during the summer (Singh 1980). Hence, maintaining pure flocks of these breeds are not practical. However, the 50% Rambouillet or Australian Merino crossbreds have shown sufficient tolerance and substantial improvement in wool weight and quality over the pure indigenous breed (Malik 1980). Three new breeds, the Avivastra, Avikalin, and Hissardale, have been produced by interbreeding the F1 from the Rambouillet cross Chokla, Rambouillet cross Malpura and Australian Merino cross Bikaneri, respectively (Acharya 1986; Malik et al. 1980). These breeds are now being improved by selection for wool weight and against medulation.

The program depended on the importance of wool, on the Merino-type sheep which is an excellent wool producer that is more accustomed to low levels of nutrition than other temperate breeds, and on the fact that in hot environment, not more than 50% Merino should be incorporated. The program likewise confirmed that the end result of crossbreeding is a purebred in which selection must continue as in any indigenous breed.

Unfortunately, the new breeds developed in India are not available in Pakistan. In addition, no similar research has been carried out in the two Pakistan provinces, Sind and Baluchistan, though some Karakals have been imported from Afghanistan.

Humid Tropics

This climatic zone includes much of India and most of Sri Lanka, Burma, Malaysia, Indonesia, Thailand, Philippines, and Coastal South China. The indigenous sheep of this zone are either hair sheep or have mixed hair/wool fleeces which are usually not shown but are allowed to fall off. There is a little or no market for wool. Sheep are not as important in the economy as they are in the other zones. Except possibly in South India, little or no breed improvement programs exist. This is understandable because of the

low sheep population. The predominance of hair in sheep of the humid tropics is probably a result of evolution.

Comparison of hair sheep and wool sheep in a tropical environment shows that the former are better adapted, more fertile, have higher survival rate, and possess greater resistance to parasites (Hernandez 1987; Fitzhugh and Bradford 1983). Temperate zone sheep are poorly adapted to the heat and humidity of the tropics and cannot be maintained except under special conditions. The zone in Africa or America as well as in Asia has a history of failure in this respect. This arises partly from failure in the early days to appreciate the severity of the heat stress and partly by poor organization of crossbreeding programs.

It is the author's opinion that the zone cannot accommodate crossbreds with more than 50% temperate zone blood. Any sheep must have at least 50% indigenous blood if it is to survive. This being so, priority should be given to acquiring indigenous ewes from lamb by the imported rams, instead of trying to keep alive a pure flock of imported sheep has often been the case in the past.

Temperate zone breeds are unlikely to improve the fertility of the existing local sheep. Wool is not wanted because all temperate breeds have wool, which leaves growth rate and size as the main objective. The main breeds studied were the Dorset, Suffolk, and Wiltshire Horn. The latter was included because it sheds its wool. These breeds have been tried in India, Sri Lanka, Malaysia, and Indonesia. In every case, crossbred lambs sired by them out of indigenous lambs give faster post weaning gains (Singh et al. 1984; Wan Mohamed 1986).

For the next step, the productivity of F1 and indigenous ewes were compared. The results in Malaysia in quite large scale trials show that Dorset x indigenous ewes give higher lambing percentage and better lambs at weaning (Wan Mohamed 1986). Fletcher et al. (1985) however, urge caution in considering growth rate alone, for the gains in growth rate may be offset by lower reproductive rates.

There is, in fact, a considerable uncertainty as to the best policy to follow. The possibilities that can be suggested are the following:

- Persevere with Dorset crosses and if promising results are obtained, stabilize by interbreeding at a 50% or 25% Dorset;
- Compare the most promising Asian breeds such as the Javanese Thin Tail, Priangan, Mandya, Red Madras; and
- Import and test whatever is considered the best non-Asian humid-tropical breed such as the Barbados Blackbelly which performs well in America (Patterson 1983).

These recommendations appear to offer a good case for international cooperation to fund and organize the needed work.

Systematic Crossbreeding

This is widely used in developed countries. Experiments in Asia confirm that breeds such as the Suffolk, Dorset, and Wiltshire Horn could offer considerable gains if used as terminal sires. However, two big difficulties can be foreseen. First, one would have to maintain pure flocks of these breeds. Such maintenance of pure flocks would be very difficult because of their lack of adaptability. It could be overcome by having crossbred flocks such as Dorset x Mandya, and by using these as terminal sires. However, the gains would be correspondingly reduced. Secondly, it needs infrastructure. Organizing the whole system would be very difficult since flocks are small and the industry is not noted for control.

It is for these reasons that crossbreeding in underdeveloped countries should aim to incorporate the exotic blood into new composite breeds, and not to maintain a crossbreeding system.

CONTRIBUTION TO SHEEP PRODUCTION AND DEVELOPMENT

As mentioned in the introduction, the most immediate improvement in sheep production is likely to come from improving the present level of general husbandry and management. Nutrition and disease control are deemed to be necessary in this context. The present level of performance is well below the potential of the existing sheep, so why widen the gap by increasing the potential through breeding instead of increasing the present performance by management?

There are several answers to this. First, one big advantage of genetic improvement is its permanency. It does not have to be repeated year after year as do feeding or parasite control. It is as difficult to lose by negligence as it is to achieve by perseverance. Second, improved sheep respond to improved nutrition and management better than unimproved sheep, but they also produce higher under normal management. This is the reason why it is important to validate the research station results by on-farm testing. Further, the distribution of rams to village or migratory flocks usually does induce some other management improvements. Third, spectacular improvement can sometimes be achieved. For instance, the results of crossing with Rambouillet and Merino have resulted in greater wool production. Such crossing is limited at present to areas where there is at least some cool period.

Breeding should be a vital component of any government's overall program; in certain circumstances, it can be the most important among all aspects.

CONCLUSION

Based on the foregoing discussions and with particular reference to improvement of sheep production through breeding, a number of guidelines for R&D can be listed:

Reproductive Rate

The number of lambs weaned per ewe per year is probably the most important factor in overall production. The requirement is to devise the best mating system. Here, there is a need for research on the frequency of lambing (once a year or three times in two years), on the periods of highest ovulation rate on controlled versus uncontrolled mating, and on nutrition of the ewe during pregnancy to reduce the high lamb losses soon after lambing.

Performance Data on Indigenous Breeds

There is a dearth of good, meaningful, and comparative data on existing breeds. In many cases, the information available is only descriptive, too narrowly based, and not reliable enough. Good data are needed so that rational decisions can be made for future breeding management such as, which indigenous breed is best for any region and which breed should be chosen for special research or for a breed improvement program.

Crossbreeding and Breed Replacement

Currently, this is the most potent method of breed improvement and is likely to remain so for some considerable time. It requires, first, the definition of objectives, and the knowledge of the characteristics and comparative production of both the base indigenous breeds and of the potential crossing breeds. The latter are most likely to be imported temperate zone breeds, but may also be other indigenous breeds.

At the research stations or at the state breeding farms, scientific comparisons must be made to determine whether crossing increases overall production. If it does, then the combination of exotic indigenous should be made known, maybe with an optimum of 25, 50, 75% or more of exotic.

On-Farm Validation

If initial results appear promising, steps should be taken to supply rams to a number of flocks to begin on-farm validation of research station results under village conditions. Nutrition is usually better on research stations than on villages or on migration. The new breed must prove itself under these practical situations.

New Breed Formation

The crossbred combination that are finally chosen and proven in on-farm trials should then be stabilized by interbreeding, with concurrent selection on performance. To prevent inbreeding, it must be done on a sufficient scale and with a sufficiently wide range of unrelated sheep. This will probably mean increasing the research station experimental flock. This should be done by screening indigenous ewes and/or crossbreds from the on-farm validation trials. Minimum numbers are about 10 unrelated exotic rams and 200 indigenous ewes. Ideally, however, it should be several times this number, or several flocks of that size set up on government farms.

Multiplication

Government breeding farms will have to be established or existing ones enlarged to guarantee an output of superior sires sufficient to make a measurable impact on the industry. Most countries have farms which, if run efficiently, could cope with this increase. Output could be increased through the use of artificial insemination (AI). Alternatively, the Department of Animal Husbandry could encourage some of the larger breeders or village cooperatives to become registered ram breeders provided they use proven rams and are subjected to supervision.

Training of Sheep Breeders

Special effort is needed to ensure that in breeding programs, sheep resources should be given as much attention as needed to the human resources. The ideal characteristics of a person that would take charge of breeding programs are: sound knowledge and practical experience of sheep husbandry and management, some training and practice in sheep genetics, some experience at a research station where proven successful breed development has taken place either in Asia or in Australia, and finally personal and professional dedication. Too often, those involved in breeding programs possess only one or more of these features, so, steps should be taken to see that they get the necessary experiences.

OUTLOOK

Experience shows that if there is a market, means will be explored to supply it. There is, at present, an unlimited market for wool, both internationally and locally. A market for sheep meat among

Asian countries is conditioned only by the price of competing meats. So, the marketing outlook is satisfactory or encouraging.

Can sheep production in Asia be expanded? There had been a fairly rapid expansion during the last 20 years and there are no good reasons why this should not continue. The possible exceptions are overgrazing in desert areas, deforestation, and encroachment of cropping into the higher elevations in mountain areas. Research has shown that grassland improvement in the cooler parts of Asia either at high elevations or latitudes can be effected with temperate grass and legume species. In the humid zone, there is a considerable room for running sheep under tree crops especially in estates. Asia has become self-sufficient for grain. Some countries have surpluses, so the opportunities for grain and grain by-product supplementation of all livestock is increasing. This would be especially valuable for stall and feedlot finishing of lambs.

It would be unwise and unrealistic to minimize the limitations imposed by the environment. But the opportunities are here. It needs the will to meet the challenge and the investment in research and development to make it succeed.

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Nutrition of and Feeding Strategies for Sheep in Asia

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ABSTRACT

This paper reviews the nutrition of sheep in the Asian region. The importance of maximizing dry matter intake (DMI), the significance of digestibility, and the efficiency of utilizing the products of digestion are emphasized in the context of the quantity of net energy available for production. Dietary protein is especially important in promoting DMI, rumen function and improved animal performance. Feeding systems for sheep are similar to that of goats, but differences exist in the feeding behavior and metabolism between the species. Studies on nutrient requirements (energy, protein, and minerals) are very sparse, but the limited data suggest higher efficiency in the utilization of nitrogen by indigenous sheep breeds. Several feeding strategies can be more vigorously pursued, and high priority needs to be given to more intensive utilization of available feeds in integrated systems with permanent tree cropping (coconuts, oil, palm and rubber) and crop residues and agro-industrial by products including non-conventional feeds in stall feeding systems. These feeding systems need to be identified with increased use of a variety of proteinaceous forages, dietary non-protein nitrogen sources and strategic use of supplements, including minerals. The strategy is to provide adequate nutrients in innovative feeding systems all the year round that can identify predictable performance with economic production. These opportunities present enormous potential for increasing the current level of productivity of sheep of Asia.

Appropriate nutrition and feeding are the most important factors affecting current productivity of sheep. However, attention to these particular factors do not appear to get the emphasis they deserve. This is reflected by the continuing low per animal performance, the urgent need to ensure increased offtakes from the species to meet national targets, and the need for technology that can support the trend in several countries especially in Southeast Asia, to embark on large scale importation of exotic sheep.

The generally low level of productivity and response to improved nutrition in sheep is demonstrated in a recent study conducted in Indonesia. Three large groups of Javanese thin-tailed ewes were each assigned to a low, medium and high level of nutrition which corresponds to 200, 250 and 300 g of concentrates/head per day, respectively, in addition to a basal diet of 3.5 kg/head per day of elephant grass *(Pennisetum purpureum)*. Ovulation rates were recorded by laparoscopy. The mean results obtained were 1.95, 2.01, and 2.45 for the three treatments where the highest value was significantly different ($P < 0.05$). Increasing body weight and body condition tended to increase the ovulation rate (Pintono, Subandriyo and Sitorus 1987). The result implies that the potential for higher litter size is considerably increased, which in turn has a bearing on the total yield of the products (meat and fiber). Similar situations throughout most part of Asia are not uncommon and clearly emphasize the paramount significance of nutrition on productivity in sheep.

Inadequate attention to the nutrition of sheep is also compounded by problems concerned with the availability of feed resources. In South Asia, chronic feed deficit situations exist such as in Pakistan (Akram 1987), India (Reddy 1987), and Bangladesh (Saadullah and Das 1986). By comparison, there is an excess supply of feeds in many countries in South East Asia such as Sri Lanka (Ranjhan and Chadhokkar 1984) and Malaysia (Devendra 1982). Coupled with nutrition is the generally low level of management, including disease control measures that severely affect performance of the animals. In the quest to increase productivity from sheep therefore, it is most essential that the nutrition of the species is adequately understood in order to apply appropriate feeding strategies that can promote this objective.

Fortunately, the subject of sheep nutrition has greatly benefited from the industrialized countries, mainly in temperate regions where they are considered important domestic animals and where the science of their nutrition is well understood. However, peculiarities exist regarding the nutrition and feeding strategies for sheep in tropical environments, an understanding of which calls for adaptation of the available knowledge. In turn, this enables the development of innovative feeding strategies appropriate especially to small farm systems that can ensure high performance with economic production.

This paper is concerned with two main components. The first part will address a comprehensive discussion on aspects of the nutrition of sheep to include dry matter intake, digestibility, level of dietary protein, quantity of net energy available, feeding behavior and metabolism, and nutrient requirements. The second part alludes to the more applied aspects, particularly the need to pursue potentially-important feeding strategies appropriate to sheep in Asia.

NUTRITION

There are several fundamental aspects of nutrition that need to be kept in perspective. In particular, this concerns voluntary feed intake (VFI) which determines the amount of dry matter intake (DMI), digestibility, level of dietary protein, palatability, and nutrient requirements.

Dry Matter Intake

High DMI is very important factor in ensuring the release of adequate nutrients for maintenance and production. With temperate grasses, voluntary food intake (VFI) directly affects their digestibility, but the relationship is less definitive for tropical species (Milford 1967) because of the different lengths of time required to digest tropical feeds. VFI has been shown to decrease with decreasing digestibility of dry matter within species for *Chloris guyana* (Milford and Minson 1968), Panicum species (Minson 1971a), and also for legumes (Minson 1971b). Minson (1971b) also reported that tropical grasses decrease in dry matter digestibility at a daily rate of 0.1 to 0.2 digestibility units.

It is now recognized that the VFI of forages depends on two independent factors: the quantity of indigestible fiber they contain and the resistance of this fiber to passage from the rumen (Minson 1983). The VFI can be increased by reducing one or both of these factors, provided protein, minerals, and vitamins are adequate.

Considerable variation in VFI intake exists between and within tropical grasses. Some of the variations are due to differences in digestibility, but other unrelated factors such as those recorded for Panicum varieties may be involved (Minson 1971a). Rate of decrease in digestibility of younger tropical herbages is as high as in temperate species (Minson 1971a). The decline in digestibility with age of tropical grasses was more rapid than tropical legumes which retained relatively high digestibilities at maturity (Milford and Minson 1966). Differences in *in vitro* digestibility have been reported between genotypes of *Digitaria* (Strickland and Haydock 1978). Selection for high *in vitro* digestibility was successful in producing a high *in vitro* digestibility of dry matter and superior VFI of *Cenchrus ciliaris* (Minson and Bray 1985).

In view of the rapid growth of herbage in tropical areas and variations in nutritive value, grasses must be fed at an optimum stage of growth to achieve high VFI and digestibilities. In general, it is rarely possible to achieve dry matter (DM) digestibilities beyond 70%. In practical terms, adult ruminants (exluding the dairy goat) are unlikely to consume beyond 8% of their live weight as fresh grass for DM digestibilities of mature forage of the order of 40%. The justification for feeding grasses at an optimum age is related to the disadvantage concerning the restriction of energy uptake imposed by the bulk of tropical grasses.

In the humid tropics, DMI is limited by the feed water content of, or the free-water on, the ingested herbage. In the West Indies for instance, the dry matter content of herbage during the wet season was very low in Pangola grass (*Digitaria decumbens* Stent) with a dry matter content of 23.4% compared to 39.3% in the dry season, such that the herbage contributes a high proportion of the total water consumed (Butterworth, Groom and Wilson 1961). Similar observations have also been made in Thailand (Holm 1973). Inadequate dietary energy arises from reduced DMI and is likely to occur when the DM content falls below 25%.

The Significance of Digestibility

Associated with VFI, and an important expression of the nutritive value of a feed, is digestibility. Digestibility of a feedstuff is affected by stage of maturity of the crop, botanical composition, DMI and dietary supplements, processing, and chemical treatment. In general, the more digestible a feedstuff is, the more it is eaten by the ruminants (Blaxter 1962). Such is the case that high digestibility increases DMI. Increasing digestibility means that high proportion of the food is absorbed and digestion is more complete, with the volatile fatty acids (VFA) showing a lower proportion of acetic acid and the lowest and energetically least useful VFA, and with the presence of higher proportion of the more useful acids such as propionic and butyric acids.

The significance of digestibility becomes more apparent by the demonstration that the efficiency for utilization of DOM eaten (OM intake x digestibility) increases as the feedstuff becomes more digestible (Armstrong 1964). Up to 60 to 70% digestibilities, increasing digestibility encourages increasing DMI and increasing efficiency of utilization of the VFA constituents.

Level of Dietary Protein

VFI is influenced, to a very large extent, by the dietary crude protein content. The protein content of tropical forages is generally low (French 1957, Bredon and Horrell 1961; Butterworth 1967). The protein content falls rapidly with growth and reaches a low level

before flowering. During the dry season, the crude protein levels fall to very low critical levels, even below 7% in the dry matter.

The level of protein in the diet affects voluntary intake of food (Campling, Freer, and Balch 1962, Blaxter and Wilson 1963, Elliott and Topps 1963). The low protein diets are not readily eaten by ruminants. In sheep, a 7% crude protein begins to limit intake (Milford and Minson 1968).

Dietary protein has three categories:

- rumen degradable protein (RDP) which is used for microbial protein systhesis;
- undegraded dietary protein (UDP) which escapes digestion in the rumen and is absorbed in the small intestines; and
- undigested UDP which escapes fermentation and absorption in the intestines.

It has been estimated (Leibholz and Kellaway 1984) that the minimum required crude protein of a poor quality diet with a digestibility of organic matter of 50% would be between 6.1 to 7.4%. In most crop residues with low N content, especially in cereal straws with 4% crude protein, protein supplementation is clearly necessary.

Quantity of Net Energy Available

The quantity of net energy (NE) available for production is controlled by three related factors (Minson 1983): the quantity of feed eaten (I), the proportion of each unit of feed that is digested (D), and the efficiency of utilization of the products of digestion (E). This is represented by the equation:

$$NE = I \times D \times E$$

The quantity of NE available and its utilization is dependent on the type of feed, nutrient balance, extent of VFI, animal species, and function.

Feeding Behavior and Metabolism

Sheep are often considered comparable to goats in feeding and nutrition. In fact, until feeding standards were defined specific for goats in 1981, the use of feeding standards and the nutritional management were similar in both species. It is now known that there are distinct differences between the two species. These differences have recently been reviewed (Devendra 1987a) and are summarized in Table 1.

Goats are browsers and have a bipedal stance (Malachek and Provenza 1981). They have a competitive advantage over sheep in woodland and shrub land; are generally more active and selective; walk longer distances in search of food, and relish variety in feeds. Thus, they are natural leaders of mixed goat and sheep flocks. Sheep, by comparison, are less selective and are essentially graz-

Table 1. Comparative feeding behavior and metabolism in goats and sheep.

Characteristic	Goats	Sheep
1. Activity	Bipedal stance and walk longer distances	Walk shorter distance
2. Feeding pattern	Browser, more selective	Grazer, less selective
3. Browse and tree leaves	Relished	Less relished
4. Variety in feeds	Greater preference	Lesser preference
5. Taste sensation	More discerning	Less discerning
6. Salivary secretion rate	Greater	Moderate
7. Recycling of urea in saliva	Greater	Lesser
8. Dry matter intake:		
— For meat	3% of B.W.	3% of B.W.
— For lactation	4-6% of B.W.	3% of B.W.
9. Digestive efficiency	With coarse roughages Higher	Less efficient
10. Retention time	Longer	Shorter
11. Water intake/unit DMI	Lower	Higher
12. Rumen NH_3concentration	Higher	Lower
13. Water economy	More efficient	Less efficient
— Turnover rate	— Lower	— Higher
14. Fat mobilization	Increased during periods of feed shortages	Less evident
15. Dehydration		
— Faeces	Less water loss	Relatively higher water loss
— Urine	More concentrated	Less concentrated

ing animals. Another feature of the feeding behavior of goats is their discerning ability to taste. Goats can distinguish between bitter, sweet, salty, and sour tastes, and show a higher tolerance for bitter taste than do sheep and cattle (Bell 1959; Goatcher and Church 1970). Because of the differences in feeding behavior, goats and sheep are often herded together to take advantage of mixed grazing situations.

Sheep, like buffaloes and cattle, are essentially grazing animals and thrive on a variety of grasses, forages, and agro-industrial by-products.

Their digestive efficiency is comparable to that of cattle. Hence, they are often used to evaluate the nutritive value of feeds. Goats and water bufalloes appear to have the ability to utilize coarse fibrous feeds more efficiently than do cattle or sheep. Precise reasons for this are not clear, but such ability is associated with the size of feed particle, amount of salivary secretion, rumination, concentration of cellulose splitting microorganisms, fermentation

rate, absorptive capacity, water turnover, recyling of urea, rate of passage, and retention time (Devendra and Burns 1983). Differences in saliva secretion between goats and sheep are evident when given the same feed, with production rates of 848 ml and 502 ml/day, respectively (Seth et al, 1976). Differences in saliva secretion are likely to influence urea recycling, an important factor in fiber digestion.

Recently, attention has been drawn to the higher rumen NH_3-N in goats which has been attributed to the greater rumen protein degradation as a result of a longer retention time or digesta in the rumen (Watson and Norton 1982). Since goats drink less water than sheep per unit dry matter intake (Gihad 1976, Gihad, el Badawy, and Mehrez 1980; Owen and Ndosa 1982; and Alam, Poppi and Sykes 1983), it was further suggested that the lower water intake may be the cause of the higher rumen NH_3-N concentration (Alam et al. 1984).

Palatability

Palatability of individual feeds and complete diet are important to ensure high DMI. Palatability of the feed is the response of sheep to accept the feed. The degree of acceptance determines the extent of the DMI. Some feeds like sweet potato vines or wilted cassava leaves have very high palatability, whereas gliricidia has a lower palatability.

An aspect of palatability and VFI is leafiness especially of tropical forages and straws. The importance of leafiness is seen in the results of the studies on sheep by Laredo and Minson (1975) who reported that the VFI of the leaf fraction was 46% higher than that of the stem fraction although the dry matter digestibility of the two fractions was similar. The intake of the leaf was always higher than the stems when compared at the same level of neutral detergent fiber, acid detergent fiber and lignin apparently due to more rapid breakdown of the indigestible fiber in the leaf fraction and a shorter retention time in the rumen. In view of this, leaf meals, rather than mixtures of leaves and stems, tend to be incorporated in most ration formulations involving proteinaceous forage supplements.

Nutrient Requirements

Studies on the requirements of various nutrients in sheep in the Asian region are very sparse, probably because of the availability of published feeding standards for sheep (National Research Council 1975; Australian Research Council 1980; Kearl 1982). Nevertheless, Table 2 summarizes the limited efforts that have been reported regarding nutrition requirements in sheep. Patnayak (1981) has reviewed the limited data on nutrient requirements in India.

Table 2. Nutrient requirements of goats in the Asian region.

Nutrient	Breed	Location	Requirement	Reference
A. Energy				
Maintenance	Indigenous	Malaysia	471.8 KJ/W	Devendra (1982b)
Growth	Rambouillet crosses	India	707.6 KJ/ $W^{0.75}$ kg/day	Ratan et al. (1987)
B. Protein				
Maintenance	Unknown	India	0.32 g DCP/kg liveweight	Singh, Mahadevan, and Aggarwal (1970)
Maintenance	Local	India	0.77 g DCP/kg liveweight	Gill and Negi (1971)
Maintenance	Indigenous	Malaysia	0.38 g DCP/kg liveweight	Devendra (1976)
Growth[a]	Rambouillet crosses	India	4.3 g/kg 0.75/ day	Ratan et al. (1987)

[a]Postweaning.

The only report on the energy requirements for maintenance is comparable with published values of tropical and temperate situations (Devendra 1976). Regarding proteins, there are two values in Table 2 which are distinctly lower than those reported for temperate sheep. Similar findings have also been reported for Blackhead Persian sheep in Rhodesia (Elliot and Topps 1963) and sheep in northwestern Australia (Robinson and Stewart 1968). It is possible therefore, that the efficiency of nitrogen utilization is higher in these indigenous breeds, associated with low indigenous losses. It is also likely that breed differences contribute to the capacity to utilize nitrogen.

More recently, Singh and Singh (1987) have reported comprehensive studies on crossbred lambs from Malpura and Sonadi ewes with exotic Dorset and Suffolk rams over the preweaning and postweaning stages. Over the liveweight range of 7.0 to 28.7 kg, they reported that the digestible crude protein and metabolizable energy nutrients varied from 8.0 to 11.2 g $W^{0.75\ kg}$ and 391.8 to 889.4 KJ $W^{0.75\ kg}$.

There appears to be no work done on the mineral requirements of sheep in Asia. Identifiable deficiencies have been reported, and responses to supplementation have been significant in India (Katiyar and Talapatra 1968); Indonesia (Prabowo et al. 1983); and Malaysia (Wan Zahari, Devendra, and Ali 1983).

FEEDING STRATEGIES

The feeding systems for sheep are similar to those that have been described for goats (Devendra 1985). Instead of reviewing these systems again, it is better to focus on those strategies that are likely to improve per animal performance and increase produc-

tivity from sheep.

In considering this approach, it is significantly important to aim for a realistic potential level of production, take advantage of the available dietary ingredients, and identify the objectives clearly in terms of production and profitability in seeking a high efficiency in specific feeding systems and in productivity to maintain the appropriate breed. It is equally important to understand the feeding behavior, response within individual environments, and potential productivity in the context of efficient utilization of the production resources.

In the Asian region, there exists several distinct feeding strategies that are worth pursuing. These are discussed in the succeeding sections of this paper.

Feed Resources in Tree Cropping Systems

Intensification of the feed resources within two production systems merit very high priority. The first is concerned with the utilization of native herbage and any crop residues within tree cropping systems (coconuts, oil palm, and rubber) in South and Southeast Asia. At present, there exists approximately 20 million ha of land under permanent crops in Asia most of which are underutilized.

Effective utilization of the available feeds and possibly, of other cultivated fodders such as gliricidia in these situations can make a significant impact on productivity from sheep. Issues that merit special attention are intensity of grazing and carrying capacity, grazing system, utilization of available crop residues, mineral imbalances, and possible toxicity problems. Integration of sheep with tree crops can make a major impact on economic productivity from the land.

Crop Residues and Agro-Industrial By-Products

A second production system that merits attention is intensive stall feeding of sheep. Current utilization systems for crop residues and agro-industrial by-products, with a few exceptions, are haphazard and yet, the opportunities for improving this situation is enormous. In particular, there exists a considerable increase in the utilization of many crop residues notably cereal straws, nonconventional feed resources, and agro-industrial by-products in intensive systems of feeding that can demonstrate economic performance. Examples of this have been demonstrated in India (Singh and Negi 1986, Reddy, Reddy, and Reddy 1986), Indonesia (Mathius et al. 1985) and elsewhere, but such examples need to be more widely applied.

Intensification provides a unique means to make more complete use of the available feeds to increase productivity from sheep (mutton, fiber, and skins). Intensification also needs to be coupled to large scale on-farm activities involving sheep. The net

effect of this approach is expansion in the use of such systems.

The basic strategy in both production systems is to utilize the available feeds of good quality all the year round. On small farms, the demand for food crops supercedes production of feeds for livestock. Thus, innovative measures are needed to meet nutrient requirements of sheep from various forages and residues from food crop production. This approach has the associated advantage of enabling seasonal surpluses, for example cereal straws or silages, to be preserved for use subsequently when feeds are in short supply such as during the dry seasons and droughts.

Proteinaceous Forages

Increasing the use of a variety of proteinaceous forages in feeding systems for sheep is a potential that has not been adequately explored.

This strategy, however, is insignificant in situations where the basal diet is coarse lignocellulosic materials such as cereal straws and sugar cane bagasse. These forages promote efficient utilization of the basal feed by strategically providing deficient nutrients.

A variety of these forages have been used in the region. Table 3 lists the more important of these forages, together with an indication of approximate crude protein content. Of these, *Leucaena leucocephala* is the most widely used in the region (Devendra 1987b) but within the last three years, emphasis has shifted to the value of other forages because of widespread attack by the jumping lice or psyllids.

The beneficial effects of including supplemental forages to basal roughage diets is to increase significantly the metabolizable energy (ME), nitrogen (N), mineral, and vitamin availability to sheep. Preston and Leng (1974) have identified rumen-available nitrogen as the first priority in a supplement to stimulate digestion of low quality roughages. Sustained degradation of protein generally leads to a more efficient utilization of the ammonia produced, and optimum concentrations of rumen ammonia should not be less than 70 to 80 mg/l (Slatter and Slyter 1974; Elliot et al. 1984). Many of the protein sources like *Leucaena* also have the capacity to escape excessive degradation in the rumen, thus making more N available distal to the rumen.

All the forages listed in Table 3 have the capacity to promote these beneficial effects and some, like *Leucaena,* have been shown to produce higher flow from the rumen (Jodoy and Elliott 1981; Bumualim 1985). The latter recorded flows of 2.9 g/day of microbial N leaving the rumen with supplementary *Leucaena* compared to 1.6 g/day microbial N when only spear grass (*Heteropogon contortus*) was fed. The increased protein flow is associated with an 11% increase in intake of spear grass. *Leucaena* leaf meal was as effective in stimulating VFI as was casein infused into the abomasum.

Table 3. Examples of potentially important dietary proteinaceous forages.

Common Name	Botanical Name	Crude Protein (%)
Acacia	*Acacia catechu*	22.2 — 24.7
Banana	*Musa* spp.	17.1 — 18.3
Cassava	*Manihot esculenta* Crantz	21.7 — 26.6
Erythrina	*Erythrina orientalis*	28.0 — 29.2
Gliricidia	*Gliricidia maculata*	20.2 — 24.6
Jackfruit	*Artocarpus heterophyllus*	14.0 — 16.8
Leucaena	*Leucaena leucocephala*	22.0 — 25.2
Mesquite	*Prosopis* spp.	15.8 — 18.6
Mulberry	*Morus indica*	16.5 — 17.9
Pigeon pea	*Cajanus cajan*	20.0 — 25.6
Pipal fig	*Ficus religiosa*	15.0 — 17.6
Sesbania	*Sesbania grandiflora*	22.6 — 24.7
Sweet potato vines	*Ipomoea batatas*	18.4 — 19.9
Tamarind	*Tamarindus indica*	14.0 — 16.4

Table 4 summarizes some results from several feeding trials on the effects of supplementing proteinaceous forages for sheep notably in Indonesia, where a considerable amount of work on this aspect has been done.

Table 5 further demonstrates the beneficial effects of supplementary forages rich in protein in rice straw-based diets for sheep. All the four types of forages used promoted high DMI expressed as percent of body weight, nitrogen, and mineral (Ca, Mg, and P) retentions. In comparison to rice straw diets, the addition of cassava leaves, *Leucaena* leaves plus stem plus pods or gliricidia leaves increased ME supply by 62.7, 67.4, 31.3 and 62.0%, respectively. Among the forages used, cassava leaves was particularly outstanding, followed by *Leucaena* leaves and gliricidia. Attention is drawn to the differences between feeding *Leucaena* leaves alone (RS + LS) in comparison to *Leucaena* leaves plus stems and pods (RS + LSP). The former gave higher DMI, and was also associated with higher N, Ca, Mg, and P retentions.

The benefits of dietary supplementary forages are particularly significant such that their inclusion with untreated crop residues such as rice straw is more economical in growing Holstein-Friesian bulls (Cheva-Isarakul and Potikanond 1984) and lactating cows (Promma et al. 1984) in Thailand and (Trung et al. 1987) in the Philippines.

As a guide to supplementation, proteinaceous forages can be fed up to 1% of body weight or about 30% of the diet.

Dietary Nitrogen Sources

Increased use of dietary nitrogen, especially nonprotein nitrogenous (NPN) sources, is justified by two considerations. One is the fact that these are important dietary requirements, and

Table 4. Effects of supplementing proteinaceous forages in sheep in the Asian region.

Breed	Major Feed	Type of Forage Sup.	Significant Response	Country	Reference
Local	LE[a]	*P. purpureum*	L.W.I.[d]	Indonesia	Semali and Mathius (1974)
Bannur	GL[b]	*B. mile-formis*	L.W.I. + Wool growth	India	Kantharayu and Chadhokar (1981)
Local	LE and GL	Rice straw	L.W.I.	Thailand	Vearasilp (1981)
Javanese thin-tailed	LE	Mixed village feedstuffs	L.W.I.	Indonesia	Chaniago et al. (1983)
Local	CA[c]	*P. purpureum*	L.W.I.	Indonesia	Mathius et al. (1983)
Indigenous	CA, LE and GL	Rice straw	Increased ME[e] intake and Nitrogen retention	Malaysia	Devendra (1983)
Javanese thin-tailed	GL[b]	*P. purpureum*	L.W.I.	Indonesia	Rangkuti, Pulangan and van Eys (1985)
Javanese thin-tailed	LE	Rice straw + *P. purpureum*	L.W.I.	Indonesia	Sitorus, van Eys and Pulangan (1985)
Crossbred fat-tailed sheep	LE	*P. purpureum*	L.W.I.	Indonesia	Ifar, Nanik and van Bruchem (1986)
Indigenous	LE	Rice straw	L.W.I.	Thailand	Meevootisom et al. (1987)

[a]LE — *Leucaena leucocephala*.

[b]GL — *Gliricidia maculata*.

[c]CA — *Manihot esculenta* Crantz.

[d]L.W.I. — Live weight increase.

[e]ME — Metabolizable energy.

Table 5. Intake and digestibility of chopped straw (RS) supplemented with other cassava leaves (LL), leucaena leaves (L), leucaena plus stems plus pods (LSP), or gliricidia leaves (GL).[a]

Parameter	RS + CL	RS + L	RS + LSP	RS + GL
Fresh intake (g/day)	1556.8[b]	1408.6[b]	1414.5[b]	1414.3[b]
DMI/kg$^{0.75}$ (g/day)	65.9[b]	69.7[b]	64.7[b]	64.1[b]
DMI as % body weight	3.0[b]	3.2[b]	3.0[b]	2.7[b]
DM digestibility (%)	53.5[b]	49.2[b]	48.0[b]	47.6[b]
OM digestibility (%)	60.5[b]	56.9[c]	55.4[c]	55.4[c]
CP digestibility (%)	49.7[b]	50.4[b]	44.3[b]	31.6[c]
Energy digestibility (%)	54.7[b]	52.6[b]	45.7[b]	48.9[b]
N retention as % of intake	16.2[b]	34.8[c]	3.9[d]	9.2[d]
CA retention as % of intake	27.4[c]	22.9[b]	7.8[b]	21.2[d]
Mg retention as % of intake	30.2[c]	30.4[c]	26.2[c]	33.4[c]
P retention as % of intake	65.3[b]	56.8[c]	38.2[d]	39.4[d]

[a]Source: Devendra 1983; means on the same row with different superscripts differ ($P < 0.05$).

especially for ruminants, an important means of reducing the cost of feeding. In this context, poultry litter which is abundantly available in Asia can be put to use to feed sheep. Present calculations indicate that approximately 3,600 million kilograms of crude protein (N × 6.25) is produced annually and this is increasing. Iqbal Shah and Mueller (1983) have shown that an optimum dietary level of 30% is suitable for fat lambs.

Of the methods available for NPN utilization, the incorporation of urea into cereal straws to release ammonia or the spraying of ammonia directly into the cereal straws and the use of urea-molasses block licks (UMBL) have made considerable success. These two innovations are significant since they represent two major success stories in Asia.

The value of UMBL is associated mainly with attractiveness and taste to livestock. The blocks are potentially effective means of making NPN such as urea (15-20%) continuously available, and fortified with macro and micro minerals and other nutrients which are essential to both the microbes and the animal. The possibility of over-ingestion of the block and the danger of toxicity appears to be remote.

Much of the early work in this connection has been confined to buffaloes and cattle in India, the Philippines, and Indonesia. Recently, however, an attempt has been made to extend the use of UMBL to small ruminants. The three preliminary experiments of Soetanto (1986) in Indonesia are possibly the first to explore on the possibility. In Experiment 1, the results of digestibility studies with sheep given waffered sugarcane tops (WST) with or without UMBL

with 0, 3, and 6% urea and 500 g *Leucaena* indicated that there was an increase in the dry matter disappearance *in sacco* of waffered sugar cane tops. The results were however not significant. In Experiment 2, four growing lambs were placed on each of the three treatments: Control (+ 300 g fish meal), WST + UMBL (3% urea) and WST + UMBL (6% urea). The significant results indicated that UMBL stimulated live weight gain (Table 6). Experiment 3 was similar to that of Experiment 2 but used goats instead. However, it was terminated because the goats got sick.

Table 6. The effect of urea-molasses block licks supplementation on feed intake and daily gain of lambs in Indonesia.[a]

	DM intake (g/day)		OM intake (g/day)		Daily Live
Diet	WCT[b]	UMBL[c]	WCT	UMBL	Weight Gain (g/day)[d]
A[e]	224.94	88.74	186.27	81.07	−35.40
B[f]	236.64	91.81	209.57	83.87	18.57
C[g]	283.27	116.69	234.15	106.47	23.60

[a]Source: Soetanto 1986.

[b]WCT — Waffered sugar cane tops.

[c]UMBL — Urea-molasses block licks.

[d]$P < 0.01$.

[e]A — Natural grass *ad lib* + 300 g fish meal.

[f]B — UMBL + 3% urea.

[g]C — UMBL + 6% urea.

Supplementary Protein Sources

Strategic and economic use of protein supplements merit consideration in relation to breed type and the potential for growth.

The importance of the decision to supplement is seen in the results of a recent study in India. The treatment involved feeding either green forage, concentrates or green forages + concentrates to a control browsing situation. Treatments, as expected, significantly stimulated daily live weight gains and also affected dressing percentages ($P < 0.05$). The net returns indicated that supplementary feeding with forages gave the highest margin of profits followed by concentrates and finally the combined effect (Table 7). The results emphasize on the one hand the value of green forages, and question the necessity for feeding concentrates for meat production from sheep in this experiment.

The strategy to use scarce concentrates implies that protein concentrates like coconut cake, cottonseed cake, groundnut cake, soybean meal, palm kernel cake, and fish meal, all of which are readily available, can be conserved, and preferentially utilized more efficiently also by nonruminant animals. Some of these ingredients may even need to be protected for local use rather than be exported.

Table 7. Performance of weaner kids in a semi-arid environment in India.[a]

Parameter	Browsing (B)[b]	B + Forage	B + Concentrates	B + Forage Concentrates
Initial weight (kg)	12.0	10.9	12.7	12.5
Final weight (kg)	13.8	14.7	22.8	22.3
Weight gain (kg)	1.8	3.7	10.0	9.7
Ave. daily gain (g)	19.4a	41.7b	111.0c	108.2c
Dressing %	45.7a	44.5a	48.2b	9.1b
Net returns (Rs/kid/90 days)	—	9.0	3.6	0.2

[a]Source: Parthasarathy, Singh, and Rawat 1983.

[b]For seven hours daily.

[c]$P < 0.05$.

ECONOMIC RESPONSE

Several studies have reported in many countries on the effects of pretreatments or supplementary feeding (energy, protein, and minerals). These include for example improved growth responses and wool production in India (Katiyar and Talapatra 1968, Chakravarty and Bhati 1971); Thailand (Meevotisom et al. 1987); Malaysia (Devendra 1983), and Indonesia (Semali and Mathius 1974); Chaniago et al. 1983; Mathius et al. 1983; Rangkuti, Pulangan and van Eys 1985; Sitorus, van Eys and Pulangan 1985; Nanik and van Bruchem 1986. Many of these have demonstrated significant beneficial effects but very few have concurrently assessed the economic benefits of the treatments, probably because the studies were undertaken at the station level. It is essential that these studies be extended to on-farm situations in which the benefits of innovative systems be realistically assessed and be subjected to economic analysis (Devendra 1987c).

The final objective in the application of approximate feeding strategies must thus ensure that the response to treatments in sheep (meat and/or wool) is economical. This means that the cost of the response should be higher than the costs of the treatment inputs (purchased supplements) and associated cost (processing, treatment, transportation and handling), in which case, that particular feeding strategy is justified. Conversely, if the costs of the strategy is in excess to the cost of the response, it is futile to pursue such strategy, except under drought conditions where the central objective is to sustain the life of the animals. Far too often, statistically significant responses have attracted more attention

than economic considerations. It is therefore imperative that the value of any strategy be identified with both statistical and economic considerations as is demonstrated in the data on Table 7.

CONCLUSION

There exists considerable potential for improving the nutrition of sheep in the Asian region through the application of available knowledge and improved husbandry practices. Past efforts in this direction are conspicuously weak and are reflected in the generally low productivity from the species. Feeding strategies need to focus specifically on mutton production in most countries. In South Asia, fine and coarse wool production are also important especially in situations where exotic breeds have been introduced. In particular, and central to the efforts to promote efficient nutritional management is the provision of adequate nutrients in innovative feeding systems all year round that can identify high performance with economic production.

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Diseases and Health Problems of Sheep

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ABSTRACT

The incidence of sheep diseases in the region exhibits marked similarities because of the climatic and geophysical environment. Sheep diseases may be classified into three major groupings. The first group consists of eradicable diseases which include foot and mouth disease, malignant catarrhal fever, rinderpest, bluetongue, and contagious ecthyma. Except for bluetongue and contagious ecthyma, sheep act as the carrier of the disease in this group. The second group is composed of controllable diseases which are mostly bacterial diseases with interspecies significance in ruminants. Enterotoxemia, tetanus, blackleg, anthrax, foot rot, and Johne's disease comprise this group. Zoonotic diseases like brucellosis, leptospirosis and melioidosis are also classified in this group. The third group consists of manageable diseases which are of considerable economic importance. This group includes internal and external parasites, disease complexes like pneumonia diseases, enteric diseases, and reproductive diseases; and nutritional deficiency and vector borne diseases.

Problems of diseases and health remain to be a major constraint in sheep production in the Asian region. The predominantly tropical environment compounded by the deficiencies in feeding, breeding, housing, and other aspects of husbandry, further aggravates the effects of disease and parasitism. Hence, the productivity of sheep, can only be improved with accompanying disease and parasite control.

The precise extent of economic losses due to sheep diseases in the region is difficult to establish. Animal loss in developing tropical countries is estimated to range from 20 to 40% of the value of all livestock species (Djojosoebagio 1986). A study in Pakistan on economic losses due to animal diseases revealed that coccidiosis, piroplasmosis, facioliasis, theileriasis, and parasitic gastro-enteritis caused 24 to 63% mortality (Irfan 1984). Liverfluke alone significantly reduced wool growth by 20 to 40% irrespective of the age or plane of nutrition of the sheep (Chaudry et al 1984). In Australia, economic losses due to liverfluke may be within $20 million (Barger et al 1978). In the Philippines, the estimated total annual cost of all livestock and poultry diseases amounts to $185 million (Anon 1986) which is 20% of the value of all livestock. Considering the region's sheep population of 458 million (FAO 1987) estimated at US$4.58 billion economic losses due to disease and parasitism at 20% of the given value would amount to US$916 million.

DISEASE SITUATION

The disease incidence in the region is in general common to mainland Asia, South Asia, Australia, and the Pacific.

In Southeast Asia, 95% of the sheep population is in Indonesia. Purnomo and Wilson (1987) aptly described three groups of disease problems of small ruminants in Indonesia. These groups are: diseases of known economic significance, diseases of unknown economic significance and which need more study to ascertain their importance, and diseases of livestock involving small ruminants as carriers (Table 1).

Observations at Guthrie's estates in Malaysia revealed endoparasites, ectoparasites, pneumonia, pasteurellosis, enterotoxemia, melioidosis, *Escherichia coli,* contagious keratoconjunctivitis, and contagious ecthyma as causes of ill health in sheep (Wan Mohamed 1987).

In the Philippines, problems on sheep diseases is minimal. Mortalities caused by diseases among small holders and commercial raisers are lower than those in other livestock species. In a study conducted on the sheep production systems of the country, infectious disease (59.07%), metabolic disorder (13.13%), and accidents (22-27%) were among the three major causes of mortality reported by 99 sheep farmers (Table 2). In the same study, endoparasite was identified by 83% of the 65 respondent-farmers (PCARRD 1988). Data on recorded sheep diseases at the Philippine ASEAN Goat and Sheep Center indicate the prevalence of internal parasitism and pneumonia as the most common causes of mortalities (Table 3).

In South Asia, gastro-intestinal nematodes, fascioliasis, and external parasitism are of prime importance in the productivity of

sheep (Rajaguru 1987; Saadullah and Shyamal 1987). In India, diseases of small ruminants such as pox, enterotoxemia, pasteurellosis, anthrax, rinderpest, and foot and mouth disease are widespread. Several chronic diseases such as Johne's disease, brucellosis, and parasitic infestations hamper productivity. Emerging diseases such as bluetongue, parainfluenza infection, mycoplasmosis, and chlamydosis are beginning to threaten the sheep industry. In lambs, pneumonia and enteritis are the main causes of death (Mukundan and Balakrishman 1987).

Table 1. Diseases of small ruminants in Indonesia.[a]

Group A. Diseases of significance in suggested order of economic importance

- Gastrointestinal nematodiasis: parasitic, endemic, widespread, *Haemonchus* most important
- *Fascioliasis: parasitic endemic, widespread Fasciola gigantica* most important
- Mange (goats only): parasitic, endemic, widespread, *Sarcoptes scabeii* most important
- Pneumonia: bacterial, endemic, widespread, *Pasteurella* most important
- Plant intoxication: toxic or fungal etiology, sporadic

Group B. Diseases known to occur

- Virological: bluetongue (other orbiviruses), contagious ecthyma (orf), rabies
- Parasitic: primary myiasis (screw worm), secondary myiasis, coccidiosis
- Bacterial: anthrax, salmonellosis, tetanus, clostridia, foot rot.

Group C. Disease of other livestock involving small ruminants as carriers

- Foot and mouth disease: large ruminant, pigs
- Malignant catarrhal fever (sheep only): large ruminants
- Bluetongue

[a]Source: Purnomo and Wilson 1987.

In mainland Asia, incidence of sheep diseases include endoparasites and ectoparasites, sheep pox, melioidosis, anthrax, and pasteurellosis (FAO 1984).

Internal parasitism has been identified as a major problem in sheep in Fiji and other parts of Oceania while mastitis, foot rot, and dermatophilosis were observed to be of common occurrence (Table 4).

In Australia, internal and external parasitism are perhaps the most common causes of diseases in sheep. Other diseases of importance are enterotoxemia, tetanus, other clostridial infections,

blowfly strike, foot rot and foot abscesses, infectious keratoconjunctivitis, blackleg, caseous lymphadenitis, metabolic diseases, contagious ecthyma, dermatophilosis, mastitis, ovine brucellosis, ovine pneumonia, and congenital diseases (Hungerford 1970).

Table 2. Incidence of parasitism and other causes of mortality in sheep in the Philippines.[a]

Parasites, Diseases, and other Causes of Mortality	Frequency	Percentage (%)
A. Incidence of parasitism (n = 65)		
1. ectoparasites	11	16.9
2. endoparasites	54	83.1
B. Other causes of mortality (n = 99)		
1. Infectious diseases		
Diarrhea	21	21.7
Pneumonia	17	17.2
Hemorrhagic septicemia	8	8.1
FMD	6	6.1
Tetanus	2	4.0
Others		
2. Metabolic disorder (bloat, cellophane disease)	15	13.1
3. Accidents		
Snake & dog bites	26	27.3
Vehicular accidents		

[a]Source: PCARRD 1988.

Table 3. Disease incidence of sheep at the Philippine ASEAN Goat and Sheep Center (1983-87).[a]

Diseases	No. of Cases	Incidence (%)	No. of Deaths
Haemonchosis	39	29.1	16
Pneumonia	23	17.2	10
Fascioliasis	15	11.2	6
Bloat	15	11.2	4
Scabby mouth	15	11.2	6
Coccidiosis	12	9	5
Physical injury	8	6	7
Foot rot	6	4.4	2
Congenital	1	0.7	1
Total	134	100	57

[a]Source: Philippine Asean Goat and Sheep Center (PAGSC), Five Year Report 1983-87.

The disease incidence in sheep in the region seems to suggest increasing problems with increased density of animal population. The degree of disease eradication and control being implemented in a particular area likewise has a bearing on the prevalent diseases.

SHEEP DISEASES

Sheep diseases are too numerous to be covered in detail by this paper. With reference to disease control measures and economic consideration, sheep diseases may be grouped into three classes: eradicable, controllable, and manageable diseases (Table 5).

Eradicable Diseases

Eradicable diseases can be totally eliminated from an area or a country. Most of these diseases are of major economic importance because of their possible influence in most countries (Anon 1986). Included in this group are the foot and mouth diseases, malignant catarrhal fever, and rinderpest which are not apparent or moderate in sheep but can be acute, fatal, and highly contagious in cattle and other animals. The cattle-to-sheep-to-cattle transmission is common in cases of malignant catarrhal fever. Bluetongue is primarily an infectious disease of sheep caused by a virus and transmitted by insect vectors. It is characterized by catarrhal stomatitis, rhinitis, enteritis, and lameness. Young sheep yearlings are most susceptible to this disease. Suckling lambs are relatively resistant. Contagious echtyma is a highly infectious viral disease of sheep and goats characterized by the development of pustular and scabby lesions on the muzzle and lips. The disease is common in lambs three to six months old with prevalence during the dry season. The diseases under this group can be eradicated by a program of vaccination, quarantine, and in some cases, the elimination of affected animals (Blood and Henderson 1974).

Controllable Diseases

These diseases are theoretically eradicable. However, experiences in many areas of the world have shown that to eradicate such diseases is very difficult. Included in this group are common bacterial and rickettsial infections. Bacterial diseases in this group are enterotoxemia, blackleg, anthrax, foot rot, and Johne's disease. Most of these diseases can be effectively controlled by systematic vaccination and chemotherapy, except for Johne's disease where control on a herd basis depends upon eradication of infected animals, hygiene and vaccination. Other bacterial diseases in this group which are of significance are brucellosis, leptospirosis, and melioidosis. These can cause severe diseases in human beings. Likewise, these diseases can be effectively controlled by vaccination, chemotherapy, and in extreme situation,

eradication of affected animals. Contagious opthalmia, a rickettsial disease in this group, is characterized by keratoconjunctivitis. It is most common in sheep and goats and can be controlled by chemotherapy and vaccination (Hall 1977).

Manageable Diseases

Majority of the diseases of sheep fall in this group. These are the diseases that are impossible to eliminate entirely and require a regular program of prevention and control. Losses can be minimized by good management, good nutrition, sanitation, vaccination and prompt chemotherapeutic treatment when needed. Neglect of these procedures results in the increased incidence of such diseases in a short time. The diseases in this group can be further sub-classified into parasitic diseases, disease complexes, and vector-borne diseases (Anon 1986).

A subgroup includes internal and external parasitism. Internal parasitism is the most common cause of diseases in sheep. A variety of infestations in sheep are caused by cestodes, trematodes, and nematodes. The two most important internal parasitic problems are haemonchosis caused by *Haemonchus contortus* and fascioliasis caused by one or a combination of *Fasciola gigantica, Fasciola hepatica, Gigantocotyle explanatum, Fascioloides magna,* and *Dicroelium dendriticum* (Levine 1978; Purnomo and Wilson 1987).

The only effective control to avert heavy infestation of haemonchosis and other nematodes is by anthelmintic drenching with supplementary pasture and grazing management like rotational grazing, zero grazing or by grazing susceptible sheep (lactating ewes and young stock) on pasture previously grazed by old animals (Davidson 1984). Fascioliasis control largely depends on the use of chemotherapy (flukecides), snail control, mollusicidals grazing management, and physical methods (Soulsby 1978).

Tactical drenching is based on the immediate recognition of conditions like rainfall which may predispose an increased worm burden associated with a declining plane of nutrition or with an increased risk of infection due to change in grazing habits (Hungerford 1970). Systems of chemotherapy must safeguard the development of drug resistance.

External parasites are common in sheep although they are not as pathogenic as the internal parasites. Furthermore, infestation is easily detected. Infestation maybe because of the presence of a single or a combination of external parasites such as lice, mites, and ticks. External parasites become more important as intermediate hosts to other diseases. Of the external parasites, the biting louse or body louse *(Damalinia ovis)* and the mite infestation caused by mange mite *(Demodex ovis),* trombicula mites and itch mites are most common. The damaging effects of lice, mites,

and ticks are mainly on wool, hide, and reduced productivity. Control is done by dipping or spraying with insecticides and acaricides (Soulsby 1978).

Table 4. Diseases of sheep in Fiji.[a]

Diseases	Frequency
Viral	
1. Orf or scabby mouth	Rare
Bacterial	
1. Tetanus	Common
2. Mastitis	Very common
3. Benign foot rot	Very common
4. Melioidosis	Rare
5. Pasteurellosis	Occasional
Fungal	
1. Dermatophilosis	Very common
Rickettsial	
1. Q. fever	Rare
Parasitic	
1. Gastro-intestinal nematodes	Very common
2. Lungworm	Occasional
3. Tapeworm	Occasional
4. Mange	Occasional
5. Lice	Very common
6. Coccidiosis	Very common
Others	
1. Pregnancy toxemia	Occasional
2. Urinary calculi	Common
3. Plant poisoning	Occasional
4. Cerebrocortical necrosis	Occasional
5. Ear and vulva tumors	Occasional

[a]Source: Walkden-Brown S.W. and Banks D.J.D. 1987.

Disease complexes include respiratory (pneumonia), enteric, and reproductive diseases, and nutritional deficiencies. Disease complexes are characterized by the presence of many causative agents (viruses, bacteria, mycoplasma, rickettsia, fungi, protozoa) and sometimes of two or more causative agents. These diseases are often associated with adverse environmental and management factors (Anon 1986).

Respiratory disease or pneumonia complex is one of the major causes of mortalities in sheep. Siddique and Ajmal (1982) conducted studies on the bacterial causes of pneumonia and were able to isolate *Pasteurella septica* and *Pasteurella hemolytica* as the most common associated with pneumonia lesions in sheep. *Staphylococcus aureus* and *Corynebacterium pyogenes* were the next most common respiratory pathogens. It is likely that primary infection by viruses and mycoplasmas predisposes the animal to

Table 5. Major classification of sheep diseases.

A. Eradicable diseases
- Foot and mouth diseases
- Malignant catarrhal fever
- Rinderpest
- Bluetongue
- Contagious ecthyma

B. Controllable diseases
- Enterotoxemia
- Tetanus
- Blackleg
- Anthrax
- Foot rot
- Johne's disease
- Brucellosis
- Leptospirosis
- Melioidosis
- Contagious opthalmia

C. Manageable diseases
- Parasitic
  - — Internal
  - — External
- Disease complexes
  - — Pneumonia (respiratory) diseases
  - — Enteric diseases
  - — Reproductive diseases
  - — Nutritional deficiencies
- Vector-borne diseases

pasteurella infection. Control can be done by vaccination, chemotherapy, and good husbandry management.

Enteric disease in this group are primarily due to *E. coli*, *Klebsiella-Acrobacter* sp., Salmonella sp., and *Shigella* sp. The most common symptom is diarrhea of varying severity. Control can be effected by bacteria, chemotherapy, and hygiene (Bruner and Gillespie 1973).

Reproductive diseases include infertility, sterility, abortions, metritis, and other related conditions. These are caused by management problems of breeding and at times by infections.

Nutritional deficiencies in sheep are more related to the type and kind of forage available, which depend largely on soil nutrient and microelements. Remedial measures include legume-grass mixtures and soil enhancement for pastures, feed supplementation, and mineral supplementation.

The third group of manageable diseases are the insects or vector-borne diseases. Diseases resulting from insects and vectors can be direct as in tick bites, irritations, and blowfly strikes, or indirectly by acting as carriers of blood parasites and other infections (Levine 1978).

CONCLUSION

Sheep are apparently less susceptible to potentially acute diseases. In typical farms where mixed farming is very common, animal health control relates to diseases of interspecies importance. Generally, drenching, spraying, vaccination, chemotherapy, and at times elimination of diseases is the main objective. Often, disease prevention and control becomes situational, depending on the epidemiology of prevalent diseases, production systems, and economics in a particular area.

Research on sheep diseases will have greater relevance if these are related to production, nutrition, breed performance, and socioenomics. Furthermore, research should consider diseases of interspecies (ruminants and monogastrics) importance and zoonotic significance. Lastly, any health program for sheep must be hand in hand with the improvement of existing production systems.

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Processing and Utilization of Meat and By-Products from Sheep

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ABSTRACT

The dressing percent for sheep in the Philippines is about 53% compared to 43% for goats. The lean yield in sheep is 39% of the liveweight while it is only 27% in goats. The proximate composition, amino acid, vitamins, and minerals of mutton and lamb are similar to those of the beef. Fatty acid composition of the lamb fat is higher in arachidonic and linolenic acid than that of the beef fat. The salt soluble proteins of sheep meat are similar to those of the chevon, and higher than those of the buffalo meat and beef. The moisture and total protein ratio of mutton is similar to that of goat, beef, and carabeef. Emulsion capacity of mutton is higher than that of beef and buffalo meat. The sensory traits of lamb and mutton indicate high acceptability of the meat. The characteristics of mutton and lamb indicate that the meat can be processed and utilized in the same manner as in beef and chevon. Sheep and lamb slaughter by-products may be utilized and processed for human food, animal feeds, industrial uses, and pharmaceuticals. Their uses for pharmaceuticals are, however, limited because more by-products are required to extract drugs at sufficient level.

Meat processing includes all processes utilized in altering fresh meat. It started as early as when man learned that salt and other meat additives can prolong the keeping quality of meat. The original purpose of meat processing was to inhibit spoilage. However, together, with the preservative effect, meat processing treatments resulted in flavorful and nutritious products. Today,

processing has taken an additional role of providing convenience and variety to meat consumption.

Increased prices for lean and other popular sources of meat have altered processing practices and encourage the incorporation of increased percentages of less expensive cuts and less popular meat species. It is for this reason that the use of chevon, rabbit, and mutton/lamb is becoming popular.

In this paper, the processing and utilization of meat and meat by-products from sheep and lamb are comparatively discussed with other meats in relation to their characteristics as material for processing meat products. It is assumed, although not conclusively, that two meat types with similar characteristics can be utilized interchangeably.

CARCASS YIELD

The carcass yield of sheep, lamb, and goats is shown in Table 1. The dressing percentage of rams from the Philippines is 53.8% compared to that of the U.S. lambs which is 50%. These are higher than the dressing percentages of goats (43%), beef (49%), carabeef (49%), and lamb (50%). The lean yield of rams of about 39% is higher than those of the goats (27%), beef (34%), and carabeef (33%). In general, the carcass and slaughter by-products yield of sheep and lambs are higher than that of goats, beef, and carabeef. Since the sheep appears to be similar to goat in breeding habits and management requirements, this animal is probably better to raise than the goat with a low dressing percentage.

Table 1. Carcass yield of sheep and lambs as compared with goats.

Part	Rams[a]		Goats[b]		Lambs[c]	
	wt. (kg)	%	wt. (kg)	%	wt. (kg)	%
Average liveweight	35.10	100	18.97	100	45	100
Dressed weight	18.89	53.8	8.19	43.16	22.5	50
Lean	13.8	39.3	5.24	27.63	15.3	34
Bones	5.09	14.5	1.71	9.02	3.8	8.5
Tongue	0.109	0.3	—	—	—	—
Brain	0.086	0.2	—	—	—	—
Heart	0.127	0.4	.060	0.4	—	—
Lungs	0.227	0.6	.114	0.6	—	—
Liver	0.462	1.3	.828	1.2	—	—
Spleen	0.037	0.1	.023	0.16	—	—
Kidney	0.068	0.2	0.053	0.36	—	—
Stomach	1.129	3.2	0.600	0.40	—	—

[a]Extracted from Villegas 1956 (Philippines).

[b]Extracted from Ibarra 1983 (Philippines).

[c]Extracted and computed from Romans and Ziegler 1977 (U.S.).

COMPOSITION

Proximate Composition

The proximate composition of the different parts and slaughter by-products of sheep as compared to goats is presented in Table 2. Sheep meat was generally lower in moisture in all the organs than the chevon. This could however be a result of the fatter sheep than the goats used in the study. Fat content of the mutton and meat by-products appears to be generally lower than the goat counterparts. The leg of sheep was found to have 15.3% protein (Villegas 1938) as compared to 18.39% in goats. The flank in sheep had 13.37% protein while the same part in goats had 17.52%. Ash content of the two species was comparable.

Amino Acid Composition

The amino acid composition of lamb, pork, and beef as indicated by Rice (1978) is shown in Table 3. It appears that lamb had a comparable essential amino acid as pork and beef except for threonine. Beef had substantially lower threonine than pork and lamb. The nonessential amino acid content of lamb was similar to that of beef and pork.

Vitamin and Mineral Contents

The calcium content of lamb ranged from 87 mg/100 g for hindshank to 21 mg/100 g for the liver (Table 4). Phosphorus ranged from 108 mg/100 g for the hindshank to 270 mg/100 g for the liver. These values are similar to those of chevon, beef, and pork. The iron, thiamine, riboflavin, and niacin contents of lamb are similar to those of beef and pork.

Fatty Acid Composition of Lamb Fat

The fatty acid composition of lamb fat is shown in Table 5. It is very similar to that of beef except that it is substantially higher in arachidonic and linoleic acid. This is probably an advantage since these fatty acids are essential ones, hence, lamb can probably be used to balance low essential fatty acid content of some food items.

Lean beef, pork, and lamb muscles contain 70 to 75 mg of cholesterol per 100. More than 90% of this is in the free form (Rice 1978). There is no substantial difference among the species but great differences among parts are observed. The brain of the animals contain high amount of cholesterol.

Table 2. The average percentage of nutrients contained in the edible portion of wholesale cuts and the internal organs and blood of carcasses of sheep and goats.[a]

Material	Moisture %		Ash %		Protein %		Nitrogen-Free Extract %		Fat %		Calories per Kg %	
	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat
Blood	77.54	86.51	0.85	0.47	14.71	9.73	2.03	2.03	4.87	0.98	1,139	585
Brain	77.43	77.66	1.33	1.47	10.71	12.07	4.11	2.00	6.41	6.80	1.202	1,209
Tongue	64.86	67.92	0.97	0.87	14.75	14.92	4.47	2.03	14.94	14.26	2,178	2,021
Heart	67.23	76.75	0.93	0.94	16.07	15.06	7.65	2.09	8.13	5.16	1,729	1,183
Lungs	77.51	78.74	1.10	1.09	17.27	15.53	0.93	1.85	3.19	2.79	1,049	972
Liver	68.61	70.59	1.58	1.46	19.65	19.47	4.43	5.06	5.73	9.41	1,520	1,323
Kidneys	76.86	78.02	1.33	1.30	13.03	15.04	2.85	3.37	1.94	2.28	995	970
Spleen	76.99	75.04	1.48	1.46	15.94	17.04	3.25	4.38	2.94	2.08	1,060	1,071
Stomach	76.47	79.68	0.86	0.73	11.99	12.62	2.52	0.98	7.97	5.98	1,336	1,114
Intestines	81.12	74.12	0.69	0.74	10.25	10.63	1.89	4.51	6.06	10.24	1,061	1,563
Chuck, including neck	57.97	63.38	0.79	0.92	16.25	18.97	3.65	1.78	21.34	8.95	2,821	1,683
Breast, including shanks	54.34	66.86	0.75	0.91	15.71	17.24	4.65	1.92	24.75	13.08	3,137	2,001
Hotel rack	52.34	66.37	0.72	0.88	14.85	19.86	5.75	4.91	26.34	7.98	9,411	1,758
Loin	49.73	66.79	0.72	0.91	16.03	18.48	6.08	1.95	27.44	11.87	3,462	1,941
Flank	45.56	67.04	0.62	0.80	13.37	17.52	1.96	2.41	18.49	12.22	4,208	1,954
Legs	61.23	70.58	0.87	0.95	15.30	18.39	2.12	0.75	20.45	9.38	2,616	1,653

[a]Source: Villegas et al. 1938.

Table 3. Amino acid composition of fresh beef, pork, and lamb as percent of crude protein.[a]

Amino Acid	Crude Protein Content (%)		
	Beef	Pork	Lamb
Essential:			
Arginine	6.6	6.4	6.9
Histidine	2.9	3.2	2.7
Isoleucine	5.1	4.9	4.8
Leucine	8.4	7.5	7.4
Lysine	8.4	7.8	7.6
Methionine	2.3	2.5	2.3
Phenylalanine	4.0	4.1	3.9
Threonine	4.0	5.1	4.9
Tryptophan	1.1	1.4	1.3
Valine	5.7	5.0	5.0
Nonessential			
Alanine	6.4	6.3	6.3
Aspartic acid	8.8	8.7	8.5
Cystine	1.4	1.3	1.3
Glutamic acid	14.4	14.5	14.4
Glycine	7.1	6.1	6.7
Proline	5.4	4.6	4.8
Serine	3.8	4.0	3.9
Tyrosine	3.2	3.0	3.2

[a]Source: Rice 1978.

Table 4. Vitamin and mineral contents of lamb and goats.[a]

Part	Vitamin-Mineral Contents (mg/100 g)											
	Calcium		Phosphorus		Iron		Thiamine		Riboflavin		Niacin	
	Lamb	Goat	Lamb	Goat	Lamb	Goat	Lamb	Goat	Lamb	Goat	Lamb	Goat
Liver	21	17	270	172	4.5	1.0	0.39	0.51	9.11	2.79	16.1	10.6
Lungs	19	15	172	142	1.8	2.5	0.10	0.10	0.43	1.16	4.2	2.9
Shoulder	16	17	146	127	1.3	0.9	0.13	0.10	0.20	0.56	5.3	3.6
Kidney	18	15	212	189	4.2	1.9	0.59	0.65	3.69	5.70	9.2	4.8
Foreshank	16	7	131	164	0.5	1.2	0.10	0.11	0.16	0.57	5.0	3.5
Hindshank	7	10	108	159	1.5	1.7	0.13	0.11	0.21	0.56	6.5	3.2
Neck	10	14	132	115	1.0	0.9	0.08	0.10	0.13	0.59	4.2	3.0
Loin	8	6	141	150	1.4	0.4	0.14	0.09	0.22	0.48	6.8	5.2
Heart	10	8	151	154	2.6	2.3	0.70	0.61	0.77	3.82	5.2	5.4
Ribs	13	7	156	114	1.5	1.4	0.09	0.10	0.13	0.46	5.5	3.7
Flank	11	11	124	1.0	0.09	0.09	0.09	0.13	0.13	0.13	4.3	4.3
Brain	11	—	189	—	—	—	0.19	—	0.31	—	3.3	—

[a]Source: Abdon et al. 1980.

Table 5. Fatty acid composition of lamb fat as compared to beef.[a]

Fatty Acid (F.A.)	F.A. Composition (%)	
	Lamb	Beef
Palmitic	25	29
Steric	29	20
Oleic	39	42
Linoleic	4.0	2.0
Linolenic	0.5	0.5
Arachidonic	1.5	0.1

[a]Source: Rice 1978.

PROCESSING CHARACTERISTICS

The selected characteristics of mutton along with beef, carabeef, and chevon as found by Turgut (1984) is shown in Table 6. The salt soluble proteins of both the young and old sheep are higher than those of the buffalo meat and beef, and similar to chevon. High salt soluble protein is an indicator of good processing characteristics since this is required for the formation of good emulsions. This suggests that lamb is a better material for the manufacture of comminuted products than beef and carabeef considering binding ability alone. The moisture and total protein ratio of mutton are similar to those of the goat, beef and carabeef and within the range of the ratio required for the development of stable and firm emulsion. The emulsion capacity of old sheep meat is 22.32 ml oil/100 g protein. This is higher than the emulsion capacity of beef and buffalo meat. Emulsions produced were more stable in sheep meat than in beef and in carabao meat as indicated by the lower amount of water and fat exuded after heating and centrifugation.

Chattoral et al. (1979), in their physico-chemical studies of model meat emulsions in relation to the preparation of meat sausages, found that at given concentrations, the maximum phase-volume ratio of oil in the emulsions for water-soluble proteins was in this order: goat ≈chicken ⟩sheep ≈pork. For pure actomyosin, the order was: goat ≈sheep ⟩pork ≈chicken.

Acceptability Traits

The acceptability of lamb and mutton by Filipino consumers is summarized in Figure 1. As a whole, mutton is less preferred than pork and almost as desired as chevon. Mutton is not habitually eaten probably because of its scarcity. The aroma, flavor, juiciness, and texture of mutton are slightly better than those of chevon. It is almost equal with chevon in tastiness, palatability, and ability to stimulate appetite.

Table 6. Selected processing characteristics of meat as influenced by animal type and age.[a]

Parameter	Age	Animal Type			
		Cattle	Water Buffalo	Sheep	Goat
Salt-soluble protein	Young	2.83a	3.19a	3.52a	3.39a
	Old	2.97a	2.59b	3.74a	3.58a
Extractable protein	Young	13.20b	15.06a	17.29a	16.24a
	Old	13.55a	11.60b	17.20a	17.22a
Moisture Protein ratio	Young	3.55a	3.57a	3.75a	3.69a
	Old	3.50a	3.38b	3.48a	3.66a
pH	Young	5.53b	5.58b	5.87a	5.69a
	Old	5.51b	5.490	6.02a	5.91a
ml oil/100 mg protein	Young	20.96b	22.26b	24.12a	22.90a
	Old	21.28b	20.92c	22.32a	22.64a
Emulsion stability (gm fat & water)	Young	24.50a	25.40a	23.70a	25.70a
	Old	22.4b	24.20a	22.80b	20.80b
Viscosity of emulsion (w/100 ml oil)	Young	5,300	4,800	4,950	4,700
	Old	5,400	5,100	5,150	4,500

[a]Source: Targut 1984.

Means within the same horizontal line followed by different letters are significantly different.

Among the consumers surveyed by Kawabata et al (1980), 25% liked, 48% neither liked nor disliked, and 27% did not like, lamb at all. Ninety-four and one-half percent of the consumers surveyed liked beef, 1.5% did not like beef, and only 4% neither liked nor disliked beef. The unpopularity of mutton compared to beef is probably due to its scarcity in the market. There are indications that if Filipinos are exposed to it, it may become popular. Production has to be accelerated; after all, present demand is above the available supply.

Organoleptic Traits

Smith et al. (1974) compared the palatability of lamb with chevon, beef, pork, and horse meat. Results of the comparison are summarized in Table 7. Lamb had the highest overall satisfaction, juiciness, and tenderness scores among all the animal species used. It has a similar flavor score as beef and pork and a higher flavor score than goat and horse meat. Bowling et al. (1976) compared the acceptability of chops and found that lamb chops had consistently higher flavor intensity, flavor desirability, initial and sustained juiciness scores, and overall satisfaction than kid chops.

Table 7. Palatability traits of mutton/lamb compared to chevon, beef, pork, and horse meat.[a]

Species	Palatability Traits			
	Flavor	Juiciness	Tenderness	Overall Satisfaction
Goat	5.68	5.48	5.04	5.40
Lamb	6.26	6.56	7.22	6.56
Beef	6.34	5.80	5.94	6.20
Pork	6.44	5.56	6.58	6.20
Horse	5.90	5.20	5.70	5.70

[a]Source: Smith et al. 1974.

Cooking Characteristics

Some cooking traits of lamb and kid chops as found by Bowling et al. (1976) is shown in Table 8. Lamb chops had consistently higher cooking loss, required longer cooking time, and had a greater degree of doneness than the kid chops at about the same size and age.

Mutton/Lamb Utilization

The characteristics of mutton as compared to other meat types tend to indicate that it can be used in nearly all processed and cooked meat recipes. With Filipino consumers, however, it appears that mutton/lamb is somewhat discriminated. It appears that under Philippine conditions, utilization of chevon/mutton in its intact form is not very attractive at present. However, it is highly appropriated for comminuted and modified types of recipes. Consumers' attitude towards mutton/lamb however, cannot be generalized for the Asian region since customs and traditions are too variable within the area. Mutton and lamb are regarded by other countries as steem meat.

Table 8. Some cooking traits of lamb and chevon chops.[a]

Trait	Lamb Chop		Kid Chop	
	Loin Chop	Leg Chop	Loin Chop	Leg Chop
Cooking loss (%)	31.9	34.3	25.7	30.4
Cooking time (min)	62.1	77.4	46.5	71.3
Degree of doneness[b]	3.2	4.3	3.1	3.6

[a]Source: Bowling et al. 1976.

[b]10-point scale (10-extremely rare, 0-overdone).

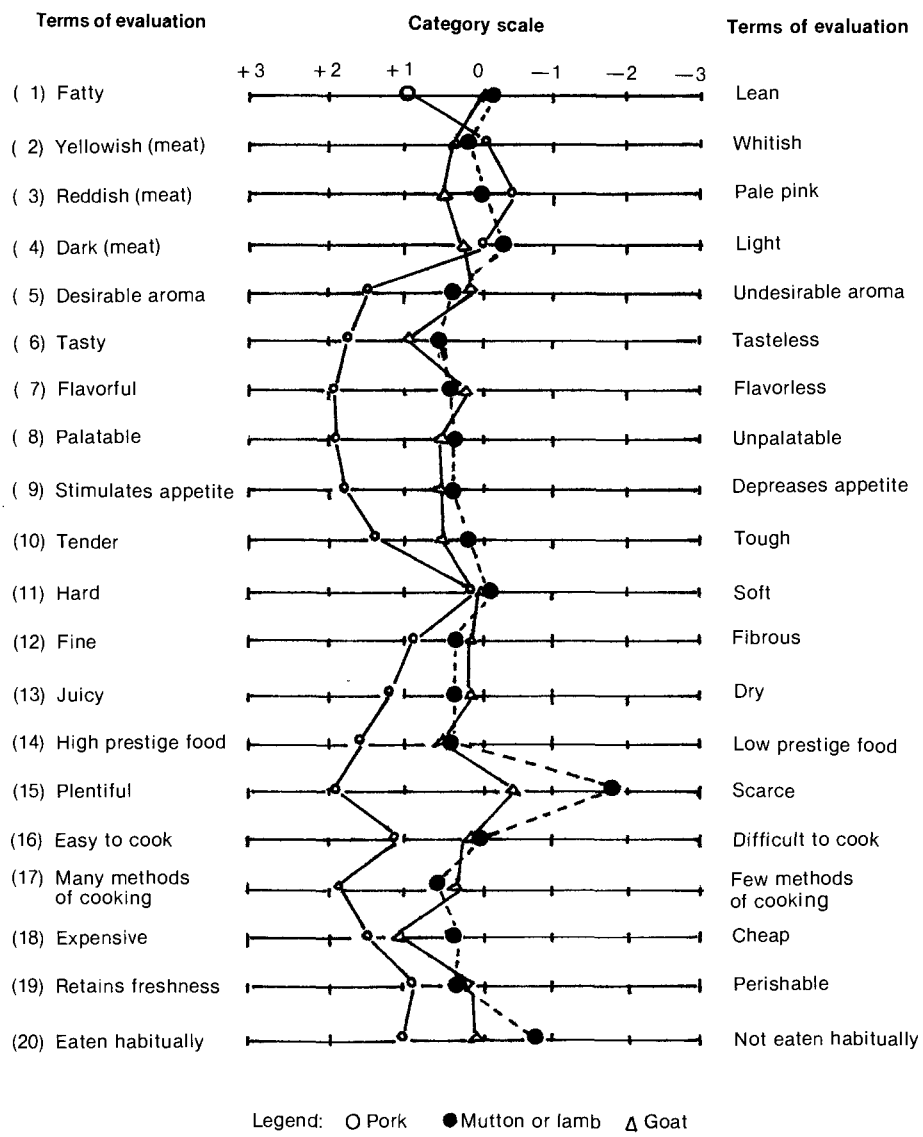

Fig. 1. Preference for chevon as compared to mutton and pork.

By-Product Utilization

According to Adams (1977), the slaughter by-products in lamb slaughter is a good source of revenue. The carcass is 91.85% of the live lamb value, while the pelt, variety meats, edible fats, flank glands, and inedible tallow comprise 3.92%, 2%, 7%, .08%, and 1.37% of the value, respectively.

By-products of sheep and lamb may be utilized in four distinct areas, as human food, as animal feeds, as phar-

maceuticals, and as industrial materials. The major slaughter by-products of sheep and lamb and the common ways of utilizing them are shown in Table 9. There are varieties of products that can be derived from each of the by-products. However, some of the end products require high level of technology and complicated equipment for their manufacture. With the increasing labor cost in the preparation of these products, it is becoming cheaper to give them free to by-standers or sell them on contract at a very low price.

By-products as human food. The cheapest and easiest way of utilizing the slaughter by-products as human food is by cooking them into dishes, however, most recipes are in highly perishable form. By-products produced in big quantities must therefore be processed. One best approach of processing these products for human food is to incorporate them with comminuted products especially the emulsion types such as meat loaves.

One common by-product used for human food is fat. It is being processed as a major component of shortening or cooking oil and margarine.

Other methods of processing slaughter by-products for human food is by converting them into tissue powders. This can be done in several ways depending on the final products desired. Powders may be obtained from an alternate extraction with an acid and base or by-products may be boiled, dried and ground or vice versa. Extraction can be made very simple but it can also be made complicated.

Meat extracts or liquid proteins is another form of by-product for human food. The simplest form of this kind of by-products is the concentrated cooking water obtained from the heating of the by-products (Clemen 1927). The process extracts proteins into solution and when evaporated under vacuum, results to a liquid which is rich in meat elements.

Other common processed forms of by-products for human food are blood extracts and gelatinous and puffed products.

By-products as pharmaceuticals. A number of pharmaceuticals may be derived from slaughter by-products. For ventures toward the production of pharmaceuticals, Lesh (1979) listed three conditions to be met. First, an adequate and steady supply of materials has to be assured; second, means of preserving the material is needed; and third, careful research must be done before release of the product is made.

In most cases, the active principle in a gland amounts to a minute fraction of the whole. Therefore, it is necessary to gather large numbers of glands for processing. Some of the common glands and tissues where pharmaceuticals are derived include the adrenal glands, blood, bone, doudenum, intestines, liver, lungs, muscle, ovaries, pancreas, etc. It is, however, unfortunate that

Table 9. Major slaughter by-products utilization.[a]

By-Product	Form Utilized/Produced/Formed
Heart	Sausages, sold fresh, animal feeds, canned, gellied products
Tripe	Sold fresh, pickled or cured, sausage manufacture, animal feeds
Liver	Sold fresh, canned, sausages, meat specialties, animal feeds
Lungs	Animal feeds, sausages, sold fresh
Sweet breads	Sausages, tanning extract, insulin
Hanging tenderloin	Sausages, sold fresh or ground
Tail	Sold fresh, animal feeds, lard and greases, pickled
Kidneys	Animal feeds, sold fresh, sausages
Intestines	Sold fresh, casings, strings and ligatures, animal feeds
Tongues	Canned, meat specialties, sold fresh, cured, pharmaceuticals, sausages, animal feeds
Head meat	Sausages, animal feeds, sold fresh, canned, meat specialties, lard, glue and gelatin
Brain	Sold fresh, animal feeds, pharmaceuticals, canned
Glands	Pharmaceuticals, animal feeds
Gall bags	Artist colors, pharmaceuticals, incense, charms, ink
Tallows	Fats, oil and greases
Bones	Glue and gelatin, animal feeds, fertilizer, greases and lard
Ruminal contents	Fertilizers
Hide/pelt, fleece	Leather, glue and gelatin, woven products, clothing materials, brushes, binder in plaster, upholstery materials
Blood	Sausages, animal feeds, glue, fertilizers, sugar refiner, color fixer
Melt & abdominal fat	Animal feeds, lard production, etc.
Stomachs	Animal feeds, lard and tallow production, pharmaceuticals, sausage casings
Backfat	Lard production, animal feeds, sausages
Ears, snouts, lips, etc.	Sold fresh, gelatin, pickled, sausage animal feeds
Wesand meat	Sausages, animal feeds
Feet with hoof	Animal feeds, fertilizers, glue and gelatin, leather finishing, handles and the like, oils and greases plaster retardent
Other by-products	Lard, soap, candles, glycerin, tallow, neats foot oil, rennet, oleomargarine
Combined by-products	Vitameat (product rich in minerals, proteins and vitamins) meat powders, meat extracts, animal feeds, etc.

[a]Summarized from different sources.

each gland yield specific pharmaceutical such that different organs and tissues cannot be lumped together during collection and processing.

Slaughter by-products as industrial materials. Several sheep by-products may be used to produce industrial items. Three of the most important materials are fat for the manufacture of oils, lubricants and soap; fleece for wool and leather; and connective tissues for glue.

The major value of sheep skin is represented by the wool. The wool is commonly processed for clothing materials and similar items. The present trend in small sheep and goat slaughter operations is however different. The wool is left intact with the skin. It is then processed for the production of handbags and similar items.

Slaughter by-products as animal feeds. The processing of slaughter by-products as animal feeds is a normal feature of big slaughter and dressing plants. By-products not commonly utilized for human food are lumped together and are then rendered. The products resulting from the rendering operations are animal protein concentrates and fats. The rendering operation also perform an important function in disposing off animal tissues which otherwise, would become wastes and potential pollutants of water and air.

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The Marketing and International Movement of Sheep within Asia

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ABSTRACT

This paper discusses marketing and international movement of sheep with reference to: marketing patterns for sheep in Asia; characteristics of these markets; trade requirements of the various countries; trade opportunities offered by some of these countries; current transportation and infrastructure; prices and demand for sheep; problems of importation and marketing of sheep; and trends in the requirements for sheep and factors affecting the supply and importation to meet these requirements. Indigenous sheep populations in most Asian countries are relatively small and scattered compared to developed countries such as Australia and New Zealand. Importation of selected types from these countries provides the required number for crossbreeding and selection and results to increased population in individual countries.

One could draw the conclusion that the early European colonial rulers of most of Asia and Southeast Asia had a masterplan for this region whereby each of the countries was chosen to grow or produce only certain commodities, and that any attempt to diverge from this plan was totally discouraged. Hence, most of tropical Asia grew plantations of spices, timber, rubber, etc. with the highlands planted to tea. In this masterplan, only the temperate regions were reserved for the specialization of extensive livestock production.

Over the past 200 years, these regions have become highly specialized in their particular "chosen" area, mostly, with their

crops and plantations, while others like ours, with wool and meat production.

We are now seeing the social and commercial pressure to break from the earlier bonds of the "masterplan." For many Asian countries, it is about time to rapidly move into largescale livestock production so as to boost the income of their farmers, create new industries and opportunities, and reduce the heavy burden of importation of meat, wool, and leather to satisfy their people's requirements.

Small ruminants such as sheep and goats have an important role to play in this endeavor. Meanwhile, countries with the experience and technical expertise on such small ruminants are expected to supply resources, and thereby provide the transfer of technology to ensure the successful integration of this new industry despite the earlier "masterplan."

MARKETING PATTERNS FOR SHEEP IN ASIAN COUNTRIES

Very little has been documented so far regarding the marketing of sheep within Asia and in most cases, the industry is still in an embryonic stage. The situation presses the need for a great deal of experimentation involving all kinds of sheep breeds (and cross-breeds) being imported from all parts of the world including Europe, North America, and Australia.

To date, these importations however, have not resulted from marketing drives by exporters of these animals in the producer countries, but rather through the forward thinking and vision of a very small number of people, usually government departmental heads, who in their desire to put the new industry off the ground, have provided the government tenders or sought out likely suppliers to meet their needs.

There are two reasons why a very strong marketing push from countries like Australia cannot be attained. Firstly, supplier countries lack information about the potential growth in these markets. Secondly, the perceived 'masterplan' view leaves the fact that such market exist.

A natural resistance of Australian and New Zealand farmers is that they have a world dominance in this field and that they are not about to give existing meat markets the expertise and breeding stock and hence, eventually cut off a lucrative export outlet.

Likewise, perhaps the huge size of the existing Middle East markets which take over 7 million sheep a year from Australia and New Zealand simply dominates the minds of producers and exporters.

There are, however, a few companies now in Australia and New Zealand who see the long-term future in marketing their ability to source the correct types and quality of sheep (in cooperation with their Asian partners) and their technical expertise in day to

day management, husbandry and implementation of breeding programs. These companies usually have extensive production backgrounds and are spending considerable time and resources not only to follow government tenders, but to actively seek for the particular market's requirements in terms of livestock and technical services, and to indulge in a long term marketing plan that will include joint ventures to offer technology transfer services over a long term period.

Despite the apparent lack of interest of Asian markets for sheep, an upsurge of interest I expected following the recent importations of sizeable consignments of breeding sheep, especially as the price being paid at this stage of development is a premium over Middle East markets.

Thus far, the main thrust has been towards marketing of sheep meat of crossbreeds and local varieties. It is expected that as the wool quality and quantity improves within these projects, a greater emphasis will be put on the multi-purpose of sheep, giving good carcass, reproduction performance, and wool production.

Market Characteristics

There exists a conflict within Asian markets as to what is exactly wanted of the type and quantity of imported sheep.

Some people advocate a very slow and careful scientific approach to the development of the sheep industry within Asia, studying first all of the breeding and production aspects of these animals before further importations and before large amounts of money are spent. There is however, an opposing view that for commercial considerations, a more rapid course must be taken, allowing for a 'learn as you go' approach to the problems.

Basically, the countries who are rapidly moving in this area have identified the need to boost their rural base, increase returns from plantations whose commodity prices may have suffered adversely in recent times, provide sources for added income to small farmer, and reduce imports. As mutton forms a substantial part of meat imports, the importation and breeding of this type of sheep is a natural consequence.

Unlike Australia and New Zealand however, most of the countries now involved in the sheep industry do not have the established facilities and infrastructure for handling large numbers of this animal. They are severely limited by a lack of knowledge on the economic and viable day to day handling of large flocks on the benefits of extensive sheep rearing, and on which breeds will best suit the local conditions.

Another inhibiting characteristic is the small farmers' lack of skills in modern husbandry techniques, and their inability to handle several animals at the same time since the potentially large farmers and plantation owners are not traditionally livestock people.

Finally, with few exceptions, all of the markets for sheep from Australia and New Zealand are vastly different climatically and environmentally, in terms of the available foodstuffs and diseases present.

These characteristics pose a great challenge to both importers and those who wish to supply the necessary number of sheep to stimulate the growth of a viable and worthwhile industry.

Personally, I am convinced that with the knowledge available from the past 200 years on sheep rearing in Australia, and with the skills and dedication of the many excellent scientists and researchers present here today, the above-mentioned market characteristics and their effect on the growth of a successful sheep breeding will soon be overcome.

Trade Requirements

No particular trade requirements of countries within Southeast Asia that have inhibited the development of the industry or market potential for exporters have so far been identified.

Naturally, in most countries, it is a requirement for a foreign company to appoint a local agent, or involve a new group within that country to be able to import livestock. For those foreign companies who wish to limit their involvement to delivery only (as in the case of government tenders), this is not a great problem. However, for those who wish to follow up this service with a greater involvement in the ongoing breeding, production and marketing, a more detailed selection of suitable long term partners is necessary to ensure that they will be well placed in rendering service to the growing needs of the industry. Also, this will enable them to share the same dedication and commitment to quality and development in individual countries. It may also be preferred or obligatory in some countries that counter trade requirements be included before any substantial contracts can be entered into for the supply of sheep and other livestocks. This may be a prohibitive step in an industry which needs all the assistance and promotion it can get to achieve the goals it has set.

Opportunities for Importation

Numerous opportunities exist within most of Asia in terms of sheep importation. First, there is a need to import large numbers of crossbred ewes (an embargo exists on the export of Merino wool sheep from Australia) of various breeds. These are mainly British breeds such as Border Leicester, Poll Dorset, Romney Suffolk, and Wiltshires for crossing with local rams order to produce an F_1 with the desirable traits from both dam and sire. Second, there is an opportunity for crossing with imported rams to hopefully produce progeny with all the known characteristics of breed, but with the necessary acclimatization to perform well in the local conditions. Along with this is the opportunity to select and supply

top producing rams to serve the same objectives. Most often, the numbers of local ewes are insufficient to carry out largescale crossbreeding.

It may even be an economic proposition to look at the feasibility of importing indigenous rams into Australia or New Zealand where crossbreeding can be done cheaply under existing farming regimes. The progeny can then be transported back to say, Malaysia, for further production. This leads to the possibility of also importing semen and frozen embryos to counter some of the problems now being faced regarding the poor performance of imported temperate rams in their new environment.

Other opportunities also exist for the importation of sheep purely for integration with plantations, where they can be grown and fattened for meat and skin value. This process would not involve breeding which, for many parties interested in the trading prospects of the end products, looks to be a profitable alternative given the ruling prices for meat, wool and skins. Equally, there are opportunities for those companies willing to offer their services and provide the transfer of all the technologies associated with an integrated livestock production industry involving sheep.

Transportation of Sheep

The single greatest problem facing the Australian exporter is the provision of transport of the sheep to the markets. Unlike the Middle East's well developed trade in live sheep, there are only a handful of ships available to the region capable of safely transporting sheep to Asia. The load sizes vary from around 4,000 to 6,000 heads which are generally more than what can be accepted by an importer other than a large firm, a large business or a government department. For small loads of say a few hundreds, one has very limited opportunities from most Australian ports.

Air shipment is very expensive (at least 50% higher than by sea) and often unavailable or unreliable because of heavy competition from other food exports.

By comparison, the shipment of sheep to the Persian Gulf takes around 18 to 20 days and costs around $US10 to $US15 per head, while the 8-day voyage from Fremantle to Port Klang costs around $A 40 to $A 45 per head.

In Australia and New Zealand, sheep are unloaded quickly and are moved in large multi-deck lorries capable of carrying up to 1,000 heads each whereas in most of Asia, this type of vehicle is not available, hence, the use of road transport which is a slower and a more labor intensive operation.

If sheep are to be imported at reasonable transport rates, full ship consignments must be planned; that is around 5,000 to 6,000 heads at a time. Charterers of ships charge on a voyage basis irrespective of whether it is full or not. Therefore, it is a very costly business, for the importer particularly, to deliver part loads. Yet,

there is the obvious need to be able to economically transport smaller numbers to meet the needs of those who wish to start on a smaller scale, perhaps with a choice of a number of breeds, so that they can feel their way before risking large expenditure on thousands of head. This is also necessary for those who simply do not have the facilities to cope with large numbers at one time.

As the livestock numbers increase into hundreds of thousands, and as significant numbers start to flow to abattoirs for slaughter, necessary changes and improvements along the lines of those utilized in Australia and New Zealand will have to be adopted to allow for their orderly and economic development.

Prices and Demand for Sheep

Prices of live sheep in most Asian markets are well above the prices in Australia and New Zealand. This is largely due to the supply and demand, and this relates to the premium paid for freshly killed 'hot' meat in the local markets. The price per kilo of such meat in most Asian markets is measured in dollars per kg as opposed to cents per kg in Australia.

At present, sheep are enjoying top prices in Australian and New Zealand markets because of the boom in the prices of wool. When this price is coupled with the stringent protocol requirements and costly shipping charges to most Asian ports, the prices of good quality breeding sheep become rarely below $150. If the markets want to import good quality sheep which have undergone all the necessary treatments and which possess every chance of surviving and breeding well locally, then this is the price structure that will prevail. It is worth noting that some importing countries are unrealistically accepting low tender prices for what they hope (and have contracted for) are good quality sheep which are properly prepared. The underlying justification is the belief that many of them will die in any event, as this has been their experience, and that it is of better economic sense to sell them at lower prices than to let them die anyway. There is something basically wrong with this outlook, and more attention needs to be given to the quality and suitability, along with back-up service to ensure that the development objectives will be met by well organized systems of production.

There are enough exporters and producers in many supplier countries who are willing to do the right thing and supply the correct product for the appropriate price and with "after sales service" support. There are however, those parties who are only interested in a quick sale of the cheapest product they can acquire before they move onto their next market.

Problems of Marketing

Some of the problems in marketing of sheep have already been covered in the foregoing. However, two other main aspects have

yet to be mentioned.

Firstly, because of the natural lack of experience in this field, specifications for certain breeds of sheep like their pregnancy status and their required delivery times have to be ascertained to ensure that all the requirements can be met. For instance, request for a particular crossbred ewe will be associated with a given age, bodyweight, early pregnancy and delivery in a certain month. To meet these requirements, the importer must take into account the normal breeding cycles locally within the part of Australia where that type of sheep can be produced, particularly when no lead time is given to allow for "out of ordinary" arrangements to be made with the farmer/producer. This problem, however, can be easily overcome by greater consultation with exporters and authorities such as the Australian Meat and Livestock Corporation.

Secondly, there is the costly requirement in meeting the veterinary and quarantine protocols of some countries. However, I do feel that in some cases, specific items must be included for expensive blood testing, etc., which can be verified as lacking in Australia or in any particular state of Australia. Further, the protocols appear to change frequently and without notice. A recent example was the Malaysian government's sheep tender requiring vaccinations and blood tests not listed on the Australian authorities' latest file copy.

Every attempt should be made to protect the importing country from any undesirable diseases, ensure the health of the sheep, and reduce the costs to the minimum necessary.

Trends Observed in the Requirements of Sheep

It is our observation that there is general uncertainty as to the truly correct breed of sheep to import, and as to where to commence a breeding program from.

Most countries are importing a variety of breeds with which they are experimenting to find the breed that suits their conditions best. This is not unreasonable when one considers the 25 to 30 breeds and crossbreds being commonly run across Australia and New Zealand, each finding its own niche where it does better than another.

It appears that there is also a strong perception that a tropical/temperate crossbred will emerge from the many breeding programs which will have the necessary hardiness and growth qualities being sought after. In this respect, it seems that any British crossbred will do as a starting point (perhaps even the Merino) to localize by mixing with the local rams. Unfortunately, the quality of some of the local sires has a very negative effect on the finished product or the resulting breed because of the many breeding and conformation faults carried by them.

In recent tenders, there has been a requirement for more Merino content which indicates the desire to look seriously at the

future of the wool clip which is almost of no commercial value to the local sheep and of no significant contribution to the overall income of the sheep enterprise.

My personal feeling is that the temperate British breeds will, given time to adapt, flourish well in their own right without the need to detract from their hundreds of years of genetic fine tuning by crossing out with inferior types. Afterall, much of their alleged lack of performance may be traced to management and husbandry, or can be improved through the utilization of fertility drugs such as "FECUNDIN". Most of these breeds may soon be available in the market and will address the absence of seasonal change which currently stimulates their coming into heat.

It is also reasonable to expect that ewes consigned as "in lamb" will have an initial good lambing (if properly managed), and that the lambs reared and weaned in local conditions will thrive. With respect to non-breeding sheep, two trends will emerge: young weaners for fattening and older sheep for undergrazing and wool production which are no longer preferred by the Middle East market.

In conclusion, the contributions that small ruminants such as sheep and goats can give to rural economies and to the evolution of new industries have been clearly identified.

Numbers of indigenous sheep are small, hence, it is deemed necessary to import quality stock for crossbreeding and fattening in order to provide sufficient numbers and allow for adequate selection pressure to take place.

The necessary numbers of a variety of breeds are available within Australia's 160 million head domestic herd and also in New Zealand which can allow for importation on a large scale, and for the rapid development of Asian sheep to meet the needs of the local demand for hardy and high producing sheep.

Discussion I

Five resource papers were presented in this session. The first paper by Professor I.E. Coop gave a very valuable background on sheep production and development in Asia. He stressed that breed improvement creates a permanent gain as compared to nutrition improvement, disease control, and management. The main emphasis on genetic improvement was through selection, irrespective of whether this is with indigenous breeds or crossbreeding. He pointed out that work on the improvement of indigenous breeds was very limited, whereas crossbreeding using temperate breeds has been more extensive. The latter had many failures and some successes. The success has been particularly apparent with wool breeds especially in China, India and Pakistan. There has been less success in hot arid regions especially in the humid regions where meat, rather than fiber is more important. He drew particular attention to the need for large scale multiplication and distribution of superior sizes.

Discussion centered on size of flocks and management at lambing which varied from location to location. Controlled lambing is only when management is efficient. Concerning twinning rate, he pointed out that the use of improved prolific breeds is only appropriate if the environment can support the extra lambs. Otherwise, slower growth rate and higher mortality will result. He indicated that in New Zealand, even with average management conditions, farmers seldom wanted a lambing percentage higher than 150%. For large sized rams, he suggested that these be used on older ewes.

Among the hair sheep, the Barbados Blackbelly and Mandya were considered superior. It was difficult to make generalizations about the extent to which temperate sheep blood can be incorporated with indigenous breeds during crossbreeding as this dependent on adaptation and also on the genetic quality of the unimproved breeds. Assessment of the F1 progeny against the local control flock is essential over several years, and for discussions about backcrossing either to the exotic or the local.

The second paper by Dr. C. Devendra drew attention to the main features concerning the nutrition of sheep, and more particularly, to feeding strategies for the species in Asia. He indicated that although there has been significant advances on the subject in temperate environments, there is, by comparison, a paucity of information on the nutrition of tropical sheep. Studies on nutrient requirements were especially sparse. Feeding systems

for sheep were similar to that of goats; however, differences existed in the feeding behavior and metabolism between species and related attributes of the species.

The paper showed that although many of the important features on the nutrition and feeding management of sheep are already known, their potential has not been investigated. Particularly important in this regard is the development of intensive systems of feeding based on cultivated grasses and leguminous forages combined with stall feeding, and systems integrated with tree cropping; these systems had great potential. The latter include coconuts, oil palm, and rubber.

The most important constraint to improved performance of sheep was associated with available feed resources and efficient utilization by the animals. The issue merited urgent attention. He emphasized that the major strategy is to provide adequate nutrients in innovative feeding systems on a year round basis wherein predictable performance can be identified with economic production.

Discussion centered on the issue of mimosine toxicity from leucaena and possible harmful side effects on sheep. It was suggested that goats have a greater tolerance than sheep to mimosine toxicity due to their ability to breakdown this substance more rapidly in the rumen. The threshold of tolerance in sheep was less and an optimum level of 30% leucaena forage in the diet was further suggested. On the use of tree fodders, it was considered important to be more selective in terms of which varieties are more preferred, utilized by sheep, and were least harmful to them. Variety in the diet is also useful to promote good performance.

It was also stressed that there is a need for more on-farm work and participatory research with farmers. Dr. Devendra noted that due to inadequate work of this nature, there is limited extension of available new technology, less improvements on animal performance, and therefore less productivity from sheep.

The third paper presented by Dr. O. Parawan focused on problems of diseases and health in sheep. Sheep diseases were classified into three groups in accordance with their prevalence in the region (eradicable, controllable, and manageable). In each category, individual diseases were discussed with reference to causes and treatments. Stomach worms were considered to be major constraint.

Discussion centered on management of lambs at birth and up to weaning including the manpower required for this. It was pointed out that much was dependent on the size of the flock. Dr. Parawan indicated that in his experience, when a 3-month weaning is practiced, there is a lamb mortality of 35-40%. In view of this, weaning has been extended to 6 months resulting in reduced mortality. By comparison, in New Zealand, it was suggested that one man can handle 2000 ewes which lamb in 6 to 7 weeks. Of all

the lambs born, 15% died before they are 3 weeks old and another 3-5% mortality occurs over the following 12 months. It was also noted that in the Philippines, farmers believed that goats are more susceptible to parasites than sheep.

The fourth paper was by Dr. P.I. Ibarra on processing and utilization of meat and by-products from sheep. He reported that in general, the amino acid, vitamin, and mineral content of mutton and lamb are similar to that of beef, differing only in fat and fatty acid composition. In addition, it was evident that the characteristics of mutton and lamb are suitable for processing as in beef. Discussion centered on the need to promote the value of mutton and lamb in the Philippines, which is estimated to be confined to only 25% of the human population. It was apparent that sheep by-products have pharmaceutical uses; however, a large amount of material is required for this purpose.

The fifth paper presented by Mr. L. Macleod highlighted aspects of marketing the international movement of sheep within Asia. He referred to marketing patterns, characteristics of these markets, trade requirements of the various countries, trade opportunities, current transportation including infrastructure, prices and demand for sheep, problems of importation, and marketing the current trend patterns to these aspects as well as factors affecting the supply and importation to meet market requirements.

Discussions raised the question of what strategies to use in the marketing of sheep in the village level. It was suggested that individual and specific strategies were needed to develop particular products (meat or milk). It was then necessary to work backwards from that requirement all the way to marketing outlets for the meat. It was also emphasized that there is a current need to address market preferences and consumption patterns for large scale production in the region.

Session II: Country Case Studies — Issues and Problems

Plate 1. Bangladesh ewe, noted for their high fertility with twin lambs in Bangladesh.

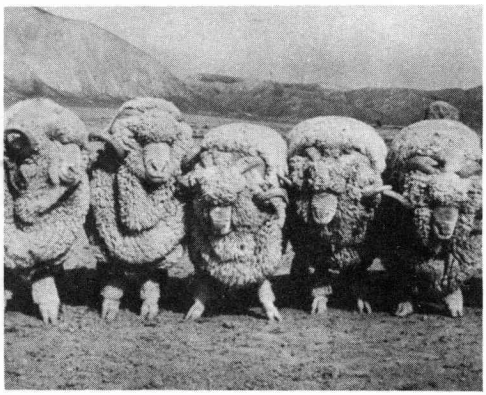

Plate 2. Chinese Merino sheep in China.

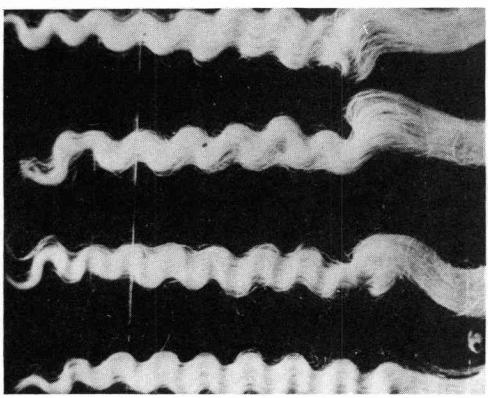

Plate 3. Wool samples from Tan sheep, China.

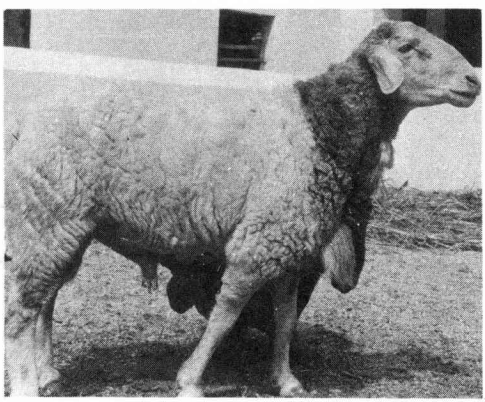

Plate 4. Mandya ram in India.

Plate 5. Group meeting of sheep farmers in India. Note Malpura sheep in the background.

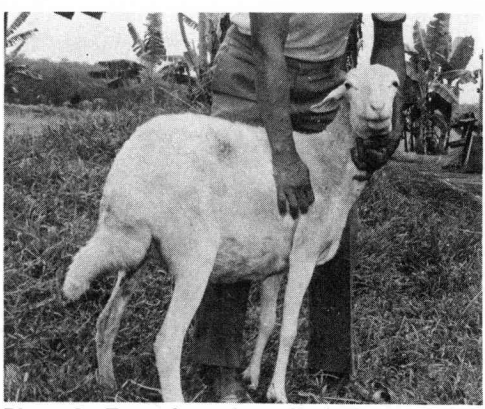

Plate 6. East Java fat-tailed sheep in Indonesia.

Sheep Production and Development in Bangladesh

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ABSTRACT

Landless and marginal farmers in Bangladesh usually raise small ruminants. Sheep are sparsely distributed all over the country except in the districts of Rajshahi Tangail and in the delta area of Noakhali. Sheep being raised are of indigenous type with a small body size and are raised primarily for meat production. They produce small amount of hairy fleece. Most of the sheep remain unclipped every year. They are reared on naturally grown grasses, with no concentrates supplied even in sturdy rams. Sheep population has been gradually increasing for the last 25 years. The most important characteristics of sheep is prolificacy. Lambing is done twice a year while twinning is common. Availability of feeds and good quality rams are the major constraints of sheep improvement in Bangladesh, besides internal parasites. No government program for the improvement of sheep has yet been started. The introduction of breeds from Pakistan had a positive effect on wool quality, but a negative effect on prolificacy and lambing interval. Further studies on economic traits like age at maturity, prolificacy and lambing interval are needed before introduction of any exotic breed is done. Organization of cooperatives may be helpful in protecting growers's interest in getting reasonable price.

Bangladesh emerged as a sovereign state on 16 December 1971, following a war of liberation which started on 26 March to 16 December 1971. With the termination of the British rule in India on

14 August 1947, it constituted the Eastern Wing of Pakistan and was known as East Pakistan for about 24 years.

Bangladesh lies between 20.34° and 26.38° north latitude and 88.01° and 92.41° east longitude. It has an area of about 143,998 sq. km. Except for the hilly region in the northeast, southeast, and some areas of highland in the north and north western part, the country consist of low, flat, and fertile land. A network of rivers and their distributories covers the whole country.

Bangladesh enjoys a generally subtropical monsoon climate. Of the six seasons a year, three (winter, summer, and monsoon) are predominant. The maximum temperature during summer months is about 40°C (104°F) and the minimum temperature during the winter months is about 6.5°C (44°F). Monsoon starts from June and lasts till October. This period accounts for 80% of the toal rainfall, the average rainfall of the country being 200 cm (550 cm in north east and 150 cm in the west). Total population of Bangladesh is estimated to be 105 million (Bangladesh Bureau of Statistics 1986).

CONTRIBUTION OF LIVESTOCK TO NATIONAL ECONOMY

Agriculture is the main occupation of the people of Bangladesh employing about 61% of the labor force. This sector contributes about 48% of the Gross Domestic Product (GDP) in the national economy. Livestock and poultry, one of the four components of agriculture, contributes about 5% of the GDP and represents about 8% export earning. This production will be much higher if contribution of livestock to crop production is included. The livestock sector is recognized to be an important source of animal protein, besides providing tractive power to farm operations and transport (BBS 1986).

Livestock population in Bangladesh is estimated at 36.0 million cattle, 1.7 million buffaloes, 12.0 million goats, and 1.1 million sheep (Food and Agriculture Organization 1983). Out of the total livestock population, 98% are reared in the rural areas. Landless and marginal farmers largely depend on livestock and poultry for their existence. They are the bulk producers of milk, meat, and eggs. The rich families residing in the urban areas are the major consumers of their products.

All the animals are kept in small farms. Livestock rearing, although a secondary enterprise, is generally supportive of crop farming. The number of animals and birds per rural households averages 2.6 cattle/buffalo, one sheep/goat and 7.5 poultry (Asian Development Bank 1984). Cattle and buffaloes are the essential sources of farm power in Bangladesh. For various farm operations, 98% power are derived from animal sources (FAO/World Bank 1983).

Contribution of Small Ruminants

Small ruminants, like sheep and goat, are reared by the landless and marginal farmers all over the country except in the district of Noakhali where sheep are being owned largely by the large landholders. In order to keep the possession of char area (reclaimed land from the river and sea), the large farmers used to place some landless families there with a few sheep and buffaloes. The owners of the land, in many cases do not know the number of animals they own.

Population. Total population of sheep in Bangladesh is estimated at 1.1 million heads which represent 2.2% of the total livestock population (FAO 1983). They are sparsely distributed all over the country except in the delta area of Noakhali, Tangail, and Rajshai districts. The distribution and its density is shown in Figure 1. The trend of sheep population along with other livestock is shown in Table 1.

Table 1 shows the increasing trend of all livestock from 1961-65 to 1983 in general. However, the higher level increase was found for buffaloes (729.3%) followed by sheep (99.3%). Further increase in livestock population as well as in sheep population is expected in the future.

Table 1. Livestock population in Bangladesh (1961-65 to 1983, 10^3 head).[a]

Species	61-65	70	75	80	83	% Increase/ Year
Cattle	21134	26800	27334	33000	36000	–3.5
Buffalo	205	670	696	1550	1700	36
Goat	8342	11400	12354	11500	12000	–2.2
Sheep	547	720	752	1061	1090	–5.0
Total	30228	39590	41136	47111	50790	–3.4

[a]Source: FAO 1972, 1976, 1981, 1983.

Meat production. Sheep produce only 0.6% of the total meat production of the country amounting to 20 t in 1983 (FAO 1983). The production of meat from livestock and poultry is presented in Table 2.

The overall increase in meat production from livestock and poultry is 116.4% from 1961-65 to 1983 (Table 2). Highest increase (100%) is observed in buffaloes and sheep (100%), and in poultry (304.4%). Buffaloes are usually kept as draft power whereas sheep are being kept primarily for meat production. Increase in sheep production is consistent with popularity among the small ruminant raisers.

Hides and skin production. Production of hides and skin increased by 27.9% for the period from 1961-65 to 1983 (Table 3). In case of sheep skins, the percentage of increase was the highest

Table 2. Meat production in Bangladesh (1961-65 to 1983, 10^3 tonnes).[a]

Species	61-65	70	75	80	83	% Increase/ Year
Cattle	1200	1570	1590	1810	1950	–3.0
Buffalo	30		40	60	60	–5.0
Goat	330		490	450	480	–2.3
Sheep	10	470	20	20	20	–5.0
Poultry	230	290	330	660	930	–15.2
Total	1590	2330	2470	3000	3440	–5.8

[a]Source: FAO 1972, 1976, 1981, 1983.

Table 3. Hide and skin production in Bangladesh (1961-65 to 1983, 10^3 tonnes).[a]

Species	61-65	70	75	80	83	% Increase/ Year
Cattle	71860	91200	96576			
Buffalo	1968	2610	3006	83690	89750	–1.0
Goat	7844	10720	11597	14100	14400	–4.2
Sheep	274	360	392	620	660	–7.0
Total	81946	95242	111571	98410	104810	–7.0

[a]Source: FAO Production Yearbook 1972, 1976, 1981, 1983.

(140.9%) followed by goat skins (83.4%), while cattle and buffalo hides increased by only 21.6%. These indicate the importance of small ruminants to the farmers.

BREED OF SHEEP

Description

Bangladeshi sheep are small, with an average adult weight of 25 kg per ram and 17 kg per ewe. The average height at wither is 53 cm, with a girth of 74 cm, and a length of 48 cm. The head is small, black or brown, or mixed with white hair on the forehead. Males are horned while females are hornless. Small ears are black or brown, eyes are bright and the nose, straight. The neck is long and narrow while the back and belly are straight which are almost parallel to each other. Majority of the animals are white although black/brown are also seen. Forelegs are generally thin and straight while hind legs are bent with moderately developed rump. Body may be white, black or brown, or an admixture of these three colors.

Utility

The sheep are raised primarily for mutton production. Mutton is

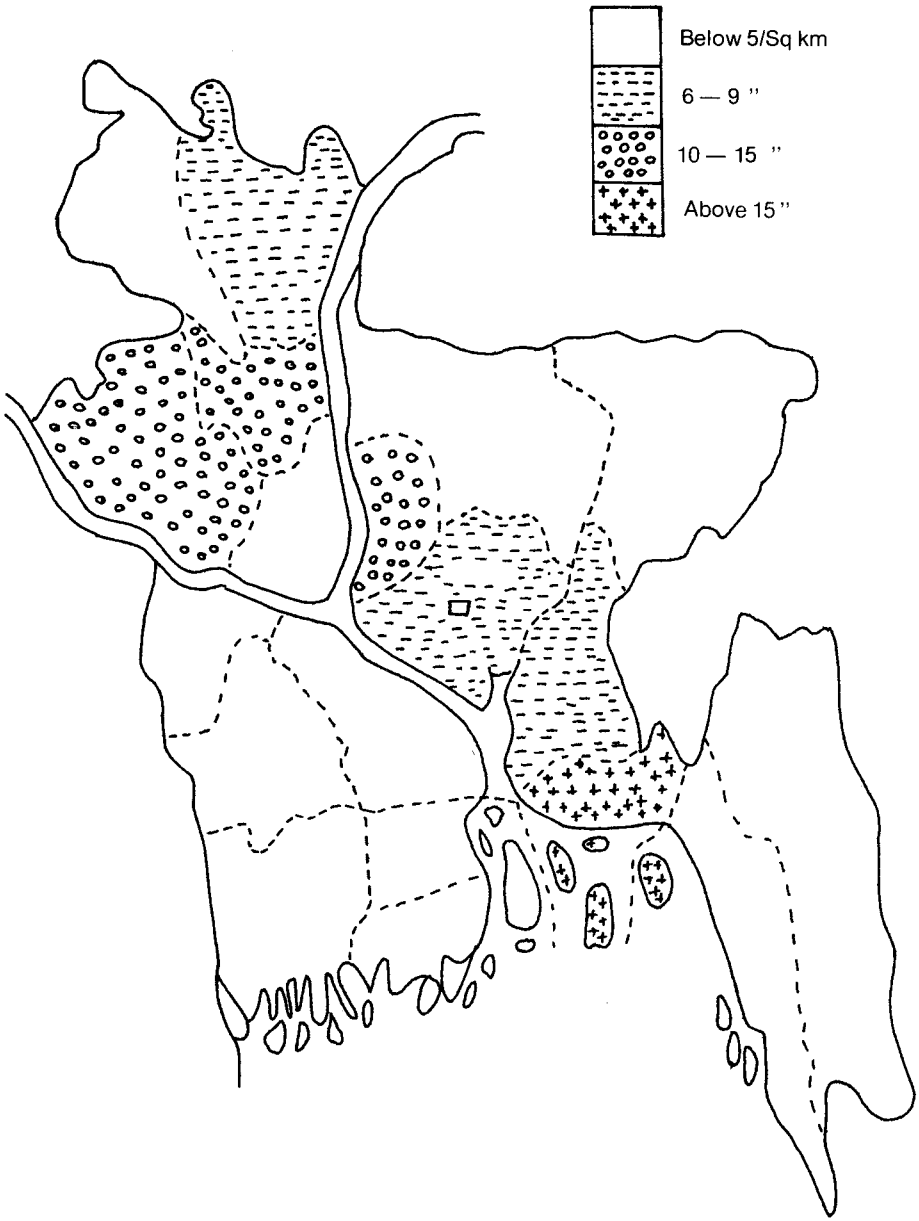


Fig. 1. Distribution and density of sheep in Bangladesh (Adapted from Bangladesh Bureau of Statistics).

of good quality; the dressing percentage is 42 to 47%. Sheep usually produce 250 to 500 g hairy fleece annually; milk yield is negligible and is often not sufficient for lambs in case of multiple births. The most important characteristic of Bangladesh sheep is their prolificacy. They usually lamb twice a year or in 15 months and twins are most common, although single and triplets are common too. The ewe lambs mature early with age at first estrus generally found within 7 to 9 months.

Flock Range

Usually, the flock ranges from 10 to 50 heads, but in the Noakhali delta area, a flock of 1,000 to 1,200 sheep may be seen. The animals generally fed on naturally grown grasses. Usually, no concentrates are supplied even to the stud rams. They are kept open day and night and sheltered in cow sheds, varandah, or even within the dwelling houses at night. At Noakhali char area, the sheep are kept in Bathan made of thatched roof and bamboo pillers and platforms to protect the animals from being washed away during high tide.

CASE STUDY

In order to seek information on sheep production and farmer/agent practices, a total of 277 farmers were interviewed using a questionaire. Because of time limitation, the data were not completely analyzed and compiled. However, some of the results are presented in this paper.

Type of Farmers

The farmers were classified on the basis of the type of small ruminants they raise. It was found that 58.8% of the farmers keep only goats, 16.3% only sheep, and 24.9% goats and sheep. The number of animals reared per farm family was 12, 11, and 19 for goats, sheep, and goats + sheep, respectively. The farmers were also classified on the basis of land holding.They were from landless (up to 0.2 ha.) to 4.8 ha of land holding with an average of 0.7 acres except at Noakhali. At Noakhali, land holding varies from landless to 202 ha, the average being 24.2 acres. Classification of sheep raisers on the basis of landholding of study area excluding Noakhali are presented in Table 4.

Table 4 indicates that landless farmers own more sheep per farm family while medium farmers are less interested in sheep raising. The latter probably devote more time to crop production or other professions for their livelihood. At Noakhali, it was observed that more sheep are possessed by the large landholders.

Table 4. Landholding of the respondents by number of sheep per family.

All Areas Other Than Noakhali			Noakhali		
Landholding	Number of Respondents	Number of Sheep per Farm Family	Land	Number of Respondents	Number of Sheep per Farm Family
Landless (below 0.2)	26 (30.23)[a]	12	Landless (Below 0.2)	9 (34.62)	46
0.2 — 1.2	46 (53.28)	7	0.2 — 4.0	8 (30.76)	169
Above 1.2	16 (16.28)	11	Above 4.0	9 (34.62)	391
Total	86			26	

[a]Figures in parentheses indicate percentage of the respondents

Family and Flock Sizes

Family size of the sheep raisers ranged from 2 to 18 with an average of 7.3. It was observed that increased family size corresponds to an increase in the number of sheep reared per farm family.

The sheep raisers were classified on the basis of flock size. It was observed that the flock ranges from 2 to 55 in all areas other than Noakhali. At Noakhali, the flock size varies from 10 to 1,200. Respondents on the basis of flock size are presented in Table 5.

Table 5. Classification of respondents on the basis of flock size.

All Areas other than Noakhali			Noakhali		
Flock Size	Number of Respondents	%	Flock Size	Number of Respondents	%
2-5	40	46.51	Up to 10	1	3.85
6-10	25	29.07	11-50	10	38.46
11-20	12	13.95	51-100	3	11.54
21-35	6	6.98	101-150	5	19.23
Above 35	3	3.49	Above 150	7	26.92
Total	86	100.00		26	100.00

Feeding and Breeding

According to the respondents, the sheep raisers depend on naturally available green grasses for the maintenance of their sheep. In addition, 38 farmers (32%) said that they supplied tree leaves during periods of scarcity. About 27.7% farmers reported that they supplied home grown concentrates when available, in

addition to grazing and tree leaves. The farmers do not feel the necessity of supplying concentrates even to the stud rams.

In contrast to goat raisers most of the sheep raisers (66%) usually keep stud rams by themselves. Those who do not have any ram, hire stud rams from the neighbors, free of cost. Almost all the farmers indicated that their sheep generally lamb twice a year and twinning is most common, but singles and triplets are not uncommon (Table 6).

Table 6. Respondents' opinion regarding types of lambing.

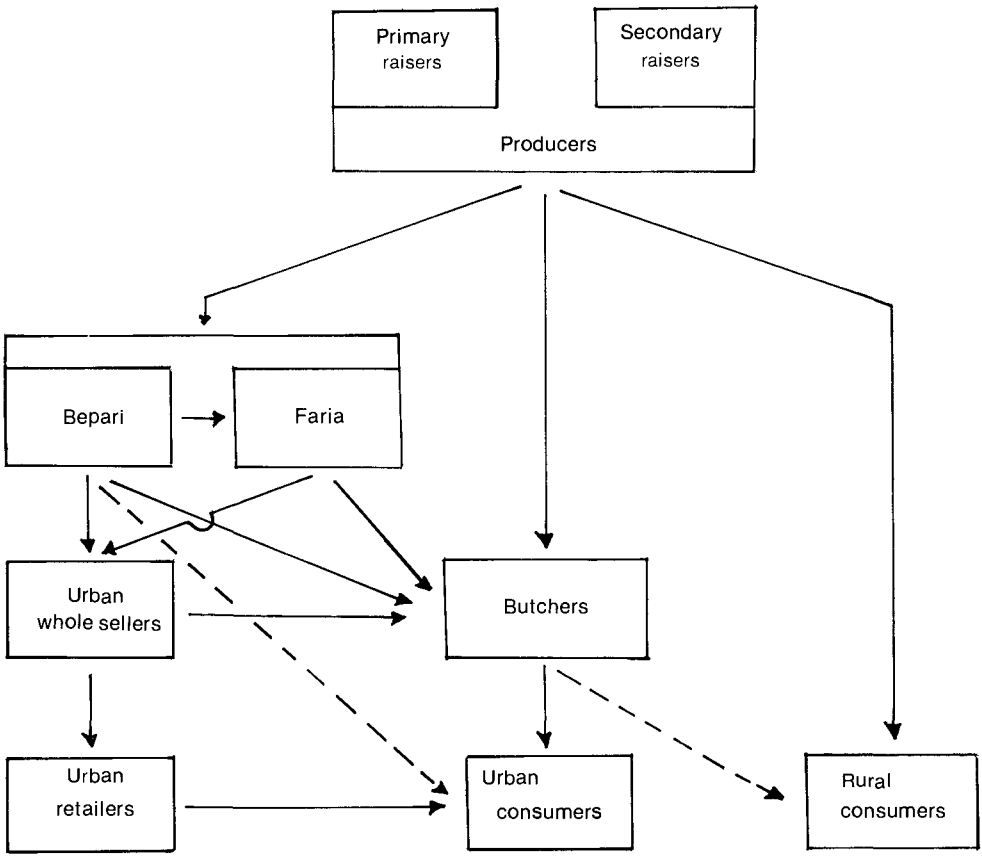
Type of Lambing	No. of Respondents	%
Single	1	0.9
Twin	59	52.7
Triplet	7	6.2
Single to twin	18	16.1
Single to triplet	2	1.8
Twin to triplet	18	16.1
No response	7	6.3
Total	112	100.0

MARKETING SYSTEM OF LIVESTOCK AND LIVESTOCK PRODUCTS

Bangladesh has a rural based economy, with majority (85%) of the population living in the rural areas and with agriculture contributing the largest share in the GDP. Traditional markets (hat/bazar) play an important role in the rural economy (Uddin 1987). Most villagers sell their surpluses and purchase their necessities at these markets. Some of the growers sell their products directly to the local consumers and others to beparis (businessmen) and forias (brokers/middlemen) at the rural hat/bazar. The beparis may sell their purchased goods to forias in the same hat or may go to another hat for selling their purchased goods. In some cases, they sell directly to the rural consumers. The price of goods is fixed during the bargaining process. The usual marketing channels of livestock and livestock products are shown in Figure 2.

PROGRAM FOR SHEEP PRODUCTION IMPROVEMENT

In all the development programs of Bangladesh, livestock and fisheries sectors usually receive less attention. Since the 1960s through the introduction of the "Grow More Food" campaign, all attempts were concentrated on the production of food grain to become self sufficient in food. These attempts have not fully suc-



Bepari = Middlemen (Businessmen)

Faria = Middlemen (Brokers)

Fig. 2. Marketing systems of livestock and livestock products.

ceeded because of the lack of animal power for tillage. On the other hand, the shortage of food of animal origin has become more and more acute because of the growth of human population and low production of livestock, poultry, and fisheries. Within the livestock sector, development has been concentrated almost on the improvement of cattle to increase milk production, tractive power being the secondary importance. For the development of goats and sheep, no government program has yet been started or being planned for the future. The sheep in Bangladesh are developed through natural selection since time immemorial.

Although sheep is a multipurpose animal producing meat, milk, wool, and skin, farmers raise sheep as scavengers primarily for the production of meat; wool and skin become slaughter house by-products. The farmers are not aware of the importance of wool. As a result, about 75% of sheep remain unclipped every year. A small amount of hairy wool as available from tanneries or through shearing are being used by few professionals in the preparation of blankets and carpet.

The Bangladesh Agricultural University (BAU) imported three Lohi rams from Pakistan in December 1964 to improve the local sheep for the production of carpet wool. The second importation of three Lohi rams and six ewes were made in December 1969. Unfortunately, all the imported sheep were destroyed by the occupation army during the war of liberation in 1971. In 1972, BAU received three Romney and three Perendale rams from the government of New Zealand as gifts. These rams were used to upgrade second generation Lohi graded sheep for the improvement of carpet wool.

The records of other economic traits such as birth weight, rate of growth, age at weaning or sexual maturity and feed efficiency of such upgraded sheep were not properly studied. However, some of the results of the upgrading program are shown in Table 7.

It was observed that all the parameters related with wool were improved as a result of the upgrading. Fleece yield increased by 100% fineness by 37%, true wool fiber by 133%, and medullated fibers by 41%. A negative effect was found with regard to prolificacy (single, 48% vs 65%; multiple, 52% vs 35%) and lambing interval (253 vs 484 days).

The Directorate of Livestock Services (DLS) established a sheep farm at Sonagazi, Noakhali. They received four rams in 1984 from the program entitled "Those who have less" for breeding purpose. The objective of the farm is to produce improved graded rams for sheep breeders. The program, however, did not have any impact due to lack of appropriate management. It is also possible that the Suffolk breed was not adaptable to Bangladesh conditions. At the moment, there is no exotic breed at the farm.

Table 7. Results of sheep upgrading program at the Bangladesh Agricultural University.

Parameter	Local Sheep	Lohi crossbreds Grade I	Lohi crossbreds Grade II	Romney Crossbreds	Perendale Crossbreds
Fleece yield (gm)	165	325			
Staple length (cm)	5.13	6.65			
Fineness (%)	49.44	43.63	38.91	35.16	31.07
True wool fibre (%)	19.45	26.43	42.72	38.90	45.29
Heterotypical fibre (%)	10.76	16.97	19.78	19.53	13.50
Medullated fibre (%)	69.79	55.31	36.78	41.57	41.21
Fleece density (no.)	2689	3526	5257		
Prolificacy, single (%)	48	71	65		
multiple (%)	52	29	35		
Lambing interval (days)	253	294	484		

CONSTRAINTS OF SHEEP PRODUCTION

Feed

Shortage of animal feed is the main constraint to livestock development in Bangladesh. The permanent use of cultivable land for fodder production is unimaginable at the moment. All cultivable land are used for food and cash crop production (FAO/World Bank). The feed supplies of livestock come from crop by-products, kitchen wastes, and scavenging. The poor farmers are not in a position to purchase concentrate even for the breeding rams.

Disease

Bangladesh is very vulnerable to diseases. Its climate is very conducive to multiplication and spreading of disease-producing agents (FAO/World Bank 1983). Substantial losses occur directly because of mortality, morbidity and indirectly, through the loss of productivity. Fortunately, loss of sheep in an epidemic form because of infectious diseases is rarely reported in Bangladesh. Warm and humid climate make internal parasites very common. This is the most important single factor which leads to losses and low productivity in all kinds of livestock.

Breeding

Quality rams for breeding purposes are not available in the country. Usually, the sheep raisers keep ram from their own flock of indigenous sheep. Genetic improvement is thus, not possible.

Marketing

In the existing system of marketing, the primary producers do not get appropriate prices for their commodities. A lion's share of the profit is being fetched by the middlemen. A system is therefore needed to be developed to protect the interest of the producers and only for livestock and livestock products but also for all other agricultural commodities.

Financial Inadequacy

Most of the sheep raisers are landless and marginal farmers. Most of them do not have adequate financial resource to raise sheep in spite of their interest and motivation. On the other hand, government support is not adequate to overcome this problem.

SUGGESTIONS AND RECOMMENDATIONS

Feed

Small ruminants are generally found as a secondary component in mixed farming. In most countries, crop by-products, kitchen wastes, and crop residues are the important feed supplements. High quality supplements are beyond the economic reach of the poor farmers. The use of tree leaves, leguminous shrubs, and foliages of certain crops are presently available to small ruminants like sheep and goats.

In Bangladesh, small ruminant raisers are generally landless or marginal farmers. Farmers with no cultivable land should be encouraged to plant few leguminous shrubs/trees within the homestead area. In such a situation, ipil-ipil (*Leucaena leucocephala*), Dhaincha (*Sesbania aculeata),* jackfruit *(Artocarpus heterophyllus*), and banana (*Musa spp*) could be useful. Leaves of these plants can be fed to the animal all year round. Ipil-ipil has been proven to be highly adaptable to a wide range of temperature and rainfall condition, but cannot resist water logging.

For those who have small amounts of cultivable land, more intensive cultivation of land is suggested. Due to the non-availability of cultivable waste and the high pressure on land for the production of food grain for human consumption, there is little scope to produce fodder crops alone. Thus fodder crops must be produced from cultivable land without affecting food or cash crops, or from making better use of non-cultivable land such as road sides, embankments, land bunds, etc. In such cases, inter-

cropping, relay cropping, crop rotation, and cultivation of fast growing fodder crops in-between two major crops may be employed. Cultivation of leguminous forage species like kheshari (*Lathyrus sativus*) and mushkalai (*Vigna mungo*) cowpea may be produced. Since crop residues do not meet up the protein and energy requirements, enriching minerals with urea-molasses block licks may be used. As for the technology available for the preparation of urea-molasses block licks, the method is considered to be easy to follow by the farmers.

Disease

Fortunately, infectious diseases of economic importance for sheep are uncommon in Bangladesh. The major problem is the incidence of internal parasites. Regular drenching with broad-spectrum anthelmintics is the main solution to the problem. The cost and availability of proper anthelmintics may likewise be a problem to the farmers. However, government assistance will be helpful to the farmers in this regard.

Breeding

Since breeding rams are not available in the country, the introduction of exotic blood is necessary. In selecting a notable breed, more emphasis should be given to meat and carpet wool production. The experience of cattle development in some milk pockets of Bangladesh (Pabna, Manikgan), Faridpur, Rajshani, and Tangail) may be useful. In these areas, the average production of a cow is higher than that in other places. Cockerel exchange programs of Manikganj and Mymenasingh could increase the egg production up to 100% by number and 50% by weight. Size of the hen was also found to increase by about 50%. Exotic rams should be made available to well to do farmers for use on the ewes. Further studies on economic traits like age at maturity, prolificacy and lambing interval are needed before any exotic rams for upgrading purpose on a commercial basis could be introduced. The Directorate of Livestock Services needs to take appropriate steps in this regard.

Marketing

Under the existing marketing system, the producers of agricultural commodities do not get appropriate prices for their products. Sometimes, cost of production is not even compensated, as a sizable amount of profit is being taken by the middlemen. In order to overcome these marketing problems of small ruminants and poultry, a village level growers cooperative/association may be organized. Organization of village cooperatives under the guidance of the Bangladesh Rural Development Board and the ac-

tive cooperative of upazila level government officers perhaps can handle the problem of marketing in an efficient manner. This may also solve the problems of small ruminant raisers regarding financial constraint.

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Sheep Production and Development in China

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ABSTRACT

Of the 156 million heads of sheep and goats in China, 25.4% are grazing in the range and 74.6% are distributed in cropping and mixed farming range areas. There are three sheep breeds in China: the fat-ramp Kazak; the thin-tail Tibetan; and the fat-tail Mongolian sheep. Among the most famous ones are the Wuzhumuxin, Tan, Tung, Han, and Hu sheep. Some fine wool and semi-fine wool sheep breeds have been developed since 1950. The biggest constraint to China's sheep and goat production is the inadequate feed supply resulting from over stocking and poor management. Improvement on range management as well as on utilization of crop residues are important areas for research and development. Additional research programs should include studies on multiple births, improvement of meat sheep, improvement of Chinese fine wool sheep, and conservation.

China is a country with more than half the territory a mountainous area. The range area is 388.4 million ha, which comprise 40.5% of the total land area, with 15.0% devoted to cropping and 12.0% to forests. The Qinghai-Xizang Plateau in the west with an elevation of 4,000 to 5,000 m is the highest part of the country. The North-west range includes Xingjiang, Gansu, Inner Mongolia, and some part of Northeast China. This range is 1,000 to 2,000 m high and has dry climate with an annual precipitation of 250 mm. About 34.8% of sheep and 12.2% of goat populations graze on the Qinghai-Xizang Plateau and the North Range. The remaining are

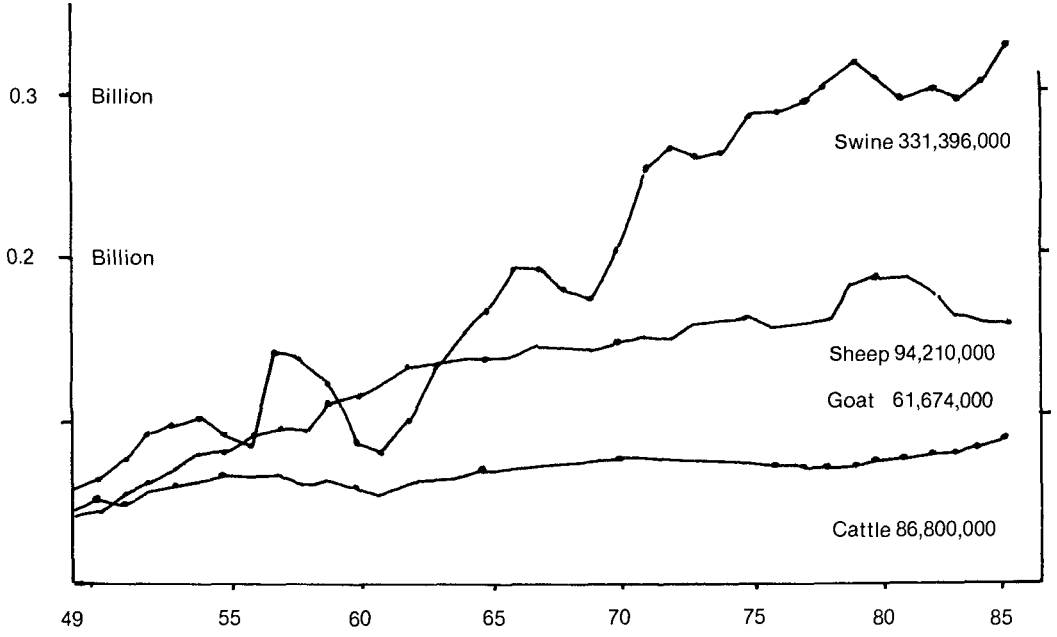

Fig. 1. Population development of China's main livestock.

distributed in cropping areas and in the so-called farming-range areas.

Figure 1 shows the growth trends in sheep, goat, cattle, and pig population in China from 1949 to 1985 (Agricultural Yearbook Editorial Board 1980-1986).

Although sheep and goats are less important in terms of meat production than pigs, they provide most of the edible animal proteins for Moslems and several other minorities. The meat produced from sheep and goats is more than those produced from cattle. In 1985, the meat production were 16,547, 467, 593, 1,602, and 56,000 tonnes for pork, beef, mutton , and goat meat, chicken, and rabbit meat, respectively.

In addition to mutton and goat meat, some 20 million pieces of sheep skins, 45 million pieces of goat hides, 4 million pieces of lamb pelt, 11 million pieces of kid pelts, 178,000 tonnes of wool, 10,500 tonnes of goat hair, and 3000 tonnes of downy wool are produced annually.

SHEEP BREEDS

Sheep are raised mainly between the latitude N 30 to 45. The sheep are hardy, very adaptable, have excellent finishing ability, and produce coarse carpet wool. There are three sheep breeds in China (Ye 1980): the fat-rump Kazak; the Thin-tail Tibetan; and the Fat-tail Mongolian sheep (Table 1). Fine Wool sheep has also been developed in China since 1950.

Table 1. Sheep breeds in China.[a]

Breed	No. of Sheep (head)	Mature Body Wt.		Fleece Wt.		Yield	Fleece			Repr. Effic.
		Ram (kg)	Ewe (kg)	Ram (kg)	Ewe (kg)	%	Downy Wool %	Medul-lated Wool	Kemp %	
Tibetan	27,000,000	44-58	39-48	1.2-1.6	0.8-1.6	70	53.5	45.6	1.0	1.0
Kazak	4,000,000	60	45.8	2.6	1.9	58-68	55.4	31.7	12.9	1.02
Altac (Kazak)	1,300,000	85.6	67.4	2.1	1.6	71			28.7	1.10
Chinese Karakul	1,300,000	77	46	3.0	2.0	65				1.05-1.15
Hetian	1,027,000	39.0	33.8	1.62	1.22	70	53.3	42.0	4.0	1.03
Mongolian	20,000,000	70	54	2.1	1.4	50-60	48.6	51.3	0.1	1.03-1.05
Wuzhumuxin	1,000,000	74	58	1.9	1.5				27.9	1.0
Tan	2,500,000	47	35	1.6-2.7	0.7-2.0	65	77	23	1.0	
Tung	25,000	45-50	40-45	1.4	1.2	55	87.7	10.4	1.87	1.03-1.05
Hun (Big-tail)	450,000	72	52	3.3	2.7	60-65	79.6	20.2	0.2	1.85
Hun (Small-tail)	770,000	70-95	45-50	3.5	2.1	63	73.6	26.3	0.1	2.37-2.70
Hu	1,700,000	49	37	1.7	1.2					2.29

[a]Ye 1980 and Zhao 1986.

Fat-Rump Kazak Sheep

Kazak sheep is a branch of Russian Kazak breed and is raised in Uygur Autonomous Region. The fat deposit in the breed makes a shape similar to the letter "W" on the surface of the rump. Kazak sheep have coarse fleece which has brown, grey or black, and white fibers. About 50-55% of the fleece is downy wool; 32%, medullated fiber; and 13%, kemp. The grease fleece of Kazak ram and ewe weigh about 2.6 and 1.9 kg, respectively and are used mainly for carpet making. Mature rams weigh from 60 kg to 85 kg and ewes about 50 kg. Currently, about 1.3 million Kazak sheep are specially used for lamb production, 1.0 million for crossbreeding with Karakul, and the majority (8.0 million) for crossing with fine wool breeds.

Thin-Tail Tibetan Sheep

Tibetan sheep account for about 20 million heads and 20% of the sheep population in China. The Tibetan sheep are developed in the Tibetan and Qinghai plateaus at altitudes ranging from 3,000 to 5,000 m. Its origin is not quite clear. Tibetan sheep are horned and have a thin tail, about 8 to 12 cm long.

The fleece of the Tibetan sheep is generally white but most have black or brown spot colorings on the legs and head. Only 7% of the Tibetan sheep are completely white. About 30,000 black or dark purple Tibetan sheep are raised for lamb pelt production. The grease fleece generally weighs about 1.0 to 1.5 kg, which is always lighter than the fleece from other breeds in China. The fleece has luster, high resilience and tensile strength which make excellent carpets.

The plateau strain is slightly larger. The rams weigh about 50 kg and the ewes, 40 kg compared to 40 kg and 30 kg for the mountain valley and river valley strains. Tibetan sheep are also used as pack animals for transporting small parcels.

Fat-Tail Mongolian Sheep

Mongolian sheep are fat-tailed and are bred in Inner Mongolia. These sheep have spread widely throughout the country. Mongolian sheep account for about 50 million head, representing about 60% of the total sheep population in China. According to historical reports, Mongolian sheep have been domesticated in China since the East Han Dynasty (220 B.C. to 25 A.D.) or even earlier. Mongolian sheep is mainly used for meat production.

The coarse fleece weighs between 1.2 and 2.0 kg, and has a two-coat structure. The under-coat, averaging about 25 u in fiber diameter, is shed between May and July and is mainly used for carpet making. The outer coat, comprising a large portion of about 13.0% coarse fibers and 11.4% kemp, is the only covering of the body from July through the late autumn.

The color of the fleece is mainly white but may contain some black or brown fibers. The shape of the fat-tail of the Mongolian sheep is round with the tip tilting upwards. The adult ram is usually horned and the ewe, always polled. This breed was once called the black-neck or black-head sheep. This characteristic enables the sheep to be easily spotted on snow-covered pastures. The rams weigh from 65 to 75 kg and the ewes from 40 to 45 kg.

The Mongolian fat-tail sheep is the original gene pool of many breeds now found in different ecological areas of China.

Wuzhumuxin sheep. These are raised in the Northeast prairie of Inner Mongolia. Its grease fleece weighs about 1.5 to 1.8 kg. About 15 to 20% of the fleece, however, is kemp. Adult rams weigh about 75 kg and ewes, 58 kg with a dressing percentage of more than 50%. Wuzhumuxin sheep are used mostly for lamb production.

Tan sheep. They are fat-tail breed descended from the Mongolian sheep raised by Moslem people who emigrated to Ningxia province several years ago. In 1985, there were a total of 2.4 million Tan sheep in Ningxia. Adult rams weigh about 47 kg and ewes about 35 kg. Tan sheep have a lambing percentage of 103%. Although it produces carpet wool, the most famous product of the Tan sheep is the skin from the lamb. The lamb is slaughtered for this skin at 25 to 30 days of age. The staple length is about 6 to 7 cm. To make a coat, about six to eight pieces of pelt are needed. The coat is warm, soft, and light, weighing only 1 to 1.5 kg. The fur color is white and has six to eight natural crimps on the fibers, which make a unique curl pattern on the pelt. Tan sheep are one of the most unique fur breeds in the world.

Tung sheep. These have been developed since 658 to 906 A.D. when the Mongolian sheep emigrated to the transitional area between the range and the cropping areas. The breed is polled and has a fat tail. The tail shape is that of a pear with the tip tilting upwards, and is divided into two lobes by a groove in the middle. The fat-tail weighs more than 6.5% of the body weight. The live weight of an adult Tung sheep is 45 to 50 kg for rams and is 40 to 45 kg for ewes. The fleece usually weighs 1.5 to 2.0 kg and is white in color with relatively fine fibers (numerical count: 50's). The ewe produces about 103-105 lamb crop yearly. Mutton and wool are the main products of Tung sheep.

Han sheep. These have been developed through the emigration of the Mongolian fat-tail sheep to the east-central agricultural area of China.This breed has two strains: Big-tail Han and Small-tail Han.

Both sexes of the Big-tail sheep are polled. Their fat tails always drop close to the ground and account for more than 20% of the body weight. Sometimes, the Big-tail Han sheep has a fat-tail weighing about 15 kg. The yearly lamb crop is around 185%. The mature body weight of ram is 72 kg while the ewe is about 52 kg.

Small-tail Han sheep are even more productive with a lamb-

ing percentage of about 237-270%. There are 0.77 million Small-tail Han sheep in Shandong and Hebei provinces. The fat-tail is not so big compared to the other strains which can only reach to the hock. The mature rams are horned and the ewes polled. Mature rams weigh from 70 to 95 kg and the ewes from 45 to 50 kg. The grease fleece of Han sheep weigh about 3.3 to 3.5 kg and 2.0 to 2.7 kg for rams and ewes, respectively. Han sheep are raised for both wool and meat. Although the wool quality of Han sheep is not so good, they produce better lamb crop per year.

Hu sheep. During the Sung Dynasty (960 to 1279 A.D.), Mongolian sheep emigrated to two provinces (Jiangsu and Zhejang) in the cropping area of Eastern China. This area is very densely populated and has a warm humid climate with about 1,000 mm annual precipitation.

Farmers keep Hu sheep indoors under semi-darkness all the year round for manure collection.

There are about 1.7 million Hu sheep in China. Both sexes, are polled and have white coat. They are early maturing, sometimes perform inbreeding, and have a high percentage of multiple births. The first mating of the ewes is at six to seven months of age. Starting with the second or third lambing, triplet births are common. Quadruplets also occur. Hu sheep are non-seasonal breeds. Ewes will rebreed succesfully soon after lambing. They normally lamb twice per year with a yearly lamb crop of around 500%.

Lamb pelts are the most important commercial product of Hu sheep. For high quality pelt, lamb must be skinned soon after birth.

Fine Wool Sheep

Fine wool sheep were introduced into China in the 1930s and some Chinese fine wool breeds have been developed thereon (Table 2). The following is a brief description of some of the more important breeds.

Xingjiang. This was developed from the Kazak and Mongolian ewes mated with Precoce Merino and Novo-Caucassian Merino rams. The fleece is around 64 to 66 while staple length is above 7 cm. The yearly lamb crop is about 135%. The breed was officially released by the Ministry of Agriculture, Animal Husbandry and Fishery (MAAF) in 1954.

Northeast. This breed was developed from a multibreed gene-pool. Mongolian ewes were crossed with Rambouillet, Soviet Merino, Stravrapol, and Askanian rams.

Inner Mongolian. This was developed recently and raised in Northwest China. Mongolian ewes were crossed with Soviet Merino, and Altac Merino rams.

Gansu. This breed was developed from the Tibetan and Mongolian ewes mated with Xinjiang fine wool sheep and Novo-

Caucassian rams. These sheep are adapted to high plateau conditions, although their wool production is not very high.

Chinese Merino. This breed was developed by crossing Chinese fine wool sheep and Polworth ewes with New-Zealand Merino and Australian Merino rams using two to three generations of in-breeding, followed by closed flock and *inter se* breeding. The grease fleece weighs 6.4 kg with a clean content of 3.9 kg. The staple length is about 10 cm. This breed was released as Chinese-Merino in 1987 by the MAAF.

RESEARCH AND DEVELOPMENT

Conservation for Genetic Resources

A nationwide program for the conservation of China's popular and unique sheep and goat breeds has already been implemented. Among the list of breeds for strict conservation are: Hu sheep, Tan sheep, Han sheep, Liaoning Downy-wool goat, Zhongwei goat, and Jining Grey goat. Funds have been disbursed from the central government as well as the governments at the provincial levels to establish pure breeding farms for the above breeds. Specialized areas for the production of fine wool, semi-fine wool, carpet wool, and fur sheep as well as meat lambs have also been set up.

Development of Fine Wool Sheep

Before 1950, no commercial fine wool sheep production exists in China. The development of fine wool sheep in China can be divided into three stages. During the first stage from 1947 to 1952, crossbreeding between introduced fine wool breeds and local breeds was conducted by individual scientists at a very small scale. From 1952 to 1972, large scale fine wool breeds were introduced from the USSR. The breeding program was accelerated through artificial insemination (AI) programs. Several Chinese fine wool sheep breeds such as Xinjiang, Ziniquan, Northeast, and Inner Mongolian Fine Wool Sheep were released. The wool quality of these breeds, however, still needs to be further improved.

Since 1972, the objective has been to improve wool quality. Along this line, 16 Australian Merino sheep were introduced from Australia in 1972. These sheep were used for crossbreeding with Chinese fine wool sheep as well as Polwarth after two to three generations of inbreeding, followed by inter se breeding, to increase clean wool content. A Chinese Merino sheep breed was released in 1986. Realizing the fine quality of Australian Merino, several hundreds of this breed were further introduced from Australia, and four demonstration areas were established. In these areas, AI and advanced techniques like frozen semen, high dilution rate (1:6-7), two inseminations (each with 0.05-0.1 ml with more than 10 million active sperms), improved inseminating syringes, and deep insemination site are being adapted. These

Table 2. Characteristics of fine wool sheep in China.[a]

Breed	No. of Sheep (head)	Body Weight (After clipping) Male (kg)	Female (kg)	Grease Fleece Weight Male %	Female (kg)	Yield Percentage (%)	Clean Content (ewe) (kg)	Staple Length (cm)	Repr. Effic.
Xinjiang	2,380,000	85.6	47.4	11.6	5.7	44.3	2.5	8.1	1.35
Northeast[b]	1,970,000	99.3	52.8	15.8	6.7	32	2.1	7.6	1.24
Inner Mongolian	3,100,00	91.4	45.9	11.0	5.5	36-45	2.0	7.2	1.1-1.25
Gansu	20,000	80.0	42.9	8.5	4.4	43-45	1.9	7.6	1.05-1.23
Shanzi	110,000	94.7	54.9	10.2	6.4	40	2.5	6.6	1.02-1.03
Ziniquan	20,000	90-95	50	11-12	5.6	45	2.5	8.0	1.30
Chinese Merino	46,000	83-90	40.9	12.5	6.4	60.8	3.9	10.2	1.23

[a]Ye 1980 and Zhao 1986.

[b]Body weight before clipping.

four demonstration areas involve 2 million Chinese Merino sheep.

Semi-fine wool sheep is being developed through the introduction of breeds such as Lincoln Long Wool (Ye 1983), Border Leicester, Romeny Marsh, Corriedale and Cigai. Our experience indicates that fine and semi-fine wool sheep cannot grow well in cold mountainous area where the more adaptable local breeds should be kept.

Studies on Multiple Births

The multiple genetic character of Hu sheep from the humid area has been successfully used to improve the reproductive efficiency of black Karakul (Shi et al 1987). The improved Karakul with 18.75% of Hu sheep blood gave 167% lambing percentage, with a lamb pelt area of 1,493 + 208 cm and a relative pelt weight of 10.71 kg/100 cm; these completely meet the requirements for good quality lamb pelts. The new multiplet Karakul strain is expanding in numbers.

Experiments have also been conducted on the use of "Fecundin" from Australia. Results from these farms in Xingjiang showed a twin lambing rate of 30.3% on the treated group, while the control had a twinning rate of 11.2%. "Fecundin" increased lambing percentage by 20%. Similar results have been obtained on a sheep farm in Gansu province.

Improvement of Meat

Commercial lamb production was not initiated until the 1970's using dual-purpose sheep namely: Xinjiang, Wuzhumuxin, and Inner Mongolian. Lamb meat is now being produced from fine wool breeds. It was found that 17.4% of Wuzhumuxin sheep had 14 pairs of ribs, 81% of the offsprings from 14 pairs ribbed parents had 14-pair-ribbed father x 13-pair-ribbed mother had 14 pairs of ribs. Preliminary results from the selection of seven joints lumbar vertebrae were also promising (Zhang 1987).

Improvement of Range Management

Majority of the sheep in China graze on grasslands. Such grasslands have great potential in terms of productivity especially in the north and west. However, these grasslands have been subjected to overgrazing for years due to high stocking rates. Although efforts have been made to improve the grasslands through fencing and reseeding, the average deterioration rate of China's whole range area is 1.7 million ha/year because of overgrazing. This has created a serious ecological crisis.

It was estimated (Jin et al 1985) that on Xinjiang grassland, the stocking rate already reached 180% of the maximum stocking rate in the cold season in 1983. Animals are stored during winter and early spring time resulting to heavy deaths and body weight loss. In 1983, the total loss of edible meat due to overgrazing from

winter to early spring was about 141,000 tonnes, equivalent to 160% of the total mutton and beef production in Xingjiang. Overgrazing due to high stocking rate also occurred in inner Mongolia.

It has been suggested that meat production can be improved by 82% in Xinjiang, through reduced stocking rates adjustment of the herd structure and cooperation between the range and cropping areas. Traditional animal husbandry systems are, however, difficult to change into more modern animal production systems and a nationwide plan is needed to improve this critical condition.

An alternative approach is to solve the problem of feed supply for sheep and goat productions by intensifying the use of crop residues as animal feeds. A great deal of research work has been done on ammoniation of straws and ensilage of corn stovers (Xiong 1987), but this still needs to be extended to the farm level.

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Sheep Production and Development in India

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ABSTRACT

This paper presents the status of sheep and wool production, and research and development programs in India. In addition to breed improvement programs, research results on feed resource development, nutrition, reproduction, adaptation, health, and wool utilization are also highlighted in this paper. Apparel wool production is being achieved by upgrading the medium carpet wool breeds through crossbreeding with fine wool breeds like Merino and Rambouillet. Improvements in fineness and medullation have been achieved, but staple length needs to be improved further for use in the worsted sector. For carpet wool production, selective breeding is being undertaken within medium wool type sheep. Hairy and coarse carpet wool breeds are being crossbred with fine wool rams to produce carpet wool producing sheep. For meat production, Dorset and Suffolk rams have been used to upgrade local mutton type animals. A body weight of 30 kg has been observed at six months of age, while a live weight of 25 kg has been achieved at 135 days of age with a feed conversion efficiency of 17 to 18% and a dressing percent of about 50%. Research on pelt production has been undertaken. The paper also discusses ongoing development programs and the constraints to these programs.

As of 1982, India has 48.6 million sheep, producing about 38.4 million kg of wool, 132 million kg of mutton and 37 million pieces

of skin annually. The sheep population has statistics of around 40 million between 1951 to 1977, but has increased in 1982. Wool pro duction has increased from 27.5 million kg in 1951 to 38.4 million kg in 1984 to 1985. To meet both domestic and export requirements for carpets and hosieries, about 18 to 20 million kg of wool is being imported annually. The sheep population figures during the last three census in different states are presented in Table 1 and the wool production status, in Table 2. Although the country possesses 4.1% of the world sheep population, it produces only 1.1% of the total wool (Chaudhry 1987) and 2.2% of the total world meat production (Panda 1987). The average sheep carcass weight in India is 9 kg as against the world average of 15 kg. Mutton production contributes only 14.8% of the total meat production in the country (848 million kg) which is less than the requirement of 423 million kg. Hence, greater efforts are needed in research and development to bridge the gaps between the demand and availability of wool and mutton.

Table 1. Sheep population in the different states of India.[a]

State	Livestock Census in 1,000		
	1972	1977	1982
Andhra Pradesh	8,343	7,064	7,507
Assam	51	59	100
Bihar	983	1,121	1,337
Gujarat	1,722	1,592	2,357
Huryanat	459	541	783
Himachal Pradesh	1,040	1,055	1,090
Jammu & Kashmir	1,073	1,210	1,861
Karnataka	4,662	4,536	4,615
Kerala	10	3	7
Madhya Pradesh	1,009	968	958
Maharashtra	2,128	2,636	2,770
Manipur	2	2	3
Meghalaya	18	20	26
Nagaland	—	—	—
Orissa	1,369	1,432	1,990
Punjab	388	493	525
Rajasthan	8,556	9,938	13,890
Sikkim	—	16	11
Tamil Nadu	5,393	5,289	5,475
Tripura	2	3	5
Uttarpradesh	1,956	2,059	2,232
West Bengal	793	793	1,034
Total	39,957	40,830	48,566

[a]Source: Ministry of Agriculture, Government of India.

Table 2. Wool production status in the different regions in India.

Region	Land		Sheep Production		Wool Production		Wool Quality
	Classification	Area (10^6 ha)	(10^6 hd)	% of Total	(10^6 kg)	% of Total	
North temperate	Utilizable	14.90	3.45	7.20	4.03	10.50	46^s and above
	Natural grazing	7.68					36^s to 46^s
North western	Utilizable	129.41	20.36	42.30	25.11	65.40	46^s and above
	Natural grazing	45.63					36^s to 46^s
Southern peninsular	Utilizable	95.38	19.80	41.20	7.68	20.00	Below 36^s
	Natural grazing	34.90					(except Nilgiri)
Eastern	Utilizable	64.49	4.50	9.40	1.57	4.1	Below 36^s
	Natural grazing	30.48					

SHEEP BREEDS IN DIFFERENT REGIONS

In India, 40 breeds of sheep are identifiable (Acharya 1982) in the different regions of the country (Table 3).

The production levels of these breeds are generally very low (Acharya 1974; 1981; 1982). The major factors contributing to such low productivity are poor genetic potential, lack of proper inputs, inadequate grazing resources and nutrition for the animal, migration, problem in breed improvement and animal health, lack of education and economic backwardness of sheep farmers, inadequate marketing facilities and lack of funds for sheep development and research.

Sheep rearing in the country primarily lies in the hands of the poor, landless, small, and marginal farmers. With the increasing and reduced land for grazing, the density of livestock per unit area is also increasing. In certain areas, the availability of drinking water is also a serious problem, causing flocks to migrate elsewhere.

Table 3. Distribution of sheep breeds by region in India.

North western Arid and Semi-arid Region	Southern Peninsular Region	Eastern Region	Northern Temperate Region
Chokla	Deccani	Chottanagpuri	Gaddi
Nali	Bellary	Shahabadi	Rampur
Marwari	Nellore	Balangir	Bushair
Magra	Mandya	Ganjam	Bhakarwal
Jaisalmeri	Hassan	Tibetan	Poonchi
Pugal	Mecheri	Bonpala	Karnah
Malpura	Kilakarsal		Gurez
Sonadi	Vembur		Kashmir Merino
Patanwadi	Coimbatore		Changathangi
Muzzafarnagri	Nilgiri		
Jalauni	Ramnad White		
Hissardale	Madras Red		
	Tiruchy Black		
	Kenguri		

RESEARCH PROGRAMS

During the last three decades, research efforts have focused on improving productivity of promising indigenous breeds, to increasing feed resources through pastures and silvipastoral systems, developing feeding systems, combating problems of reproduction and adaptation, and employing proper health control.

Breed Improvement

Experiments have been undertaken to improve various indigenous breeds of sheep for production of apparel wool, carpet wool, mutton and pelts. Earlier experiments aimed at producing uniform fleece of finer quality through selection against medullation (Acharya 1981; Lall 1982). However, the results were not encouraging.

Attempts were made to improve indigenous breeds by crossbreeding with exotic fine wool breeds. Some fine wool strains such as the Hissardale, Kashmir Merino and Nilgiri sheep. With the establishment of the Central Sheep and Wool Research Institute (CSWRI) at Avikanagar (Rajasthan) in 1962, and its substations at Kullu in Himachal Pradesh and at Kodai Hills in Tamil Nadu during the early sixties, crossbreeding programs started to improve Chokla, Malpura, and Jaisalmeri breeds of sheep by crossing with Rambouillet, by crossing Gaddi sheep also with Rambouillet, and by crossing Coimbatore sheep with Corriadale rams. The crossbreeding program was further expanded during the 1970s by starting the All-India Coordinated Research Project (AICRP) on Sheep Breeding of the Indian Council for Agricultural Research (ICAR), which emphasized fine wool and mutton production. The carpet wool component has been added recently. Experiments on pelt production were started in the hot arid area in Rajasthan and in the cold arid area in Jammu and Kashmir State following the importation of the Karakul Sheep in 1975.

Fine wool production. Research in this field has been reviewed (Acharya 1981; Lall 1982; Shakla et al 1987). At present, three strains of fine wool type sheep namely: Avivastra, Chokla Synthetic and Nali Synthetic have been evolved at Avikanagar through crossbreeding of indigenous sheep with the Rambouillet and Merino breeds. Similarly, fine wool sheep are being produced in Tamil Nadu by crossbreeding Nilgiri Sheep with Merino. The objective is to create sheep capable of producing 2.5 kg grease fleece with fiber diameter of less than 24 *u*, 5% medullation and a staple length 5.5 cm. Efforts are now in progress to improve the strains through selection from the crossbred base.

A very fine wool strain of sheep similar to the Merino is being evolved from the crossbred with 75% Rambouillet and Merino. Some 75% Rambouillet and Merino crosses with Gaddi sheep in the northern temperate hill region have also produced wool of apparel type qualities, although the staple length needs to be increased further. Efforts are also being made to upgrade Patanwadi sheep of Gujarat to produce apparel type wool. Chokla sheep, the best wool type in Rajasthan, is being improved through selection to produce finer wool. The fleece weight and wool quality attributes of all these fine wool type strains which are in the process of further improvement are given in Table 4.

Carpet wool production. About 5% of the total wool produced in the country is available from the northwestern arid and east arid region and are available for carpets. At present, the annual availability of carpet wool is around 22 kg. Uniformity in the quality of wool is important and can be achieved through selection. Research on breeding for carpet wool production has been reviewed (Chaudhry 1978; 1981, Chaudhry and Saraswat 1983: Acharya and Batra 1978; Singh and Rathore 1987). The breeding strategy for carpet wool production is aimed at improving coarse carpet and hairy type sheep by corssbreeding with exotic or improved half bred rams, and at making selection within the indigenous carpet wool breeds such as, Magra, Marwari, Pugal and Patanwadi.

Avikalin is a new carpet wool strain that has been evolved at CSWRI by crossbreeding Malpura and Jaisalmeri with the Rambouillet and by stabilizing the population through interbreeding and selection. Further selection is in progress to balance the medullation percentage and fiber diameter and to improve luster in the wool. Mutton synthetic sheep developed through crossbreeding of Malpura and Sonadi with Dorset and Suffolk are also producing wool for carpet production. The greasy fleece weight and fiber characteristics of different carpet type sheep are presented in Table 5.

Mutton production. Very little work has been done on breeding sheep exclusively for mutton. During the 1960s, feedlot experiments were conducted with lambs of different indigenous breeds and their crosses. No improvement in growth and feed conversion efficiency was achieved by crossbreeding among the indigenous breeds (Acharya 1974; Arora 1981; 1987). Under the AICRP on sheep breeding, experiments are in progress at five centers to improve mutton production.

Dorset and Suffolk rams have been used to improve the mutton breeds namely: Malpura, Sonadi, Mandya, Nellore, Muzzafarnagri, Daccani, and Madras Red. Through crossbreeding and interbreeding, a strain of "Mutton Synthetic" sheep has been evolved at Avikanagar and 'Mandya Synthetic' and 'Nellore Synthetic' have been evolved at Palamner in Andhra Pradesh. Crossbreeding experiments to improve Deccani Sheep and Madras Red Sheep are in progress at Rahuri in Maharashtra and at the Madras Veterinary College, respectively. As there was no improvement in crossbreds of Muzzafarnagri with Dorset and Suffolk, within breed selection is being undertaken at the Central Institute for Research on Goats, Makhdoom.

The newly evolved mutton type sheep attains 30 kg body weight at five months of age under intensive feeding conditions. Lambs weaned at 60 days age and fed with 50% concentrate and 50% roughage feedlot attained 25 kg liveweight at 135 days of age. The weight gain, feed genotypes are given in Tables 6 and 7.

Table 4. Fleece weight and quality of fine wool strain/crosses.

Strain/Cross	Annual Greasy Fleece wt. (kg)	Medullation (%)	Av. Fiber Diameter (μ)	Staple Length (cm)
Avivastra	1.9 ± 0.06 (1653)	7.6 ± 0.56	21.6 ± 0.07 (776)	3.5 ± 0.05 (670)
Nali synthetic	2.7 ± 0.02 (1697)	10.3 ± 0.70 (320)	22.6 ± 0.16 (320)	4.5 ± 0.07 (325)
Chokla synthetic	2.6 ± 0.02 (1190)	6.2 ± 0.67 (233)	22.1 ± 0.22 (238)	4.5 ± 0.09 (237)
3/4 Interbreds	2.7 ± 0.03 (632)	3.0 ± 1.41 (30)	19.8 ± 0.39 (30)	4.9 ± 0.11 (30)
Merino x Niligiri ... 1/2	1.5 ± 0.02 (151)	3.0	21.3 ± 0.19 (151)	4.6 ± 0.08 (151)
Rambouillet x Niligiri ... 1/2	1.1 ± 0.02 (151)	3.2	20.6 ± 0.24 (151)	4.6 ± 0.07 (151)
Niligiri	0.9 ± 0.02 (128)	21.3	24.3 ± 0.26 (128)	4.4 ± 0.07 (128)
Rambouillet x Patanwadi ... 1/2	1.6 ± 0.02 (263)	20.8 ± 0.63 (591)	23.2 ± 0.18 (591)	5.2 ± 0.76 (293)
Merino x Patanwadi ... 1/2	1.7 ± 0.02 (226)	19.8 ± 0.65 (499)	22.8 ± 0.19 (499)	6.2 ± 0.09 (180)
Merino x gaddi	1.5 ± 0.03 (605)	0.9 ± 0.16 (26)	22.6 ± 0.7 (26)	4.2 ± 0.12 (209)
Kashmir Merino	2.8 ± 0.08 (38)	—	20.4 ± 0.14 (197)	5.6 ± 0.07 (191)

Table 5. Greasy fleece yield and quality of promising carpet wool/dual purpose sheep.

Breed	Annual Greasy Fleece Wt. (kg)	Medullation (%)	Fleece diameter (μ)	Staple Length (cm)
Nali	2.8 ± 0.02 (1045)	41.1 ± 2.9 (49)	29.9 ± 0.94 (49)	6.8 ± 0.34 (51)
Chokla	2.5 ± 0.13 (1073)	18.9 ± 2.1 (65)	27.2 ± 0.40 (65)	5.9 ± 0.20 (64)
Avikalin	1.6 ± 0.01 (1824)	22.1 ± 0.45 (183)	25.2 ± 0.20 (863)	4.2 ± 0.06 (762)
Marwari	1.01	56.1 ± 2.07	38.0 ± 0.99	—
Magra	2.2 ± 0.01 (649)	48.3 ± 0.39 (2968)	32.5 ± 0.35 (2995)	5.8 ± 0.02 (2851)
Patanwadi	1.2 ± 0.03 (139)	34.1 ± 0.85 (277)	27.8 ± 0.25 (277)	5.0 ± 0.76 (293)
Pugal	1.6 ± 0.02 (72)	61.9 ± 0.62	35.1 ± 1.0 (524)	5.7 ± 0.04 (513)
Mutton Synthetic	1.0 ± 0.01 (1298)	39.8 (196)	28.00 (144)	4.4 (127)
Rampur Bushair	1.2 ± 0.06 (47)	23.8 ± 1.30 (185)	34.4 ± 2.7 (185)	7.7 ± *2.05* (185)
Gaddi	0.78 (2650)	25.7 ± 0.32 (2653)	28.5 ± 0.07 (2692)	5.7 ± 0.01 (1245)
Deccani	0.7 ± 0.02 (225)	24.2 ± 1.02 (266)	34.9 ± 0.47 (266)	7.0 ± *0.23* (47)
Bellary	1.0 ± 0.03 (88)	43.4 ± 1.42 (81)	59.0 ± 1.06 (36)	—

Mean ± SEM, figures in parentheses indicate number of observations.

respectively. These research results have to be applied in commercial scale to increase meat production in the country.

Pelt production. In 1975, Karakul sheep have been introduced in the hot arid and cold arid areas. Their performance have been satisfactory. Crossbreeds of 75% Karakul with Marwari,Sonadi and Malpura have produced pelts comparable with those of pure Karakuls (Arora and Dhillon 1981; Sahni and Dhillon 1987). Pelt quality evaluation data of Karakul and its crosses are presented in Table 8.

Biochemical genetics and cytogenetics. Researches on hemoglobin types, blood potassium, and gluthione levels have been undertaken to relate these parameters with the different sheep production traits. Studies have also been undertaken to detect chromosomal abnormalities through blood lymphocyte culture techniques related to infertility and sterility in rams. Information on hemoglobin and potassium types in relation to production traits have also been reported (Shukla et al 1987).

Table 6. Feedlot performance of indigenous mutton-type sheep and mutton synthetics.

Breed	Initial Weight 90 days (kg)	Final Weight 180 days (kg)	Ave. Daily Live-weight Gain (g)	Feed Efficiency (%)
Malpura	12.7 ± 0.21 (132)	22.3 ± 0.35 (132)	107	12.7 ± 0.24 (132)
Sonadi	11.5 ± 0.24 (123)	19.85 ± 0.41 (123)	92	12.2 ± 0.27 (123)
Mutton synthetic	14.1 ± 0.11 (718)	26.6 ± 0.17 (718)	139	15.00 ± 0.10 (718)
Mandya	10.2 ± 0.83 (23)	18.1 ± 1.22 (23)	87	13.5 ± 0.69 (23)
Mandya synthetic	13.9 ± 0.42 (88)	23.79 ± 0.62 (88)	110	14.5 ± 0.35 (88)
Nellore	11.8 ± 1.06 (14)	20.0 ± 1.57 (14)	90	14.6 ± 0.89 (14)
Nellore synthetic	14.5 ± 0.44 (83)	26.5 ± 0.64 (83)	134	14.5 ± 0.37 (83)
Muzaffarnagri	19.2 ± 0.47	31.2 ± 0.92	129	23.8
Deccani	17.1 ± 0.49	32.2 ± 1.17	167	14.7 ± 0.76
Dorset × Deccani 1/2	17.7 ± 0.35	34.7 ± 0.97	188	16.2 ± *0.70*
Merino × Deccani 1/2	16.3 ± 1.0	29.6 ± 1.27	147	12.8 ± 0.78
Madras Red	9.5 ± (35)	18.5 ± 2.22 (35)	101	12.5

Mean ± SEM, figures in parentheses indicate number of observations.

Feed Resource Development and Nutrition

Resource development. Research on feed resource development for sheep production have been carried out largely at the Indian Grassland and Forage Research Institute (IGFRI) in Jhansi, the Central Arid Zone Research Institute (CAZRI) in Jodhpur, and at CSWRI, Avikanagar. The work comprises of the following:

- Establishment of pastures in arid and semi-arid areas and in temperate hill regions.
- Introduction of legumes in grass pastures.
- Development of silvipastoral systems (2 tier and 3 tier).
- Inter-cropping of legume fodder crops in cereal crops.

Different varieties of grass species suitable to arid and semi-arid climates have been tried for pasture development. The CSWRI has developed 'Marwari Anjan' *(Cenchrus ciliaria)* suitable to arid climates. Dry matter production from grass pasture alone varied

Table 7. Carcass traits of feedlot lambs.

Breed/Cross	Hot Carcass Weight (kg)	Dressing %[a]	Dressing %[b]	Bone: Meat Ratio
Malpura	9.8 ± 0.18 (102)	49.4 ± 0.22 (102)	57.0 ± 0.25 (102)	1:8.1 (11) KOH method
Sonadi	8.7 ± 0.19 (111)	48.3 ± 0.26 (111)	55.9 ± 0.31 (111)	1:7.4 (2)
Mutton synthetic	11.6 ± 0.10 (491)	50.1 ± 0.11 (491)	57.5 ± 0.13 (491)	1:8.4 (50)
Mandya	8.2 ± 0.66 (19)	49.0 ± 0.79 (19)	56.8 ± 0.69 (19)	1:4.8 (19)
Mandya synthetic	10.6 ± 0.44 (44)	49.0 ± 0.52 (44)	56.6 ± 0.45 (44)	1:5.1 (44)
Nellore	8.7 ± 0.92 (10)	48.3 ± 1.08 (10)	55.4 ± 0.95 (10)	1:5.1 (10)
Nellore synthetic	11.4 ± 0.50 (34)	50.2 ± 0.59 (34)	57.3 ± 0.52 (34)	1:4.6 (34)
Muzaffarnagri	18.3 ± 0.48	55.0 ± 0.54	62.5 ± 0.41	1:3.12
Deccani	10.3 ± 0.06	45.1 ± 1.02	51.6 ± 1.11	1:6.7
Dorset × Deccani	14.2 ± 1.19	49.9 ± 0.76	57.2 ± 1.50	1:8.8
Merino × Deccani	12.3 ± 0.37	45.7 ± 0.61	51.4 ± 0.64	1:6.1
Madras red	8.6 ± 1.26	51.6 ± 4.0	57.2 ± 2.1	1:3.30

[a]Before slaughter.

[b]Based on slaughter weight.

from 2 to 4 tonnes/ha depending upon rainfall. Production of sewan grass *(Lasiurus sindicus)* which is specific to hot arid areas is being enhanced through minimum irrigation during the dry season. Different sowing methods of grass seeds have also been tried for pasture establishment. Introduction of legumes in grass pasture has increased the dry matter yields by 50%. The legumes are *Dolichos lablab, Clitoria ternatea,* and *Stylosanthes* sp. The carrying capacity of improved pasture are five to seven per hectare on a year round basis. Production of tree fodders from different tree species has been estimated. Forage production could be increased to 6 to 8 tons/ha by developing silvipasture in a three tier system (grass-shrubs-trees) in semi-arid areas of the country. The technology developed to increase forage production in this system has to be applied in vast areas of wasteland available in the country.

Nutritive evaluation. The nutritive value of different feeds for sheep have been tabulated (Mathur 1960; Patnayak and Singh

Table 8. Pelt quality evaluation of Karakul and its crosses.

Genetic Group/ Pelt Type	Jacket (%)	Caucas- sian (%)	Ribbed (%)	Flat (%)	Rejects (%)	Total
Karakul	56.8 (614)	29.8 (322)	6.6 (71)	3.2 (35)	3.61 (39)	1081
Karakul × Malpura	28.9 (77)	31.6 (86)	15.0 (34)	22.9 (61)	3.0 (8)	266
Karakul × Marwari	36.7 (43)	28.2 (33)	12.8 (15)	15.4 (18)	6.7 (8)	177
Karakul × Sonadi	24.0 (55)	36.3 (53)	12.7 (29)	26.6 (61)	0.4 (1)	229
½ breds	28.6 (175)	33.1 (202)	11.1 (78)	22.8 (140)	2.8 (17)	612
Karakul × Malpura 3/4th	47.4 (45)	26.3 (25)	13.7 (13)	9.5 (9)	3.2 (3)	95
Karakul × Malpura 3/4th	54.2 (39)	25.8 (18)	11.1 (8)	9.9 (7)	—	72
Karakul × Sonadi 3/4th	49.3 (49)	29.3 (29)	8.1 (8)	9.1 (9)	4.4 (4)	99
3/4ths	50.0 (133)	27.9 (72)	10.9 (29)	9.4 (25)	2.6 (7)	266

Note: Figures in parentheses indicate number of observations.

1972; Singh 1981; Singh 1983; Bhatia 1982; Patnayak and Singh 1983, and Thakur et al. 1987) Although some common tree leaves contained 13 to 14% protein, the digestibility was only 25 to 30%. High tannin content and its protein precipitating capacity appeared to be contributing factor for the low protein digestibility. Tree leaves have been utilized after mixed with straw or as complete feeds for lambs.

The digestible crude protein (DCP) and total digestible nutrient (TDN) values of pastures containing grass and bushes varied from 34 to 50% and 0.39 to 6.38% in different month (Bhatia et al. 1973). Weaner lambs gained 100 to 120 g/day when fed grass-legume mixed pasture. (Patnayak 1986; Singh and Patnayak 1987; Thakur et al. 1987).

Lamb feeding experiments. Complete feeds have been developed for feedlot lambs containing 50% cowpea fodder or tree leaves. Weaner lambs gained from 150 to 200 g/day and attained 25 to 30 kg weight at six months of age. In some experiments, 25 kg weight has been achieved at four months of age. The feed conversion ratio of 5 to 8% with dry matter of 3.5 to 5.0% of body weight has been obtained in feedlot lambs under different

feed regimes with complete feeds. By-product feeds like sugar beet pulp, seaweed meals, deoiled rice polish, wheat straw, poultry litter, fallen tree leaves, molasses, and various products have been used in preparing complete feeds for maintenance or growth performance.

Nutrient requirements. Studies on nutrient requirements are very limited (Patnayak 1981). Information on this aspect are available at the Indian Council for Agricultural Research (ICAR). There is a need to conduct more experiments to determine nutrient requirements for growth, pregnancy, and lactation.

Utilization on nonprotein nitrogen. Several experiments have been conducted to utilize urea as concentrate supplement in the form of licks and in drinking water with molasses. Urea has been used to enrich the low quality *Cenchrus ciliaria* grass through ensilage by stacking.

Reproduction and Adaptation

Reproduction. Preservation of ram semen is a major constraint in the fast propagation of improved germplasm in rural flocks. Emphasis therefore, should be on the preservation of ram semen in liquid form to improve sterility in rams. Experiments have been undertaken to study reproduction in ewes and determine the optimum season of breeding sheep in arid climate. Studies on the performance of rams under hot-arid and hot-humid conditions and preservation of ram semen have been reviewed by Sahni and Tiwari (1981). Technology has been developed to preserve ram semen in liquid form for 24 hours by using egg yolk-citrate-glucose (EY-CG) and Egg yolk-Mcillvain glucose (EY-MG) diluents. The latter was found to be more effective. Egg yolk extract could replace fresh egg yolk diluent without affecting the semen quality. Suitable management practices and semen collection schedule have been developed to avoid the problem of summer sterility and to reduce reproductive wastage in exotic rams. Recently, efforts are being made to freeze ram semen in pellet form. The motility of frozen semen has been found to be better in batches of three to four pellets.

A detailed study on the optimum season of breeding of Marwari ewes was undertaken in the arid climate at Bikaner. Marwari ewes, although found to be nonseasonal, had two peak breeding seasons namely; August-September and March-April. Although tupping percentage during August-September was relatively high, overall production from ewes was higher when they are bred during March-April. This was due to the higher survivability and body weight of lambs and heavier wool clip from ewes during August-September. About 90% of the ewes ovulated within 30 hours after detection of oestrus. The average duration of heat stress ranged from 23 to 24 hours. The average oestrus cycle length ranged from 18 to 22 days with an overall average of 19 days. Overall produc-

tivity of the ewes was low when maintained on grazing alone.

Adaptation. Studies have been undertaken on thermo adaptability of various crossbred sheep as compared to indigenous animals (Singh and Rai 1981). Crossbreds with 50% exotic inheritance have been found to be as adaptable as negative counterparts. The physiological and biochemical responses of the crossbreds and the native sheep subjected to water restriction were similar. In general, animals maintained under shade with low humidity performed better compared to those under heat stress or under shade with added humidity.

Studies have also been undertaken on yellowing of wool, a phenomenon commonly occurring during autum season. High humidity associated with high ambient temperature appears to be the cause for the yellowing of wool. The researches carried out on canary coloration of wools have been compiled in the proceedings of the seminar on "Canary Coloration of Indian Wool" (Acharya et al. 1980; by Narayan and Bhan 1982). Reduction in the thermal load during hot humid months produced reduction in the canary staining of wool. Shearing sheep before the onset of staining season helps in the heat dissipation. Provision of shade during the hot dry and grazing during cooler hours help in reducing the canary staining of wool.

Sheep Diseases

Results of several researches on various diseases of sheep and their problems have been highlighted in the National Seminar on Sheep and Goat Diseases (CSWRI, 1987). The major diseases identified are sheep pox, viral pneumonia, pasteurellosis, clostridiosis, contagious-abortions, and helminthic gastroenteritis, blue tongue, viral abortions, and theileriasis are the emerging diseases recorded during recent years. The incidence of important helminth diseases of sheep have been reviewed by Mathur (1981) and the prophylactic measures to be adopted are given by Uppal (1981). Flock health management practices for the year have been established for the northwest semi-arid regions.

The present emphasis on sheep health research lies in the epidemiology of various diseases and in the preparation of vaccines against some important viral diseases. Studies have been undertaken on viral pathogens causing pneumoenteritis. Prevalence and epidemics of chlamydial pneumonia and abortions are also being studied. Epidemiology of blue tongue is being investigated, and blue tongue virus in some farms and villages in Rajasthan have already been isolated. Emphasis is also being given on the economic effects of diseases, the cost of their control and the impact of diseases on productivity. Pneumonia due to adeno-viral infections and sporadic occurrence of sheep pox with special reference to break in immunity are being investigated.

Efforts to control the Johnes disease through regular vaccination and culling have resulted in the incidence of the disease. Antibiotic sensitivity tests are being done in species with suspected bacterial infections. Prevalence rates of enteric parasites have been recorded. Investigations are being undertaken to control gastrointestinal parasitosis by using different products. Technology for a disease data and information system for organized sheep farms has also been developed (CSWRI) for monitoring diseases.

Wool Science

Research is being undertaken to evaluate different types of wool available in the country and of new strains being evolve with respect to their physical attributes, mechano-chemical properties and end use suitability.

Physical properties. The physical attributes being measured in the different types of wool are diameter, medullation, staple length, crimp, cross section and scales. Under mechanical properties, stress-strain properties, recovery properties tortional studies and crystallinity studies are being undertaken. The effects of storage on quality of wool and on standardization of sampling technique have also been studied. Simple method of wool grading has been suggested (Pokharma 1981).

Wool processing. Wool from different breeds and breed crosses are evaluated for spinnability, fabric and knitting performance. The fabric produced by half bred wool was much better than the natives in terms of breaking strength, color fastness, relaxation shrinkage, abrasion resistance etc. The half bred wools met the norms stipulated for knitted fabrics.

Various types of blends of wool with vegetable fibers and other animal fibers have been prepared. The woollenized jute could be successfully blended with carpet wool up to 30% without any serious effect on yarn characteristics. Carpets of jute wool blends can be chemically washed to provide good luster. Blending 50/50 coarse wool below 365 with fine wool produced satisfactory blankets. Blended yarns of wool and mohair were superior to mohair or wool alone. Mohair blended with wool could be processed conveniently without losing high tensile properties of end products. Wool blended with rabbit hair produced products of soft, light, warm, and unique feel. The 50/50 blend of coarse wool with polyster filament yarn (PFY) waste produced good yarn for furnishing fabrics. Blends of wool with camel hair and polyster produced good overcoating and furnishing cloth.

Chemical processing. Methods have been developed to carbonize wool with 5% vegetable matter by using 3.5 to 4% sulphuric acid. Canary stained wools could be dyed without serious ill effects after bleaching to different levels of brightness. Low temperature dyeing has been done using a water-alcohol mix-

ture. Different dyeing methods are also being developed by using dyes of various plant origin.

DEVELOPMENT PROGRAMS

Sheep development programs were started after launching the five year plan in the country. The programs emphasize on the following:

- Improvement in wool production with regard to quality and quantity.
- Development of dual-purpose or mutton type sheep to augment meat production.
- Provision of prophylactic measures against parasitic diseases and important bacterial and viral diseases.
- Provision of marketing for wool and live animals through sheep and wool boards federations, and
- Development of pastures and fodder tree plantation in drought prone areas

Breeding Strategy

The breeding policy includes the following:

- Selective breeding within indigenous breeds of carpet wool producing sheep like, Magra, Marwari, Pugal and Patandawi for carpet wool production. Chokla and Nali sheep are also being improved through selection to produce fine wool/carpet wool.
- Crossbreeding of coarse and hairy type sheep with exotic wool type/mutton type sheep to produce dual-purpose sheep and to upgrade the medium wool sheep breeds like Chokla and Nali by crossing with exotic fine wool rams (Rambouillet/Merino). The sheep in the Northern temperature region are being crossbred with exotic fine wool rams for upgrading and fine wool production.
- Certain important mutton type indigenous sheep like Mandya and Nellore are being selectively bred to increase mutton production.

In order to provide improved germplasm to the sheep farmers, the following programs are being undertaken:

- Exotic rams are being produced in the large scale sheep breeding farms under specialized management conditions. The exotic rams are provided to different State Departments for production of half-bred rams. In the northern temperate region, exotic rams are also supplied to the farmers.
- The half-bred rams are produced in the sheep breeding farms in different regions/breeding tracts in the states.
- Half-bred rams produced in the state sheep breeding farms are distributed to the village flocks in the respective breeding tracts to produce quarter breds and to attain further improvement to half bred level.

Artificial Insemination

In some areas, specially in Rajasthan, artificial insemination (AI) is done by using exotic ram semen to produce half breds directly in the field. This has, however, entered into difficulties due to low lambing percentages. Preservation of ram semen for longer periods is the major limitation in artificial insemination. Efforts are being made to develop frozen semen technology to overcome this difficulty.

Grading and Marketing Wool

During the 1960s, shearing and grading of wool was started. The wool was graded into several classes according to fineness, color, burr content, and staple length. About 90 grades were identified in Indian wools, but this system could not be practised fully. An alternative system was evolved by the Indian Standard Institute based on micron value. A further simplified grading system has been introduced in Rajasthan from which basic quality grades have been kept with the total of 59 lines. On the basis of evaluation experiments, it has been suggested (Pokharna 1981) that if wools originating from a particular breed and area is kept separate and properly skirted to remove leg, britch, belly, colored, and soiled wool and then graded into fine medium and coarse, this will serve the purpose and complicated grading system can be avoided. This method needs to be practiced at the shearing points and at grading centers.

For marketing of wool, Boards/Corporations have been formed in some States. But these organizations have not been able to compete with the private wool traders. A good marketing infrastructure in the country is necessary for wool, meat and live animals. Sheep breeders' cooperatives have been formed in the rural areas, but these need to be more active.

Feed Resource Development

Pasture development programs are being undertaken by Forest and Animal Husbandry Departments in the States. Pasture development programs have also been undertaken in drought prone areas under the desert development program. It is necessary to create fodder banks as a part of animal feed security system to meet the situation during drought and scarcities. Large scale afforestation is also being done as an ecology improvement measure. Fodder trees should be included in large numbers in such programs.

Constraints

The constraints to development are as follows:

- Lack of availability of adequate grazing areas and use of public grazing lands

- Absence of sufficient fodder banks to meet the fodder requirements during droughts
- Migration of animals in search of grazing and water resources
- High incidence of mortality
- Absence of shelters or proper housing facilities in mountainous regions and in hot-arid regions.
- Absence of adequate marketing infrastructure for purchase of wool and live animals from the farmers.
- Inadequate doses of vaccines against important sheep diseases
- Low allocation of funds for medicines and other treatment facilities.

Suggestions

To effectively implement development programs, emphasis should be given on the following:

- Supply of improved genetic materials to the farmers at appropriate time
- Efforts are required to produce genetically improved crossbred rams in the breeders flocks with arrangement for purchasing back these rams by paying incentive prices. These rams should be reared at the State Farms/Ram Rearing Centers for further distribution to farmers during breeding season.
- Improvement and availability of grazing land
- Organization or proper marketing systems to provide incentive prices for the wool and live animals, and purchase of these from producers.
- Ensure better production per head of sheep.
- Augment production of meat lambs and lamb pelts. Commercial production should be introduced.
- Intensification of research efforts to achieve the targets of per capita production of wool and mutton of desirable quality.
- Proper coordination of the programs being implemented by the ICAR, Agricultural Universities, Development Departments and the Department of Rural Development and the Government of India for effective implementation. To provide this coordination, a national-level Board of Corporation on Sheep and Wool needs to be set up to augment production of wool and mutton.

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Sheep Production and Development in Indonesia

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ABSTRACT

The rural poor farmer is the basis of sheep production in Indonesia. However, sheep production in this country is low. Sheep is traditionally raised at an average of two to five per farmer. Although on a national scale, sheep production ranks the lowest compared to that of other ruminant animals, sheep is important in relation to the country's present agricultural system. It is a national task to increase the income of the poor farmers either through the intensification or extensification of their farm activities. Hence, a national sheep research and development program was initiated, but it is currently far from reaching the national objectives. More information is needed to be able to formulate a sound technological package that is adoptable under the present farming system.

The national development goals of the agriculture sector in the fifth Five-Year Development Phase 1988-1991(PELITA V) in Indonesia include the following:

- achieve self sufficiency in the production of food including protein from animals;
- increase the production of agricultural commodities for export and local industries;
- improve the efficiency of farm operations and increase value added of the commodity;
- increase the farmers' income and welfare; and
- prepare the agriculture sector for PELITA VI.

Sheep, an important national asset, can play a significant role in the national development scheme. In Indonesia, there are two major indigenous breeds of sheep known as the Javanese Thin Tail (JTT) and the Javanese Fat Tail (JFT). The JTT, constituting about 50 to 80% of the total sheep population in Central and West Java, is characterized by its small thin tail. The ewe is usually polled, while the ram has closely curled horns. In contrast, the JFT which is common in East Java, has a fat tail. The JFT's wool has a white color. Usually, it is hornless but some rams have spurs.

Majority of the sheep in Indonesia are raised in small numbers under traditional management systems. They are relatively small and slow growing, their productivity and reproductivity are considered low.

The sheep industry in Indonesia cannot be separated from the goat industry since management practices for both animals are relatively the same. Hence, it is common to find farmers raising sheep and/or goats in Java. There appears to be no particular reason for raising either of the two animals rather than preference.

Status of Sheep Production

The population growth of sheep from 1984 to 1987 under PELITA IV was estimated to have increased at an average of 3.3% per year. Meanwhile, in 1987, 5.2 million heads were reported (Anonymous 1987). The estimated population coefficient (% of animals at the beginning of the year) for births and mortality were 36.4% and 3.7%, respectively.

Sheep is primarily raised for meat. About 490,000 sheep were reported slaughtered in 1986. This figure may well be below the actual since slaughter of sheep for private use is not considered illegal. Aside from meat, hide is also a potential product of economic importance either for local consumption or for export purposes. At present, the development of commodities, in particular nonoil export commodities, that could generate foreign exchange is of national priority. While the total volume of exported sheep skin decreased from 791 t in 1984 to 466 t in 1987 (believed to be due to the increased local demand rather than reduced production), the export value increased by 11.85% per year.

Compared to other ruminant animals, sheep ranks the lowest in terms of total meat produced or total volume, and value of export. However, the strength of sheep production in the national development scheme lies in the fact that sheep fits well in the present agricultural system and is an important component in the economy of the small farmers. In addition, sheep production is considered an important employment and income generating activity for the poor farmers, many of whom are landless.

Production Systems and Limitations

Aside from being an important source of meat, sheep is also raised as a source of manure, as a form of savings, for use in culture and religious functions, for accumulation of wealth, for carpet manufacture, and for recreation (fighting sheep at Garut). The sheep population is widely distributed within Indonesia but is heavily concentrated in a few provinces of Java, which constitutes only about 6 to 7% of the total land area of Indonesia. A positive correlation exists between the number of ruminant animals (such as sheep) and the human population due to the production structure which is highly characterized by the small scale farming system.

Majority of the sheep are raised by farmers under traditional management practices in small numbers (two to five animals per farm). It was estimated that about 20% of all farms in Indonesia have sheep and/or goats (Knipscheer et al. 1983). The average growth rate of sheep under village condition is much lower than the growth potential under on-station management.

The production potential of the Indonesian sheep is believed to be superior over some temperate breeds that have been introduced in this country. However, little effort to improve their productivity index was done in the past. The local sheep breeds year-round, a distinct advantage over the seasonal breeding pattern of some temperate zone sheep. However, the lambing interval under village condition was found between 12 and 15 months. It is highly probable, therefore, that under better management and feeding conditions, three lamb crops over a two-year period can be obtained.

The quality and quantity of feed as well as the feeding management are undoubtedly important factors that influence the production of sheep. Feed, generally obtained at "zero cost," is mainly comprised of natural or road side grasses and/or agricultural by-products. Supplementation with a concentrate feed is rare because of its high cost which is not affordable to the low-income farmers. Farmers, however, make efforts to provide palatable and good quality feeds for their animals when possible.

Disease is a major problem in sheep production, the most common of which is parasitic infestations (e.g., haemonchus, flukes, mange). Most of the sheep in Indonesia are kept in elevated bamboo or wooden houses. This housing system reduces internal parasitic infestations. However, partly grazing of sheep during the day is also being practiced. Contagious ecthyma (orf) caused by pox virus is often a problem particularly when followed by secondary bacterial infections.

Although several factors are limiting the production of sheep, marketing is relatively easy. The price setting is not based on the

animal's body weight, but the price is relatively stable throughout the year. Dramatic increases in consumption and price are observed during the observance of the Idul Adha (holy day for Moslems). Market volume and price during this season could double, if not triple, particularly for rams of good performance.

In general, constraints to sheep production fall into three major areas: ecological, biological and socioeconomical. Although these constraints are separated into different areas, their interaction or combined effects greatly influence sheep production. For instance, the hot humid tropical environment influences the production of sheep either directly through the animals metabolism or indirectly through the quality of roughage. Biological and management interventions therefore, could greatly improve sheep production.

R & D Program Highlights

A national small ruminant research and development (R & D) program was initiated at the Balai Penelitian Ternak (RIAP-Research Institute for Animal Production), Bogor in 1980. The program, supported by the United States Agency for International Development through the Small Ruminant — Collaborative Research Support Program (SR-CRSP) established under the Title XII of the International Development for Food and Agriculture Act 1975, is a multidisciplinary approach program to study the limitations and provide solutions to increase the production of sheep under village conditions in Indonesia.

Most of the researches on sheep have been documented in working papers (98 papers to date) while some have been presented in international meetings and journals. Currently, the work over the past seven years is being summarized and reviewed and is expected to be available soon.

The R & D program activities consist of two distinct areas: on-farm and on-station activities. The on-farm R & D work is a multidisciplinary approach to the three major areas of research and development. As part of this activity, genetic/breeding, nutrition/feeding system, and socioeconomic studies are being conducted using the village laboratory facilities.

At the start of the activity, a monitoring program in two villages of different altitudes (highland and lowland) was established. It became the basis for the nutrition, breeding, and socioeconomic data collection of on-farm management conditions. In this program, a group of farmers in each of the villages was provided with sheep; this served as the field laboratory for the researchers. Production parameters as well as socioeconomic changes were monitored.

The surveys and long-term regular monitoring of the production systems have identified some major factors that determine the low take-off rate in sheep production. The long parturition in-

terval of sheep appears to be one such major factor. This is attributed to the failure of the animals to mate at the right time rather than to poor fertility. Further, there are a number of critical nutritional and management limitations to increasing productivity.

On-Station Research Programs

Genetics/breeding aspect. In the past, attempts to improve the production of sheep in Indonesia have been made through the introduction of temperate breeds of sheep. However, information on the outcome of these initial attempts is scarce.

In the late 1970's, a study was conducted to evaluate the production potential of the available local breeds under on-station management condition (Obst et al. 1980). JTT appears to be superior over some temperate breeds or their crosses (Fletcher et al. 1980; Fletcher et al 1985). Gunawan and Bakrie (1987) again reported the superiority of the pure JTT over their crosses with Suffolk, Polled Dorset, and Wiltshire Horn in terms of fertility and total productivity (Table 1). However, a higher mortality rate of the JTT lambs (multiple births) during 0 to 7 days after parturition was observed. It was further noted that importation of temperate breeds of sheep should not be recommended unless an evaluation of their exotic genotype performance has been carried out before introduction into the country. Hence, selection of the existing breeds must be implemented in order to gain genetic improvement of sheep.

A breeding and selection program was later initiated at the Cicadas Breeding Station in Bogor to develop lines of local sheep

Table 1. Reproductive performance of Javanese thin tail (JTT) sheep and their crosses.[a]

	JTT	Suffolk × JTT	Polled Dorset × JTT	Wiltshire Horn × JTT	SD
No. of ewes	14	16	17	9	—
Age at first lambing (days)	348	432	456	427	67.56
No. lambs born	48	34	16	18	—
No. lambs weaned	33	31	7	14	—
Prolificacy	1.41	1.41	1.33	1.04	0.75
Lamb survival:					
Singles	1.00	0.39	0.64	0.33	0.33
Twins	0.63	0.92	0.00	0.73	—
Total production	32.57	35.67	10.12	26.22	—

[a]Source: Gunawan and Bakrie 1987.

based on their prolificacy trait. From the data collected over the past years, it was found that prolificacy is observed only on certain ewes. It is likely transmitted as an autosomal dominant gene similar to that of Booroola gene in Australian Merinos (Bradford 1987). Studies to confirm whether the mechanisms of inheritance of prolificacy is being controlled by a major gene are still underway. If this is proven, then there is a high possibility that strains of consistently-known prolificacy could be developed in a relatively shorter time than required for a quantitatively inherited trait.

Nutrition and feeding systems aspect. Evaluation of the most important feedstuffs in sheep diets has been the earlier activity of the sheep production program; at present, evaluation is still going on. The chemical composition of the feeds was analyzed to obtain a database of such feeds' nutritional value. Under village conditions, grass and some agriculture by-products are the main roughages offered to sheep. The low growth rate of the animals suggests that tropical grasses singly fed to the animals allow only for maintenance level performance. Hence, supplements should be provided to increase production of sheep. Feeding trials which provide various levels of locally available materials such as concentrate feeds, protein-rich agriculture by-products, and tree legume leaves as supplements were conducted to determine palatability, voluntary intake, nutrient digestibility, and animal growth responses. These trials were carried out mainly with growing lambs using either elephant grass or native grass as the basal roughage. Some of the results of the feeding trials are shown in Table 2. Pooling of the data (Figure 1) indicates that an intake of around 200 to 250 g digestible dry matter only meets the maintenance requirement of sheep. Based on the results of this program, some empirical information about diet formulation can be obtained.

Outreach pilot project (OPP). This project was a follow-up of the on-station research activities to test the adoptability of the new technology under village conditions. In addition, socio-economic studies on the impact of the adoption was conducted. Initially, 10 groups of farmers were involved but this has risen to 42 groups. Animals of known prolificacy were distributed to the farmers. The productivity of the animals was monitored at regular interval. The animals were the result of the on-station breeding/selection program where their prolificacy was evaluated.

Preliminary information indicates that in general, the highly prolific animals are not preferred by the producers because the new born lambs are small and mortality rate is very high. Some recommendations on feeds and feeding management have also been tried with the village farmer. For instance, mineral blocks were provided to the farmers. It was found that such mineral blocks appear to contribute to the weaning weight and post-

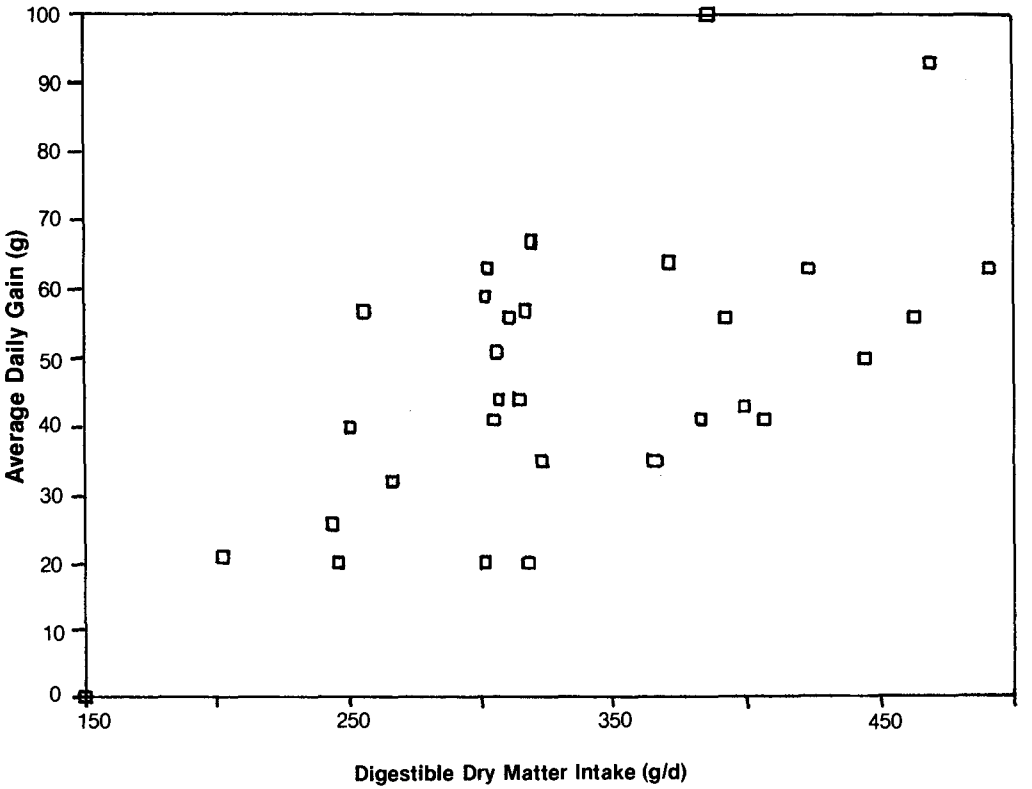

Fig. 1. Relationship between digestible dry matter intake and average daily gain.

Table 2. Intake, digestibility, and daily gain of JTT sheep fed with napier grass as basal roughage and various supplements.

Supplement 1	Supplement 2	Total Intake (g/kg)	Total Intake (g/day)	DMD (%)	Weight (kg)	ADG (g)	F/G	DDMI	References
Fresh		29	429	57	14.8	26	16.5	244	van Eys et al. 1984
Silage		25	375	40	15.0	0		150	
None		28	465	53	16.6	20	23.2	246	Mathius et al. 1984
Leucaena		33	548	59	16.6	35	15.7	323	
Leucaena		34	564	56	16.6	44	12.8	315	
Leucaena		44	730	61	16.6	50	14.6	445	
None		27	559	57	20.7	20	27.9	318	Semali and Mathius 1984
.5 kg Leucaena		32	662	49	20.7	35	18.9	324	
1.5 kg Leucaena		33	683	45	20.7	44	15.5	307	
2.0 kg Leucaena		44	911	44	20.7	43	21.2	400	
Leucaena +	None	57	878	48	15.4			421	Rangkuti and Djajanegara 1983
Leucaena +	Molasses	45	693	51	15.4			353	
Leucaena +	Molasses	55	847	56	15.4			474	
Leucaena +	Molasses	42	647	55	15.4			355	
None		37	555	66	15.0	35	15.9	366	Rangkuti et al.1985
Gliricidia		40	600	64	15.0	41	14.6	384	
Gliricidia		41	615	64	15.0	56	11	393	
Gliricidia		41	615	69	15.0	63	9.8	424	
Gliricidia		40	468	57	11.7	32	14.6	266	
Gliricidia		37	433	58	11.7	40	10.8	251	
Gliricidia		39	456	67	11.7	41	11.1	305	
Gliricidia		43	503	62	11.7	56	9	311	
Gliricidia		39	647	63	16.6	41	15.8	407	Mathius et al. 1984

Table 2. Continued.

Supplement 1	Supplement 2	Total Intake (g/kg)	Total Intake (g/day)	DMD (%)	Weight (kg)	ADG (g)	F/G	DDMI	References
Gliricidia		41	681	68	16.6	56	12.2	463	
Gliricidia		39	647	76	16.6	63	10.3	491	
None		29	415	49	14.3	21	19.7	203	Mathius and van Eys 1983
Sesbania		31	443	58	14.3	57	7.8	256	
Sesbania		36	515	59	14.3	63	8.2	303	
Sesbania		43	615	63	14.3	100	6.1	387	
Sesbania		33	548	58	16.6	57	9.6	317	Mathius et al. 1984
Sesbania		38	631	59	16.6	64	9.9	372	
Sesbania		45	747	63	16.6	93	8	470	
None		37	522	58	14.1	20	26.1	302	Mathius et al. 1983
Cassava leaf		41	578	53	14.1	51	11.3	306	
Cassava leaf		39	550	55	14.1	59	9.3	302	
Cassava leaf		42	592	54	14.1	67	8.8	319	

weaning growth of lambs (Table 3). However , at present, it is not yet possible to identify which minerals have the major impact. Daily use of legume foliage as a supplement was also introduced to make more efficient the use of limited amounts of high quality feeds. Later, a "calendar" feeding system, which consists of a guided feeding program based on monthly monitoring of the farmers' feed resources, was also tested. Regular meetings with the farmers were made to evaluate the implications of the new technology from the socioeconomic point of view. Recent findings from these meetings showed that adoption rate of the new technology is relatively low. This may be a result of the limitations in the method of disseminating the information. At present, a new program was initiated to test various methods of transferring the technology.With the present OPP projects serving as a field laboratory, extension of the program to other villages is being established. In this project, the farmers will be provided with an alternative sheep management system where the production and marketing of the lambs are regulated to obtain a more even distribution of income throughout the year (Djajanegara et al 1987).

Future Development Program

The sheep industry in Indonesia is envisioned to develop towards specialized enterprises such as fattening of yearling lambs, and

Table 3. Pre-weaning weight gain (g/d) of sheep under village condition as affected by supplementation with mineral blocks.[a]

Variable	Mineral Block Treatment[b]			Marginal Means
	Control	MB.A.	MB.B.	
Between location				
rice fields	80	79	61	76
dry fields	76	63	93	82
plantation	65	42	90	68
Between litter size				
one	80	90	83	84
two	61	44	81	60
Between sex				
male	78	65	79	74
female	69	67	85	73
Marginal means	73	66	82	—

[a]Source: Dwi Yulistiani et al. 1987.

[b]Control: the block contains (g) 35 rice bran, 40 molasses, 7.5 urea, 5 salt and 10 CaO.
MB.A: as control added with 2.5 g superphosphate.
MB.B: as MB.A added with 5 trace mineral mix.

ultimately towards the establishment of large scale sheep industries with the smallholder farms producing stock animals as core of the production system. The possibilities and economic feasibility of utilizing available feed resources on land areas under estate crops such as rubber, coconut, palm oil, and the like are being explored in North Sumatra (rubber plantations) and in West Java (grazing under coconut). Sheep production contributes to the estate profit by reducing the cost of weed control (provided no adverse effect on the estate production is experienced), and by utilizing the available forage, which, at present, is being explored.

CONCLUSION

The sheep research and development achievements are far from reaching their goals since much more information is still needed to establish sound technological packages to increase the sheep production in Indonesia.

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Sheep Production and Development in Malaysia

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ABSTRACT

This paper presents the current status of the sheep industry in Malaysia with special reference to Peninsular Malaysia. The problems and constraints to sheep development are identified. In view of the high potential for sheep development, the role of research and avenues for development are highlighted and enumerated. Regional cooperation is recommended.

Contribution

In 1985, production of mutton was 580 t which only met 9% of the demand. Sheep contributed about 8% of the total animal products. Mutton was consumed by about 20% of the population with a per capita consumption of about 5.2 kg. In the same year, 5,681.7 t of mutton (frozen and fresh) were imported from New Zealand and Australia at a cost of 18,475,921 Rgt. The average c.i.f. price of mutton was 3.25 Rgt/kg in 1972 to 6.00 Rgt/kg in 1986.

During the last few years, sheep farming has received over-

whelming response both from the public and the private sector following encouraging results of research on integration with tree crops by RRIM, MARDI, and GUTHRIE, which showed that this system is not only viable and practicable but also profitable. The introduction of sheep under rubber and oilpalm reduced the cost of weeding between 15-30% and increased the productivity of the plantation crops by 25-33%. The concept of integration under plantation crops also overcome the necessity of acquiring virgin land for farming, as the sheep could graze on existing planted areas.

It is estimated that more than a million hectares of land under plantation crops (rubber and oilpalm) exist, out of which 336,914 ha in Peninsular Malaysia have already been identified for sheep integration. Government agencies such as the Federal Land Development Authority, Federal Land Consolidation Rehabilitation Authority, Farmers Organization Authority, Rubber Industry Smallholders Development Authority, Rubber Research Institute of Malaysia, and private agencies such as GUTHRIE, SIME DARBY, and others have already ventured into sheep farming by integrating sheep with their plantation crops.

Sheep Population

The population of sheep is estimated at 91,417 heads, of which 99% is found in the Peninsular Malaysia and about 1% in Sabah and Sarawak. In Peninsular Malaysia, the concentration is greatest in the states of Kelantan, Negeri Sembilan, Kedah, and Pahang (Table 1).

Table 1. Sheep and goat population in different states of Malaysia, 1986[a]

State	Sheep	Goats
Perlis	4,229	9,229
Kedah	9,912	41,712
Penang	1,981	16,531
Perak	5,962	28,854
Selangor	3,880	16,769
Negeri Sembilan	15,348	29,272
Melaka	3,706	13,248
Johor	7,741	23,897
Pahang	6,072	15,069
Terengganu	3,616	20,068
Kelantan	27,962	42,389
Wilayah Persekutuan	N.A.	508
Peninsular Malaysia	90,409	257,546
Sabah	1,000	32,000
Sarawak	8	12,043
Total	91,417	301,589

[a]Source: Malaysia, Ministry of Agriculture Statistics 1986.

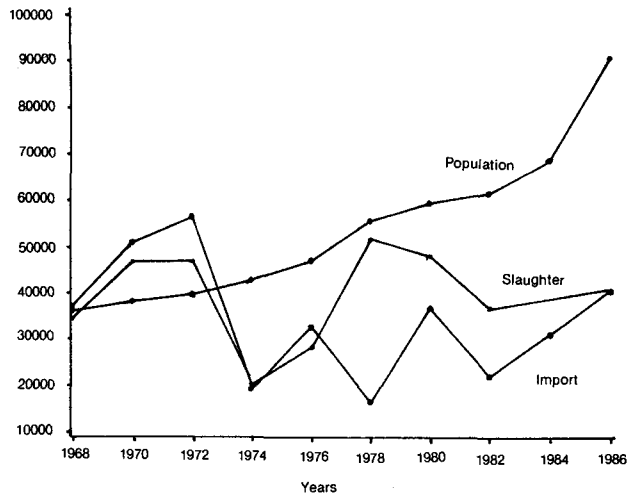

Fig. 1. The trend in population growth, slaughter, and imports of sheep in Peninsular Malaysia from 1968 to 1986. (Malaysia Ministry of Agriculture Statistics 1985).

The livestock census for the last 18 years (1968-1986) illustrates the growth pattern of the industry (Figure 1). The population increased by 153.18%. A significant increase in the extraction rate was observed especially between 1974 and 1978.

Breeds of Sheep

The sheep are of three types: a) Malin, b) imported exotic purebreds, and c) crossbreds of these two types.

Malin. The indigenous sheep which are sometimes referred to as the Kelantan sheep, ISM, and local sheep, have now been renamed as Malin (Malaysian indigenous) sheep. The population is estimated to be about 70,000. They are mainly found in the states of Kelantan, Negeri Sembilan, and Terengganu and to a lesser extent in Pahang. They are prolific and are reported to lamb twice a year. They are hardy and able to survive despite poor grazing and management.

Exotic breeds. A number of exotic purebreds have been imported for crossbreeding and upgrading. These include Dorset Horn, Poll Dorset, Wiltshire Horn, and Romney. Recently, Suffolk, Corriedale, Border Leicester crossbreds have also been imported from Australia. Initially, these purebreds were reared at government farms, but due to good results from crossbreeding, they have been distributed to farmers. The results of these introductions await further evaluation. Total mortality is less than 11%.

Crossbreds. Various crosses have resulted by crossing Dorset Horn, Poll Dorset, and Wiltshire Horn with Malin. The F1 crossbred have given encouraging results (Table 2). Except for data on crossbreds of Dorset Horn with Malin, information on other breeds and crossbreds is scanty.

Table 2. Performance of Dorset, Malin, and crossbred sheep in Malaysia.

Variable	Dorset Horn			Malin	Authors
	Purebred	Crossbred			
		50/50	25/75		
Respiration rate (unit)	95			48	A. Wahid (1986a)
Pulse rate (bpm)	80			79	A. Wahid (1986a)
Rectal temperature (oC)	39.1			39.0	A. Wahid (1986a)
Birth weight (kg)	3.2	2.1	1.9	1.6	Devendra (1975); Lee et al. (1978); A. Wahid (1978)
Weaning weight (kg)	16.8	10.2	9.3	8.0	Devendra (1975); Kanal Hizat et al. (1986); A. Wahid (1987)
Year old weight (kg)	30.7	26.7	23.7	18.7	Devendra (1975); Kamal Hizat et al. (1986); A. Wahid (1987); Kamal Hizat (1988)
Pre-weaning ADG (gm)	121.2	87.0	81.0	71.0	A. Wahid (1987); Kamal Hizat (1988)
Post weaning ADG (gm)	51.5	59.0	51.0	38.0	A. Wahid (1987); Kamal Hizat (1988)
Feed intake (g/Wkg0.75)	182.6			200.8	A. Wahid, M.A. Dollah, and M.Y. Jaafar (1987a)
Water intake (m/Wkg0.75)	170.1			69.8	A. Wahid, M.A. Dollah, and M.Y. Jaafar (1987a)
Lambing (%)	45.5	64.0	69.0	75.80	A. Wahid, M.A. Dollah, and M.Y. Jaafar (1987a); Lee et al. (1978)
Lambing interval (days)		— 207-259 —			
Litter size (lambs/ewe)	1.1	1.2		1.3	Lee et al. (1978); Ani Arope et al. (1985); A. Wahid and Rozimah (1987)
Single birth (%)	89	— 89.4 —		64.5	Wan Mohd (1977); A. Wahid and Rozimah (1987)
Multiple birth (%)	10.3	— 10.6 —		35.5	A. Wahid and Rozimah (1987)
Gestation (days)	151	150		150	Ani Arope et al. (1975); A. Wahid and Rozimah (1987)

Table 2. Continued.

Variable	Dorset Horn			Malin	Authors
	Purebred	Crossbred			
		50/50	25/75		
Male: Female ratio	53:47			48:52	A. Wahid and Rozimah (1987)
Time to mount (sec)	36.2	12.7	13.1	19.6	A. Wahid, M.Y. Jaafar and M.A. Dollah (1988)
Time to ejaculation (sec)	57.1	15.3	18.5	26.0	A. Wahid, M.Y. Jaafar, and M.A. Dollah (1988)
Volume of semen (ml)	0.8	1.0	0.7	0.7	A. Wahid, M.Y. Jaafar, and M.A. Dollah (1988)
Motility (%)	25.3	78.2	76.2	82.4	A. Wahid, M.Y. Jaafar, and M.A. Dollah (1988)
Sperm count (x108)	20.06	29.2	32.4	25.1	A. Wahid, M.Y. Jaafar, and M.A. Dollah (1988)
Live sperm (%)	42.8	90.4	90.3	95.0	A. Wahid, M.Y. Jaafar, and M.A. Dollah (1988)
Mortality (%)		— 15-50 —		10.0	Wan Mohd (1977)
Wool production (kg)		— 1.5 —		1.5	Ani Arope et al. (1985); Kamal Hizat (1988);
Dressed carcass (%)				37-46	Devendra (1975); Devendra and wan Zahari (1977) Moh Salleh Rejab (1982); Wan Mohd. (1977)

Sheep Production System

There are four types of production systems, namely: a) tethering; b) extensive; c) intensive; and d) semi-intensive.

Tethering. This is commonly practiced by smallholders with a few head of animals. The animal is tied to a peg or tree and allowed to graze in the vicinity. After a couple of hours, the animal is shifted to another location and tied to another tree or a peg. This system restricts the movement of the animal hence, the amount of feed available is also limited.

Extensive. This system is the least popular but is practiced by some farmers in Terengganu and Negeri Sembilan. The animals are allowed to graze the the whole day and night. No housing is provided and no supplementary feed is made available. The animals rest under the house or under a tree for the night.

Intensive. This system is popular with goats. The sheep farmers do not favor this system as it entails large input in the form of housing and supplementary feeding.

Semi-intensive. This is the most popular system being practiced by small and large scale entrepreneurs. The animals are grazed during the day and housed during the night. This can take the form of grazing on planted pastures or under plantation crops. Supplementary feed may or may not be provided depending on the financial status of the farmer.

Performance of Breeds of Sheep

The Malin sheep are bred for the sole purpose of meat production and their distribution appears to be associated with climatic conditions which are found in areas with longer dry spells. As the sheep are primarily for mutton production, wool production is of secondary importance.

The available information on the performance of sheep in Malaysia is summarized in Table 2. The mean birth weight ranges from 1.6 in Malin to 3.2 kg in Dorset Horn. The daily liveweight increase up to 12 months of age is about 38-59 g. Devendra (1975), however, has reported a 49-73 g increase. At one year of age, Malin reaches 18 kg and Dorset Horn attains 31 kg (male; 18-25 kg and female: 25-31 kg). The average height at wethers of Malin (Devendra 1975) is 46.7 cm (range: 43-64 cm), heart girth is 51.6 cm (range: 51-55 cm), and total body length is 71.3 cm (range: 71-74 cm). Malin ewes exhibit estrus throughout the year whereas the imported exotic are reported to be seasonal. Malin ewes produce their first lamb at 12-18 months of age. Average lambing rate is reported to be 106-151%. The gestation length is 150 days and the lambing interval is 207-259 days. The lambing percentage is 45-80% and the age at first lambing ranges between 11.5 and 20.3 months. Mortality is 5% in Malin, 15-50% in Dorset crossbreds, and 4-31% in Wiltshire Horn crossbreds (Vanselow 1978). The incidence of

singles is 90% and twins, 10%. The sex ratio (M:F) is 50:50, and peak lambing is observed to occur in April, May, and October.

There is very limited milk production of 0.2 kg/day in Malin with butterfat of 3.30%; protein, 4.58%; solid-non-fat, 9.34%; ash, 0.6%; and total solid, 12.64% (Rahman and Khusahry 1979). Carcass analysis of Malin rams showed that the dressing percentage varied from 37.2 to 46.0%, and the meat: bone ratio was 2.1:1.

Smith and Clarke (1972) and by Abdul Wahid (1982) characterized the fleece of Malin as a coarse carpetwool type which appears to contain hair. The staple length was found to be 3.0-12,40 cm while fiber diameter is at 24.5-72.9 m (primarily fibers ranging from 70.5 to 72.9 m and secondaries ranging from 24.5 to 27.6 m). The head, underside of neck, brisket, belly, and legs are bare. The greased fleece weight is 0.8-1.5 kg; vegetable matter, 3.6%; medullation, 37.5-42.0% (range: 33.8-60.5). The pH (aquaeous extract) is 7.0-7.5. The sheep are never shorn and the wool is always matted into inseparable clumps. Shedding of wool has also been observed. This has aroused the interest of some breeders to determine the causes of shedding.

Considerable research had been undertaken to evaluate the performance of imported Dorset Horn (Abdul Wahid et al. 1987; Kamal Hizat et al. 1987; Wan Mohamad 1986; Tajuddin and Chong 1986), Poll Dorset (Abdul Wahid 1986), and Wiltshire Horn (Vanselow 1978) breeds of sheep and their crossbred progeny. The adaptive and reproductive performance has not been very encouraging; however, the growth performance was reasonably good but incomparable to the temperate countries.

The Dorsets possessed greater rectal temperature and pulse rate. The respiration rate (98.1 bpm) was almost double than that of Malin (48.4 bpm). The coefficient of heat tolerance was lower and index of adaptability was greater than that of Malin (Abdul Wahid 1986a). The daily feed intake was reduced whereas water intake was significantly increased in Dorsets. The birth (3.24 kg), weaning (16.8 kg) and 12-month body weights (30.7 kg), as well as pre-weaning and post-weaning average daily gain (ADG) of Dorset (121.2 and 51.5 g) were greater than those of Malin, and the differences were significant ($P < 0.05$). The Dorset rams took longer time to mount, longer time to ejaculate, and greater number of mounts per successful ejaculation (Abdul Wahid et al. 1988). The Dorset rams also produced greater volume of semen but with lower motility and lower percentage of live sperms. The lambing percentage and litter size was inferior to Malin (Abdul Wahid and Rozimah 1987).

The F1 progeny of Dorset Horn has shown potential both on the government stations and on smallholder farms. The results presented by Kamal Hizat et al. (1986), Wan Mohamed (1986) and others are encouraging.

Problems of the Industry

Traditionally, sheep farming is an uneconomic activity compared to other agricultural activities. Sheep and goat development programs are being implemented as an integral part of the agricultural activity, but large proportion of the national budget for livestock has been for cattle development. There are a number of constraints that affect the sheep industry.

Small base population. The 8% annual increase in sheep population has not been able to produce any significant impact until recently when, because of large importations, the increase has been significant. The present increased rate can now cope with the rate of slaughter; the country now has a surplus for export.

Low productivity of local animals. The Malin sheep are small in size and demonstrate low productivity. The mature weight is between 20-25 kg and the growth rate range from 16 to 43 g/day. Productivity of meat has to be doubled or tripled to achieve the national goals.

Undefined system of production. Except for a few large farms, most of the sheep are grazed in the open during the day and housed during the night. The establishment of improved pastures is difficult and land ownership is very small. The lands identified as "grazing reserves" are more often than not unsuitable to grazing.

Supportive services. Because of the insufficient trained personnel, who are specialized in a small ruminants, an efficient supportive service for health and extension could not be provided. Extension services have been developed with little research backing since technology packages on sheep farming has not been fully developed.

Priority. As the national priority has been dairy development since the 1970's, little emphasis has been given to sheep. The goat and sheep sector received very little attention until recently when the sheep was highlighted for its role as "biological mower" and "nonunionized labor" in plantations (Ani Arope et al. 1985).

Marketing. At present, there is no proper planned marketing system for sheep in particular, and for ruminants in general. The small holders market their animals live especially during festivals and ceremonies. Prices and profit margins are largely controlled by the middle men.

Potential of the Sheep Industry

The demand for mutton is expected to increase between the year 1986 from 8,129 t to 13,188 t in the year 2000, with increased per capita income and consumption of mutton (sheep and goat meat). However, the increase in slaughter will necessitate the increase in productivity by at least three fold, and a scope for further development of the industry could be attained. This can be achieved by increasing the productivity, thereby reducing or maintaining the pro-

duction cost. Productivity can be increased through breeding and mutiplication, integration of sheep with plantation crops, utilization of least cost rations from cheap readily available feeds and by-products, reduction of importation of mutton and feed stuffs, and improvement of supportive services such as herd health and disease diagnostic services. A well-planned and organized marketing system for local distribution as well as for export, and the utilization of by-products for the cottage industry are fundamental requirements.

It is estimated that in Peninsular Malaysia alone, there exists 2.8 million ha of plantation crops (rubber and oil palm) which could be utilized for sheep raising. At the rate of 7-10 sheep per hectare (Wan Mohamed 1977), the country would be able to meet the national requirement of 850,000 heads of sheep for slaughter. To date, the country has imported a number of breeds for multiplication and distribution to farmers to increase the population. Importation of 5,000 to 6,000 heads per year for the next five years would increase the base population for multiplication to the targeted million sheep by the year 2000.

Role of Research and Development

Sheep research must be organized to fulfill the following broad goals: develop and introduce technology which would increase sheep and, for that matter, goat productivity; and collect and disseminate information on all aspects of sheep production to appropriate extension agencies to increase and improve productivity and raise the standard of living of the sheep farmers.

Increase of base population. It is evident that importation of sheep or breeds of sheep cannot be avoided. However, ways and means should be sought to increase the population and productivity of the local breed of sheep. The use of genetic principles and application of artificial insemination using chilled or frozen semen on a large scale could hasten the development of the industry. Good potential breeders should be identified and, using the embryo splitting and embryo transfer techniques, the productivity of superior animals should be increased. Initially, importation of large number of specific breeds of sheep accompanied by controlled breeding and stringent selection and culling procedures are necessary.

Breed improvement. Since the main objective of sheep farming is meat production, emphasis should be given to the improvement of characteristics important to meat production such as good growth rate of lambs and adults, survivability, reproduction (prolificacy and fecundity), maternal ability, milk production, meatiness, and carcass quality.

Breeding research should be properly designed planned, and executed using defined breeds. The whole program in the country

should be coordinated and implemented to provide a continuous update for extension and development agencies. Breeding should not only be to identify and characterize breeds and crossbreds, but also to provide animals to the implementing agencies or farmers when requested. The establishment of sheep breeding centers to multiply and distribute good rams and ewes should be considered. The animals, which were distributed, should be monitored to collect information and identify problems on the ground. Although Malin presently comprises a large proportion of the local sheep population, the importation and introduction of large number of various breeds into the country without any proper planning will create a situation where it would be impossible to identify the level of crossbreeding or blood level and eventually, the evolution of chosen genotypes.

The results of sheep production research conducted in Malaysia is summarized in Table 2. Certain conclusions are apparent:

- The birth, weaning, and yearling weights of Malin could be improved by crossbreeding with exotic breeds such as Dorset Horn, Poll Dorset, and Wiltshire Horn. At this stage, it is not possible to identify the best breed for crossbreeding, but the limited data indicate that the Dorset might be a favorable choice. However, more information should be gathered on F1 and F2 generations as well as on crossbreds of the other remaining exotic breeds before any concrete recommendations can be made.

- There is no depressing effect on the reproductive performance of the crossbreds. Recent observations (Abdul Wahid et al. 1988) have shown that the libido and semen quality of F1 and backcross progeny was better than that of the exotic breeds. Research in reproduction therefore, should be aimed to improve fertility, prolificacy, lambing rate, fertility rate, weaning rate, survival rate, number of lambs weaned/ewe/lambing, number of lambs weaned/ewe/year, weight of lambs weaned/year, weight of lambs weaned/ewe/lambing, and weight of lambs weaned/ewe/year. The latter factors contribute directly to total meat yield.
- There is no information on the milk production of sheep except for the preliminary results of the studies of A. Rahman and Mohd. Khusahry (1979). It has been estimated that the local sheep produce only 0.2-0.3 kg of milk per day. The performance of purebred exotic so far has not shown their true potential compared to results obtained in other countries.
- Studies conducted to observe changes in the physiological response showed significant and Poll Dorset when exposed to local environment. The effect of temperature and relative

humidity on the respiration and rectal temperature suggests the need to have modified conducive environment for the imported animals. It appears that sheep of purebred origin, such as Dorset, imported into Malaysia from the temperate countries need to be intensively managed.

Use of agricultural products and by-products. Feed availability is one of the most important factors limiting total productivity. Because of land limitations, it may not be possible to plant grasses but the available resources within the plantation crops could be utilized to feed the sheep. Besides the green feeds, there are about 5 million tonnes of agricultural and industrial by-products available in the country for feeding sheep and other livestock.

The intake and utilization of locally available products and by-products should be intensified to replace the imported feed stuffs. The evaluation of local products could be carried out to identify the grains, grasses, legumes, and leaves suitable for feeding to or grazing by sheep. Research on feed stuffs should be enhanced to identify and evaluate the acceptance, palatability, assimilation and rate of absorption of these by-product/rations. The modification of the feed stuffs for better utilization and actual inclusion into formulated least cost rations needs further investigation. Planting of legumes, fodder and/or leguminous crops for feeding or grazing should be encouraged.

Proper production system. Systems of sheep production have to be identified according to agro-climatic regions. Research to reduce stress (climatic, nutritional, and managemental) on sheep should be done to provide the most conducive environment for the animal to show its potential.

With the adoption of integration as a production system, research on shade-tolerant species of pastures and legumes under plantation crops will have to be intensified. Besides the grasses, broadleaves, and ferns enumerated by Lowe (1968) and Chen et al. (1978), other species of vegetation under rubber and oil palm have to be identified and characterized as those suitable to feeding or obnoxious or poisonous.

Housing also varies with the number of animals and financial capacity of the farmers. There are two types of housing: a) ground level in the northern and eastern states of Malaysia and, b) raised with slatted floor in the other parts of the country. Shape, size, and the material used for the shed is very variable. The use of cheaply available material for housing or for the roof has to be tested.

Product utilization.. As the acceptance and demand for prime cuts of mutton increase, a system of grading local carcasses needs to be identified.The hygienic slaughtering of sheep, processing, and preservation of meat and milk need to be looked into. Different types of culinary preparations have to be ascertained to encourage people to try new dishes. Likewise, the taboo about the detrimental effect of mutton and goat meat on the heart and blood

pressure needs to be investigated and clarified. Canning of "halal" and hygienic meat should be encouraged.

By-product utilization. Research needs to be geared to intensify the utilization of sheep by-products such as wool, skin and hides or pelts, faeces, horns, hooves, bones, etc. The use of wool from crossbred animals for cottage industry is envisioned to increase the income of the farmers, thus eliminate one pollution problem.

Marketing. Marketing is the most important but most neglected aspect of the industry. Although as early as 1979, the need to organize the marketing system was realized by Hawari and Vendargon (1979) and reemphasized by Abdul Wahid (1986b), still, no organized marketing infrastructure exists in Malaysia for the sheep and goats to date. The farmers sell their stock live direct to the butcher and sometimes through the middlemen. This way, the farmers get cash in their hands. Since the buyers are limited, there is no competition in price and the producer seldom gets a very good bargain for his stock. The Federal Agriculture Marketing Authority (FAMA) could play an important role to measure outlet for the sheep.

A well organized marketing system needs to be identified so that a very minimal fluctuation in price of the animal products or by-products could be attained. The demand for mutton by hotels, restaurants, etc., should be properly monitored to determine the cut and taste preference. The potential of exporting the animals to the Middle East, Japan, Hongkong, and other countries should be looked into. Collecting centers or holding yards should be established to house the sheep before slaughter and/or export.

Economic viability. The viability and profitability of sheep enterprise should be determined. The optimum number of sheep for a break even point in profit should be identified so that entrepreneurs may be guarded against nonprofitable ventures. Scale of production has to be determined and documented.

Extension services. Dissemination of technology to intended farmers is very important. However, it is not as acute as in the goat industry. There is lack of trained personnel to provide effective services to the farmers. Effective linkages and feedback mechanisms are necessary in identifying and resolving some of the major problems affecting production. The impact of new technology for development therefore would depend upon sustained research efforts that are: 1) problem oriented; 2) interdisciplinary; and 3) appropriate. The farmers should be trained in proper management of sheep.

Scope for Regional Cooperation

Keeping in view the potential of sheep development in the region, a number of avenues are now open for futher collaboration between the countries in the region. Some of the areas that can be

worked on are:

- Exchange of genetic material;
- Facilities for training of personnel; and
- Establishment of a databank for information on sheep encompassing data on animal statistics, animal performance, relevant research and production institutions, and available trained personnel in each country, work done so far, work in progress, etc.; and
- Possibility of forming a regional coordinating committee to monitor activities and developments in the sheep sector.

CONCLUSION

The scope for the development of the sheep industry is tremendous and the potential of the producers is significant. Properly organized research with adequate extension facilities is deemed necessary. Regional cooperations in prioritizing the needs of the industry, as well as establishment of gene pools and a data bank, are likewise seen as important considerations. Close rapport between the research and development or extension agencies is necessary. The need to monitor the progress in each participating country is inevitable.

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Sheep Production and Development in Nepal

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ABSTRACT

Nepal has good prospects for sheep production but development programs for sheep have been inadequate. This paper highlights the country's research and development efforts and experiences over the past two decades. Major problems and collaborative research, including the exchange of information have been discussed and elaborated.

Nepal, a small land-locked country, is blessed with scenic grandeurs, deep gorges and fast-flowing rivers. It is, however, beset with transportation and communication problems.

Nepal has a total area of 147,200 sq km. Hills and mountains cover two-thirds of the country and the rest form the terai plains, the main crop producing areas of the country. The human population is 16.4 million in 1984 and the growth rate is 2.7%. The population density is 111 persons/sq. km. While the literacy rate is only 23% and the infant mortality, 152 per thousand live births (Central Bureau of Statistics 1986).

The Gross Domestic Product (GDP) of the country for 1984-1985 was Rs. 40.3 thousand million (CBS 1986). The share of agricultural products in the GDP is 53.8% of which the livestock contributes 15.2%. The contribution by small ruminants is about 3.84% (Pradhan 1986). Livestock is an inseparable component of traditional agriculture in the country. This is particularly for the people of the mountain regions who depend virtually on livestock for their daily needs.

Population Status

The sheep population in the country from 1986 to 1987 was 826 thousand which is 5.2% of the total livestock population of 15.8 million in the country. The original estimate of 2.1 million sheep has been corrected to 552 thousand in 1979 to 1980. The growth rate of sheep population during the years 1966 to 1969 was 2.2% per annum. It has improved to 2.6% during the years 1984-85 to 1986-87. The sheep population increases by 3.2 to 3.4% in the hills and mountains and decreased by 2.9% in the terai region (Table 1). The increase in the sheep population can be seen in the Central Development Region where major development efforts have been undertaken during the last decade.

Table 1. Trends in sheep population in different ecological and development regions of Nepal (10^3).[a]

Description	1984/85	1985/86	1986/87	% Change/ Annum
A. Ecological belt				
Mountain	351.9	363.5	376.2	+ 3.45
Hills	335.9	346.6	357.7	+ 3.25
Terai	97.4	97.9	91.8	-2.87
Total	785.2	808.0	825.7	+ 2.58
B. Development region				
Eastern	114.2	118.1	120.5	+ 2.76
Central	107.8	111.2	116.7	+ 4.12
Western	129.2	131.8	134.5	+ 2.05
Mid-western	377.5	391.3	399.2	+ 2.87
Far-western	56.5	55.6	54.8	-1.50
Total	785.2	808.0	825.7	+ 2.58

[a]Source: Department of Food and Agricultural Marketing Services 1987.

Economic Contribution

Sheep contributes only 2.0% (2,722) to the total meat production of the country, but it accounts for 94.0% of the total animal fiber production in the country (708.3 t).

The small ruminants are highly priced for manuring the fields in the western regions and for carrying loads in difficult mountain tracks of the mid-western and far-western regions of Nepal. It is estimated that 45.3% of the total manure production by sheep (5,600 t) is recovered for agricultural use by night camping and manure collection. The load carried by the sheep in the country is estimated to be 272.3 t/annum (Pradhan 1986).

The major economic impact of sheep lies in the volume of overseas export trade of the country. The export of woolen goods and carpets is about 22.7%. The total overseas trade (Rs. 254 million), and is a major foreign exchange earner. Although the pro-

Table 2. Physiographic distribution of different breeds of local sheep in Nepal.[a]

Physiographic Region	Altitude (above sea level)	Climate	Sheep (10^3) Breed	Number	%	Management System
Mountain						
•Trans Himalaya	above 2500	temperate/ sub-alphine	Bhanglung (Tibetian)	33.04	4.0	sedentary and transhumance
• High Mountain	above 2500	temperate/ sub-alphine	Barwal & (Jumli)	338.66	41.0	transhumance
Hill						
• Mid hill	1500-2500	temperate	Barwal	181.72	22.0	transhumance
• Lower hill	300-1500	sub-tropical	Kage	173.46	21.0	sedentary
Terai						
• Terai	below 300	sub-tropical/ tropical	Lampuchre/ (Lohia)	99.12	12.0	sendentary/ moving
	Nepal			826.0		

[a]Source: Pradhan 1986.

portion of exports has reduced from 49.3% in 1982-83 to 22.8% in 1984-84, the actual volume of trade has not been reduced. However, the trend is on the change. The contribution of carpet alone has reached the mark of 38.0% of the total export in 1986-87 (Rs. 630 million) and there are good prospects for increasing this. This total export has created, however a big demand for raw wool. The present demand of 3,000 t/annum is inadequate for the production limit of 708.3 million presently which is not entirely suitable for Tibetian style carpets based on the raw imported mainly from Tibet, Australia, and New Zealand.

Local Breeds

Only four breeds of local sheep are identified and these are Barwal, Kage, Lampuchhre, and Bhanglung (Pradhan 1986). Jumli and Lohia breeds have often been cited but not confirmed (Epstein 1977). The principal local breed of sheep is Barwal (63.0%) of the sheep population, which is being raised in the mountains under transhumance system of management (Table 2). This breed is used widely in the mid-western and far-western development regions for carrying loads and for manuring the field during the annual cycle of movement from mountains to lower hills.

The second important breed is a valley breed in the lower altitudes named as Kage (21.0% of the sheep population) which is prolific and adapted to warm and humid conditions of the lower hills. This breed is raised under confinement in agricultural areas of the south (Table 2).

Bhanglung is a Tibetian breed (14.0% of the sheep population) which is being raised in the Transhimalaya region of the north close to the boarder. Its wool is widely used for making Tibetian carpets. However, the population of this breed is limited by its narrow adaptability range.

Lampuchhre is the fourth found in the south (12.0% of the sheep population) and is a long-tail sheep adapted to the hot and humid conditions of Terai plains. This breed is closely related to the Kage, but its adaptive range is wider.

The mortality of local sheep (lambs and adults) is relatively high because of poor nutritional status and management, predators, plant poisoning, and disease and parasites (Table 3).

Research and Development

For the last two decades, efforts have been concentrated on infrastructure development for breed improvement and providing extension and animal health services in the major sheep production areas. Out of four sheep farms, the two in the mountains (Karnali Sheep Farm and Pansayakhola Sheep Farm) were established 2000 m above sea level to develop the mountain sheep Barwal. The other two were developed in the lower hills for Kage sheep.

The Bhanglung and Lampuchhre sheep in the terai plains

Table 3. Production parameters and reproductive characteristics of local breeds of sheep.

Parameter	Bhanglung (Tibetian)	Barwal	Kage	Lampuchhre	Reference
Birth weight (kg)	2.2	2.4	1.6	1.6-2.0	
Adult body weight (kg)	29.8	32.0	23.7	20.0-40.0	
Lambing (%)	61.5	76.1	118.2	115.0	
Lambing frequency per annum	1	1	1.5	1-1.5	
Adult mortality (%)	15-20	18.7	5.0-10.0	5.0-10.0	
Lamb mortality (%)	30.0-50.0	15.6-40.0	14.4-30.0	20.0-30.0	
Wool production (%)	0.8-1.0	0.94-1.2	0.387	0.3-0.5	
Fiber diameter (μ)	25-28 (14-70)	30 (14-64)	28-47 (10-144)	36.0-77.2	
Kemp fibre (%)	12-13	68	20-81	52.3-67.9	Epstein (1987)
Wool use	carpets/ rough garment	radi (woven belt)/ rough covers	medium quality covers & shawls	rough mats	

have only received animal health and advisory services.

Limited research efforts have been made on the evaluation of suitable exotic breeds to develop local sheep. The emphasis was on medium to fine wool in the high mountains, and meat and wool for the lower altitudes.

Exotic breeds that have been tried in Nepal are Polwarth and Merino D' Arles for the mountain regions, and Rambouillet, Polwarth and Border Leicester for the lower altitudes. For the past decade, crossbreeding and the evaluation of different crossbreds have been the major field of research in sheep. The following sections present a brief review of the past researches on sheep conducted in the country.

Improvement of Barwal sheep. In the mountain farms above 2,000 m, Polwarth sheep were used initially to improve wool production characteristics of Barwal sheep in terms of quantity and quality. The Polwarth rams showed poor libido under the transhumance system of management and the performance of crossbreds was not satisfactory. Considering the breeds available for mountains and transhumance system of management, the

Merino D' Arles from France (French Alps) was chosen for breeding in a Sheep, Goat and Wool Development Project financed by UNDP/FAO/HMGN. For the last six years, breeding work on these two farms were concentrated on the evaluation of crossbreds of Polwarth and Merino. The lambing percent of 85.7% milk Merino was found to be better than that of the Polwarth of 72.6% with a 50% level of exotic inheritance (Table 4). The Merino crossbreds weaned 0.54 lambs/ewe per annum while the Polwarth crossbred weaned only 0.41 lambs/ewe per annum. However, the performance of 25% Polwarth crossbred was comparable to the 50% Merino crossbred, but the quantity and quality of wool produced were inferior to 50% level crossbreds.

Wool production from 50% Polwarth crossbreds of 1.84 kg was better than from the 50% Merino crossbred (1.70 kg), but the difference was marginal. On the other hand, Merino crossbreds raised more live weight/ewe per annum (7.9 kg) than Polwarth crossbred (5.8 kg) under improved management systems. On the whole, the performance of both crossbreds was far from satisfactory as there was no improvement in live weight weaned/ewe per annum (5.8-7.9 kg) compared to the local Barwal (8.8 kg), except for the improvement in quantity and quality of wool produced. It was clear that the transhumance system of migration placed stresses on the performance of crossbreds for production, compared to the performance of crossbreds under the confinement systems of management.

Improvement of Kage sheep. In the lower hill areas, Kage is the important breed which is raised under a stationary management system. Kage sheep are small but their prolificacy is high. The lambing percent is 118.2%. The main objective for crossbreeding with Rambouillet, Polwarth, Merino D' Arles, and Border Leicester with the Kage is to produce dual purpose sheep for wool (apparel or carpet type) and for meat. Rambouillet was initially introduced in Chitlang Sheep Farm from the U.S.A. and Polwarth in Pokhara Livestock Farm from Australia. At a later stage, Merino D' Arles was introduced in Chitlang Sheep Farm and Border Leicester in the Pokhara Livestock Farm. Border Leicester was introduced to improve Kage sheep for carpet wool and meat production characteristics.

The lambing percentage with 50% exotic inheritance of Rambouillet was 112.8% which was better than Polwarth crossbreds with 101.5% and Border Leicester crossbreds with 85.1% (Table 5). The latter had higher lamb mortality (23.8%) compared to Rambouillet crossbred (17.2%) and Polwarth crossbred (9.7%). This indicated that Border Leicester crossbreds need better management.

In terms of wool production, Polwarth crossbreds produced 1.3 kg wool/annum which was higher than that produced by the Rambouillet crossbreds (1.04 kg) and the Border Leicester crossbreds (1.01 kg). However, the latter had a better carpet type

Table 4. Comparative performance of different crossbreds in high mountains of Nepal.[a]

Parameter	Polwarth × Barwal (50%)	Polwarth × Barwal (25%)	Merino D' Arles × Barwal (50%)	Polwarth (100%)	Merino (100%)	Barwal (100%)
A. Reproductive characteristics						
Lambing %	72.6	75.4	85.7	74.5	87.8	76.1
Number of lambings/ewe/annum	0.99	1.09	0.99	1.0	1.0	0.94
Lambing interval (ewe/annum)	12.1	11.0	12.1	12.0	12.0	12.8
Number of lambs weaned/ewe/annum	0.41	0.59	0.54	0.42	0.57	0.57
Number of lambs born per ewe/annum	0.72	0.82	0.85	0.70	0.88	0.74
B. Body weight						
Birth weight (kg)	2.95	2.20	3.72	2.71	3.17	2.68
four months weight (kg) (weaning wt.)	14.19	10.59	14.58	12.75	15.0	15.4
Six months weight (kg)	16.94	NA	18.4	15.45	15.45	18.9
12 months weight (kg)	22.10	NA	27.69	20.0	26.4	29.35
Adult weight (kg)	35.51	30.9	41.0	37.3	36.0	43.9
C. Mortality						
Lambs (%)	30.8	21.3	30.8	33.0	31.0	15.6
Adults (%)	18.1	18.0	6.7	6.7	11.1	18.7
D. Production						
Wool (kg)	1.842	1.470	1.703	2.588	2.420	0.942
Stable length (cu) (6 months average)	8.34	9.40	NA	7.59	3.62	8.46
Total weight of lambs weaned/ewe per annum	5.82	6.25	7.9	5.36	8.55	8.78

Source: Karnali Sheep Farm, Annual Report 1985 (three years average).
Pansayakhola Sheep Farm, Annual Report 1986-87 (five years average).

Table 5. Comparative performance of different crossbreds at lower hills of Nepal (Chitlang Sheep Farm and Pokhara Livestock Farm).

Parameter	Polwarth × Kage (50%)[a]	Polwarth × Kage (75%)[a]	Border Leicester × Kage (50%)[a]	Rambouillet × Kage (50%)[b]	Rambouillet × Kage (75%)[b]	Kage (ave.)
A. Productive characteristics						
Lambing (%)	101.5	92.7	85.1	112.8	108.9	118.2
Number of lambing/ewe/annum	1.02	0.96	0.88	0.94	0.89	1.09
Lambing interval (months)	10.8	12.1	11.3	N.A.[c]	N.A.[c]	11.4
Number of lambs born/ewe/annum	1.06	1.02	1.02	1.59	1.14	1.35
Number of lambs weaned/ewe/annum	0.92	0.83	0.84	1.04	0.93	1.11
B. Body weight						
Birth weight (kg)	2.5	2.5	2.7	2.0	2.6	1.6
4 months weight (kg)	14.6	18.1	15.1	14.4	13.8	7.9
6 months weight (kg)	17.8	16.9	14.2	N.A.[c]	N.A.[c]	N.A.[c]
12 months weight (kg)	21.9	21.2	17.9	N.A.[c]	N.A.[c]	N.A.[c]
Adult weight (kg)	28.7	29.2	30.5	28.6	37.1	23.7
C. Mortality						
Lambs (%)	9.7	12.4	23.8	17.2	11.0	14.4
Hoggets (%)	9.5	6.2	15.9	N.A.[c]	N.A.[c]	26.7
Adults (%)	2.6	3.0	3.0	18.4	18.1	5.1
D. Production						
Wool production (kg)	1.29	1.48	1.08	1.04	1.16	0.39
Staple length (cm) (ave. six months growth)	11.42	11.41	13.6	N.A.[c]	8.34	8.848
Total weight of lambs weaned/ewe/annum	13.4	15.1	12.7	14.94	12.8	10.82

[a]Pokhara Livestock Farm, Annual Report 1985 (three years average).

[b]Chitlang Sheep Farm, Annual Report 1985 (seven years average).

[c]Not applicable.

wool which is preferred by the carpet makers.

In terms of live weight weaned per ewe per annum, Rambouillet crossbreds performed better (14.9 kg) than Polwarth (13.4 kg), the Border Leicester (12.7 kg), and the Kage (10.8 kg). Both Rambouillet and Border Leicester tend to have higher adult mortality rates which also emphasizes the need for better management.

Management. The poor performance of different crossbreds compared to the Barwal under a transhumance system of management must be given much concern especially since their performances under farm conditions are comparatively better. In the transhumance system, lamb losses of 32.5 to 52.0% and an adult mortality of up to 19.7% have been reported in western Nepal (Pradhan 1978; Karki 1984). Major losses of up to 64% of the total mortality were due to mismanagement, predators, poisonous plants, accidents, and nutritional stress while disease and parasites accounted for only 36% (Karki 1985) of the losses. In the government flock at the Pansayakhola Sheep Farm, losses of up to 40% of the total loss were due to predators such as leopards and jackals. More attention should be given to reduce the losses.

Diseases and parasites. Major diseases of sheep are Pasteurella, pneumonia, enterotoxaemia, foot rot, foot and mouth disease, sheep pox, liver fluke, and round worms in internal parasites; and mange, tick and lice in external parasites. The economic impact of these diseases and parasites have not yet been assessed properly nor has control measures been tested effectively.

Sheep development. The Government of Nepal has given priority to sheep development in the mountains as the people rely heavily on livestock for food, manure and power. Six districts in the high mountain region have received top priority for sheep development. The main efforts were directed towards animal health services, pasture development, breed improvement, extension and training services. Sheep development programs are also conducted in 22 districts of the midhill and lower hill regions with reference to breed and feed improvement of animal health services and extension services.

Despite the priority being given by the government, sheep development in the hills has not progressed substantially to the satisfaction of economists and planners. Success of sheep development program lies in solving the problems of transhumance system of management, nutritional stress, propagation of adaptive breeds, development of alternative means of transport in the mountain tracks, improvement of mountain tracks, passes and possibility roads, and also, in correcting the perception of people towards production.

Major Problems and Issues

The major problems and issues encountered in sheep development in Nepal are as follows:

- inadequate feed supply;
- traditional management system;
- inadequate recognition of sheep genetic resources and breeding systems;
- predators;
- poisonous plants;
- inadequate marketing outlets;
- inexperienced shepherds;
- inadequate health and extension services and technical backstoppings;
- unbalanced priorities; and
- inappropriate taxation system.

Inadequate feed supply. Land holding per family in the mountains is just too small to produce food crops as well as maintain a large number of animals required for manure, power and food. Naturally, the farmers have adopted transhumance systems of management to make the best use of available feed resources in the stock route, fields, forest, and on summer pastures. Feed supplies during the summer (monsoon period) are adquate to maintain the population but are insufficient during winter period (September to March) when the sheep are in late pregnancy. This explains the root cause of heavy lamb losses encountered by the moving flocks.

Traditional management system. Major losses of up to 64% in the sheep have been reported due to mismanagement of animals and carelessness by shepherds.

Poor genetic resources and breeding systems. While the local sheep are adapted to the environment, they are not very productive. Survival, rather than productivity, is the main theme of breeding system under the prevailing conditions. The breeding system adopted by the farmers are very poor, sturdy animals are often castrated for meat and are used in transportation, not for breeding purposes. Additionally, there is a shortage of good quality breeding animals.

Predators and poisonous plants. These are major problems for the sheep farmers in the transhumance system. Losses of up to 20 to 40% are often encountered in the forest tracks especially those close to the wild life sanctuary.

Inadequate marketing outlets. These have not been developed in the mountains to give the best price to the farmers for their produce. As a consequence, farmers have to sell the animals in the villages away from the main business centers of the towns at reduced prices.

Inexperienced shepherds. Inexperienced shepherds are often the root cause of poor management, especially of lambs. The available animal health, advisory services and technical backstoping are far from satisfactory. Also, the infrastructure development is inadequate to cater to the needs of farmers who are always on the move in search for grazing and with the dictates of climate.

Unbalanced priorities. The biggest hurdle in sheep development is the unbalanced priorities set by the farmers for use of animals for transportation and for manuring the field against the production of wool and meat within the traditional agricultural systems.

Further, the growth of the carpet industry was not based on wool produced in the country but on imported wool from Tibet and other countries. Local farmers have only received limited benefits.

Taxation. Most often, local taxes against grazing in the forest are levied on kind, for example, lambs rather than cash, which discourage farmers to move their flocks to places where feeds are available for the animals.

Priorities

Sheep raising in Nepal is sustained only for three seasons. First, it is a traditional profession of certain ethnical communities. Second, there is no alternative means for livelihood. Third, it is a means to maintain the agricultural system of the hills.

To make sheep production a viable entity, major hurdles and problems have to be tackled within the limitations of available resources in the country. Future research and development on sheep must give priority to solve the basic problems of farmers and to fulfill the country's aspirations by 2000 AD. The following priorities for sheep research and development need attention:

- Evaluation of sheep genetic resources of the country
- Evaluation of production systems of sheep adopted by farmers in various physiographic regions, to develop viable production systems for different ecological zones to meet the basic needs of the farmers and for export opportunities.
- Evaluate the breeding schemes that have been launched for the last two decades and identify the suitability for the production of crossbreds and breed establishment appropriate for different environmental conditions.
- Study on the economic impact of major diseases and parasites on production and formulation of appropriate health management systems.
- Study on the traditional marketing system and trade routes of sheep and wool in the country. In addition, there is a need to identify appropriate marketing outlets for the sheep raisers as well as provide incentives to make available their produce to the cottage industries.
- Evaluation of conventional and non-conventional feed

resources of the country, suitable pastures and fodder production system was to make feeds available all the year round in the different ecological zones of the country.
- Critical studies of traditonal management systems of sheep especially transhumance and confinement system to identify the most appropriate measures to minimize losses of animals.
- Identification of support services required to make sheep farming an economically viable system in the country.
- Development of a national data of genetic and feed resources, production systems, epidemiology of diseases and parasites, major research breakthroughs and development experiences in the country.

Collaborative Research and Exchange of Information

Collaborative research, and exchange of ideas and information on research and development experiences will be most beneficial for the following:

- Evaluation of genetic and feed resources.
- Study on the production systems for sheep.
- Creation of a data base for the: exchange of information on the performance of different breeds of sheep, feed resources, diseases, and parasites as well as successes and failures of sheep development programs and for the exchange of genetic materials for research and development.
- Rendering of support to the research and development institutions in the country in terms of funds, technical manpower research facilities and technology generation.
- Exchange of scientists and development experts with other countries in the region.

The development of small ruminants has a great future for small countries like Nepal with an average land holding size of less than 0.25 ha and a growing human population. However, the research base is too meager and needs much attention and support. The recent establishment of the National Agriculture Research and Service Centre under the Ministry of Agriculture is a milestone in this direction.

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Sheep Production and Development in the Philippines

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ABSTRACT

This paper presents the results of a survey in sheep production systems in the Philippines. During the last 50 years (1936-1987), only about 33 completed research projects were documented and retrieved. In most cases, these projects used sheep just as a test animal rather than to improve the performance of the animals per se through improvement of the production systems. The indigenous sheep were raised basically like goats. They are either tethered, grazed or raised in semi-confinement. Sheep are raised merely for meat. The average mature weight is 29 kg. The liveweight of male sheep was significantly higher than ewes by about 25%. In both sexes, white was the predominant color although brown and brown and white were also available. Coarse wool covering was conspicuous in the majority of animals sampled. There was a wide genetic variability of the quantitative and qualitative traits. These heterogeneity suggests that the animals resulted from the mating of several introduced breeds since the Spanish era. The high variability and significant regression and correlation values could very well indicate the potential for improving performance through breeding and management. The results enable the formulation of priority areas for future research and development.

A Filipino farming community is traditionally composed of crop-farmers with an average of six members. Usually, two to three members are either idle or unemployed. Sheep production is a com-

ponent of integrated crop farming and provides the following: (a) employment to idle farm family members; (b) additional income from sales of stocks; (c) optimum utilization of farm resources, i.e., farm by-products as feed for sheep; and (d) mutton or lamb to improve the nutrition of the farm family.

The country's human population has been growing geometrically against the livestock population. As a result, in 1976 — 1982, the per capita consumption of animal products was below the required nutritional standard. This is due to the decline in domestic meat production and the prohibitive prices which were detrimental to the majority of consumers. To fulfill this deficiency, the country has to import meat particularly beef. Locally produced mutton could fill the demand for beef.

In 1985 — 1986, beef imports were valued at ₱53 million and ₱58 million for 1,700 and 2,500 t, respectively. On the other hand, about ₱16 million worth of mutton and chevon was imported in 1981 — 1985. These importations contributed to the significant drain in our foreign exchange. Based on the country's current human population of 54 million, the beef deficit would amount to 133,000 t annually.

Sheep, as a commodity, has a very low priority in the national research and development (R and D) programs. While sheep raising dates back to the Spanish era, its economic importance is not given due recognition. The country continuously imports mutton from Australia, New Zealand, and the U.S.A.

Filipino farmers can profitably raise sheep for mutton or lamb if given the right support in terms of appropriate support policies. The biological suitability of sheep to fit existing farming systems is a built-in factor for the species to attain the same leverage and acceptance as traditional livestock for the production of meat.

STATE OF THE ART

Problem Areas and Research

As of December 1987, very few R & D projects have been implemented or completed to explore the economic potential of sheep.

Observations on husbandry practices and biological adaptability of sheep suggested that less problems were associated with sheep management, nutrition, and health relative to goat. These claims however, necessitate scientific verification.

Research and development efforts on sheep must therefore include the improvement of the animals through the use of appropriate breeds and breeding systems, feeding and nutrition, flock management, and health programs. Similarly, development of strategies to promote sheep raising and utilization of mutton through improved technology transfer, credit and marketing must be considered.

Problem Areas Attended To

A meager sum of 33 documented research projects on sheep have been implemented for the last 50 years (1936 — 1987).

Area	No. of Research Studies
Nutrition	12
Breeding and reproduction	3
Management systems	4
Physiology and anatomy	5
Animal health	2
Product evaluation, processing, and utilization	4
Socioeconomics	3
Total	33

Data obtained between 1983 to 1985 from the ASEAN Goat and Sheep Research and Extension Center (AGSREC) provided data on reproduction (Table 1). The recorded performance of male and female lambs for one year is shown in Table 2. Generally, the male lamb was heavier than the female lamb from birth to one year (Table 3).

SHEEP RESOURCE ASSESSMENT

A technology assessment study of the prevailing production systems was conducted to identify technologies on sheep production and to categorize these technologies according to the level of development and adoption from the R & D center to satellite selected government farm and finally, the station farmer cooperators.

Table 1. Performance of the Philippine sheep at the ASEAN Goat and Sheep Research and Extension Center.

Parameter	No. of Observations	Range	Mean
Age at puberty (days)	20	282-553	396
Weight at puberty (kg)	20	14-24.5	19.5
Age at 1st lambing (days)	20	432-703	546
Litter size			
1st lambing	85	1-2	1
2nd lambing	53	1-2	1
3rd lambing	15	1	1
Average interval of three lambing (days)	16	193-296	218

Table 2. Average daily gain of male and female lambs.

	Average Daily Gain (g)	
	Male	Female
Day old — 3 months	75	65
Three months — 12 months	34.2	53.1
Day old — 12 months	56.1	43.5

Table 3. Weight gain of sheep (from birth to 12 months age).

Sex	Birth Number	Birth Month Wt. (kg) (kg)	Three Month Weaning Wt. (kg)	12-Month Weaning Wt. (kg.)
Male	10	2.5	8.4	23.0
Female	15	2.0	8.5	17.9

Field assessment through interviews and site visits revealed that technologies or practices on sheep raising adopted at the various R & D stations were basically similar in goats. Despite several extension programs, improved management practices were not readily adopted even by farmers living within the stations. Generally, farmers reared sheep just like goats (Faylon et al. 1986).

Stock Identification

Out of the 751 head of mature (one year old and above) sheep, 86.3% were classified as indigenous stock. Purebred Barbados Blackbelly and their upgrades of varying blood composition represented 1.6% and 11.3%, respectively, of the total sheep population sampled. A small percentage (0.8%) of the samples were crossbreds of exotic breeds such as Shropshire, Rambouillet and Wiltshire.

Stocks with unknown pedigree, but which are already adapted to local conditions, were classified as the Philippine sheep. Stocks classified as purebreed, crossbreed, and upgrade were identified based on the information given by the sheep owners or raisers.

Characterization

Quantitative traits. Table 4 shows the average bodyweight, body length at shoulder points, height at withers, heartgirth, ear length, and tail length of the Philippine sheep by sex. Mean values for all quantitative traits considered were consistently higher ($P < 0.05$) in the males than in the females. Average weight of adult male sheep (31.8 kg) was found to be significantly heavier than that of the adult female (25.4 kg) by approximately 25%.

Mean differences in all quantitative traits considered in the males (Table 5) and the females (Table 6) were found to be in-

Table 4. Quantitative traits of Philippine sheep.

Trait n = 648	Sex[a] Male n = 177	Female n = 471	Grand Mean
Body weight (kg)	31.80[b]	25.41[c]	28.61
Body length (cm)			
At poll	90.52[b]	86.27[c]	88.40
At shoulder	59.49[b]	56.52[c]	58.01
Height at withers (cm)	59.71[b]	55.31[c]	57.51
Heart girth (cm)	74.46[b]	69.63[c]	72.04
Ear length (cm)	9.84[b]	9.32[c]	9.58
Tail length (cm)	17.93[b]	15.24[c]	16.59

[a]Means between sex within traits with common letters are not significantly different (P > 0.05).

Table 5. Comparison of quantitative traits in various male sheep.

Trait	Breed Type (Mean ± Standard Error) Philippine Sheep n = 177	Pure Barbados Blackbelly n = 6	Grade Barbados Blackbelly n = 23	Others n = 2	Grand Mean
Body weight (kg)	31.80 ± 0.72	46.83 ± 3.78	36.83 ± 2.01	40.00 ± 7.00	32.81 ± 0.69
Body length (cm) at poll	90.52 ± 0.63	89.00 ± 8.67	92.15 ± 1.63	101.50 ± 13.00	90.76 ± 0.59
at shoulder	59.49 ± 0.59	65.33 ± 2.43	60.57 ± 1.01	65.00 ± 10.00	59.84 ± 0.54
Height at withers (cm)	59.71 ± 0.40	66.93 ± 2.49	61.19 ± 1.09	60.50 ± 5.50	50.09 ± 0.39
Heart girth (cm)	74.46 ± 0.72	83.50 ± 2.38	78.41 ± 1.54	81.50 ± 4.50	75.22 ± 0.75
Ear length (cm)	9.84 ± 0.17	9.25 ± 0.25	9.40 ± 0.24	10.00 ± 0.00	9.75 ± 0.15
Tail length (cm)	17.93 ± 0.25	19.67 ± 2.59	17.54 ± 1.66	16.00 ± 1.00	17.92 ± 0.34

significant (P < 0.05). Comparison between sexes of the different quantitative traits within the purebreed Barbados Blackbelly, Barbados Blackbelly upgrades, and crosses are shown in Table 7.

Upgraded male sheep with the Barbados Blackbelly were significantly heavier and longer than the female upgrades. Likewise, they possessed significantly higher heart girth, higher height at withers, and longer ears and tails than the female upgrades. Significant regression coefficients were obtained suggesting that the mature body weight can be predicted with relative accuracy using information on either their body length, height at withers, heartgirt, or a combination of such parameters. Table 8 shows the approximate live bodyweight of sheep based on measurements of heart girth and shoulder body length. Similarly, with the quantitative traits considered, there were relatively high

Table 6. Comparison of quantitative traits in various female sheep.

Trait	Breed Type (Mean ± Standard Error)				Grand Mean
	Philippine Sheep n = 177	Pure Barbados Blackbelly n = 6	Grade Barbados Blackbelly n = 23	Others n = 2	
Body weight (kg)	25.41 ± 0.27	30.92 ± 0.94	28.59 ± 0.66	25.25 ± 2.93	25.81 ± 0.25
Body length (cm) at poll	86.27 ± 0.35	90.42 ± 1.25	86.85 ± 0.87	84.75 ± 4.17	36.37 ± 0.32
at shoulder	56.52 ± 0.35	64.00 ± 4:49	58.80 ± 0.62	55.50 ± 2.72	56.79 ± 0.31
Height at withers (cm)	55.31 ± 0.25	59.83 ± 0.87	57.39 ± 1.03	55.75 ± 2.32	55.58 ± 0.25
Heart girth (cm)	69.63 ± 0.30	71.83 ± 0.95	71.93 ± 0.75	68.50 ± 4.99	69.88 ± 0.28
Ear length (cm)	9.32 ± 0.11	9.50 ± 0.13	9.17 ± 0.22	11.00 ± 0.71	9.34 ± 0.12
Tail length (cm)	15.24 ± 0.16	16.42 ± 1.39	13.68 ± 0.58	17.50 ± 1.19	15.06 ± 0.27

Table 7. Quantitative traits of purebred and grade Barbados Blackbelly.

Trait	Purebred Barbados Blackbelly		Grade Barbados Blackbelly	
	Male n = 6	Female n = 6	Male n = 23	Female n = 23
Body weight (kg)	48.83[a]	30.92[b]	36.83[a]	28.59[b]
Body length (cm)				
at poll	89.00	90.42	92.15[a]	86.85[b]
at shoulder	65.33	64.00	60.57	58.80
Height at withers (cm)	66.93	59.83	61.19[a]	57.39[b]
Heart girth (cm)	83.50[a]	71.83[b]	78.41[a]	71.93[b]
Ear length (cm)	9.25	9.50	9.40	9.17
Tail length (cm)	19.67	16.42	17.54	13.68

Different letters indicate significant difference ($P < 0.05$) between sex within stocks.

correlation coefficients. This suggests that the expression of these traits are governed by common factors.

The Philippine sheep gave on the average, the following data: 28.6 kg body weight, 88.4 cm body length, 58.0 cm body length, 57.5 cm height at withers, 72.0 cm heart girth, 9.6 cm ear length, and 16.6 cm tail length (Table 4). A prominent sex dimorphism in favor of the male was observed. Average values of the quantitative traits for the performance were found to be comparable to improved sheep. The generally high variability and the significant regression and correlation values obtained from the various quantitative traits indicate that such traits, through the application of

Table 8. Approximate body weight of sheep (kg).

		Heart girth (cm)										
		50	55	60	65	70	75	80	85	90	95	100
B	50	14.92	17.34	19.77	22.19	24.62	27.04	29.47	31.89	34.32	36.74	39.17
o s	55	16.32	18.75	21.17	23.60	26.02	28.45	30.87	33.30	35.72	38.15	40.57
d h	60	17.73	20.15	22.58	25.00	27.43	29.85	32.28	34.70	37.13	39.55	41.98
y o	65	19.13	21.56	23.98	26.41	28.83	31.26	33.68	36.11	38.53	40.96	43.38
l u	70	20.54	22.96	25.39	27.81	30.24	32.66	35.09	37.51	39.94	42.36	44.79
e l	75	21.94	24.37	26.79	29.22	31.64	34.07	36.49	38.92	41.34	43.77	46.19
n d	80	23.35	25.77	28.20	30.62	33.05	35.47	37.90	40.32	42.75	45.17	47.60
g e	85	24.75	27.18	29.60	32.03	34.45	36.88	39.30	41.73	44.15	46.58	49.00
t r	90	26.16	28.58	31.01	33.43	35.86	38.28	40.71	43.13	45.56	47.98	50.41
h	95	27.56	29.99	32.41	34.84	37.26	39.69	42.11	44.54	46.96	49.39	51.81
(cm)	100	28.97	31.39	33.32	36.24	38.67	41.09	43.52	45.94	48.37	50.79	53.22

Note: If heart girth equals 60 cm and body length equals 90 cm, then body weight equals 31.01 kg.

judicious breeding and appropriate management, could be greatly improved.

Qualitative traits. The results on the qualitative traits are presented in Table 9.

Male sheep were found to be predominantly Roman-nosed (77.4%) while the ewes showed an almost even frequency for both face type (straight and Roman-nosed). Rams are mostly horned (70.1%) while some (29.9%) are polled. All of the ewes evaluated were polled (98.9%). Ears in both sexes were mostly erect. Generally, all the animals sampled show thin-tail characteristics.

In both sexes, white was the predominant color although brown and brown and white combinations were noted. Coarse wool covering was apparent in majority of the animals (male — 85.9%, female — 79.0%). A very small percentage of the population had hair covering. The coarse wool predominantly cover the body and neck area (Table 10). However, upgrades with Barbados Blackbelly blood had necks covered with hair.

The results revealed a relatively wide genetic variability of the qualitative traits in sheep. This heterogeneity in phenotypic traits suggests that the country's indigenous stock probably resulted from the use of several breeds introduced since the Galleon Trade era.

Production System

Out of the 114 raisers interviewed, 34.3% practiced integration of sheep with crop farming. Of those, 6.2% also raised fish and/or

Table 9. Qualitative traits of the Philippine sheep.

Trait	Male		Female	
	Frequency	Percentage	Frequency	Percentage
Face:				
Straight-nosed	40	22.6	235	49.9
Roman-nosed	137	77.4	236	50.1
Horn:				
Horned	124	70.1	5	1.1
Polled	53	29.9	446	98.9
Ear:				
Erect	177	100	452	96.0
Rudimentary	0	0	19	4.0
Coat color:				
White	86	48.6	172	36.5
Color combination	50	28.2	139	29.5
Brown	41	23.2	160	34.0
Body cover:				
Wool	152	85.9	471	79.0
Hair	3	1.7	2	0.4
Combination	22	12.4	97	20.6

Table 10. Frequency and percentage of all sampled sheep with mature body weight according to wool location.

Wool Location[a]	Frequency	Percentage
NB	407	57.6
NUB	89	12.6
B	169	23.9
LNUB	12	1.7
LNB	17	2.4
UB	10	1.4
LB	1	0.1
FNB	1	0.1
FLNB	1	0.1
Total	707	

[a]Includes those with "wool" and "combination" body cover.
Legend:
F — Face
L — Legs
N — Neck
B — Body (lateral & dorsal side of the torso)
U — Underbelly

other livestock. Raisers who integrated sheep solely with other livestock and/or fish accounted for 31.7% of the total respondents.

Management Systems

Feeding management. The feeding systems was mainly extensive. Unimproved pastures constituted the major source of feed for sheep in 95 out of the 114 farms (83.3%) surveyed. Of these, about 24.5% were under plantations with other cash crops (Table 11). Cultivation of improved grasses was minimal in both open areas (13.2%) and under plantations (3.5%).

Majority of the farmers (77.4%) practiced continuous grazing. Only 3.5% and 6.1% followed zero and rotational grazing, respectively. The rest of the farmers (13%) combined these grazing systems. In general, the animals were allowed to graze 24 hours a day.

Concentrate feeds were provided by 48% of the farmers while 46.5% gave crop residues to their animals. Concentrates and even crop residues, however, were offered to the animals only when available.

Breeding management. Based on the interviews conducted, farmers preferred to keep breeding ewes and disposed off the rams for the market or slaughter. Farmers generally selected the ram, rather than the ewe, for breeding (Table 12).

Fifty-four percent (54%) of the farmers did not take into consideration the age of the female lambs as a criterion for first mating, whereas 33.3% allowed first mating at an age of eight

Table 11. Pasture characteristics, utilization, and feeding systems observed in sheep farms.

Feeding Practice and Pasture Characteristic	Frequency	Percentage
1. Type of pasture, n = 114		
a. Open	82	
Unimproved		58.8
Improved		13.2
b. Under plantation crops	32	
Unimproved		24.5
Improved		3.5
2. Pasture area, n = 114		
Above 7 ha	36	31.5
7 ha and below	78	68.5
3. Stocking rate, n = 94		
Above 7 head/ha	40	42.5
7 head/ha and below	54	57.4
4. Grazing system, n = 114		
Continuous	88	77.4
Rotational	7	6.1
Cut and carry	4	3.5
Combination	15	13.0
5. Grazing time, n = 114		
Continuous	98	39.3
Limited	12	11.0
6. Concentrate feeding, n = 114		
Yes	55	48.0
No	59	52.0
7. Crop residue feeding, n = 114		
Yes	53	46.5
No	61	53.5

months and below, and 12.4% farmers delayed first mating beyond eight months. Age was likewise not considered at first mating for the male lambs. Lack of farm infrastructures, such as pens and subdivisional fencing prevented the farmers from controlling the age at first mating.

No definite male to female ratio was followed by 48.2% of the farmers, while 47.4% claimed they employed a male to female ratio greater than 1:30. Contrary to the observations of Villegas (1950), the majority of the farmers (62.29) observed that mating occurred throughout the year while 24.5% noted the mating season during the last half of the year.

Uncontrolled mating was evident in most farms (68.4%). Only about 31.6% of the farms practiced upgrading. Lack of farm facilities prevented farmers from implementing a sound mating system. Likewise, the incidence of inbreeding cannot be discounted as farmers do not have ready access to source of replacement rams.

Due to the absence of farm records, most farmers (66.7%)

Table 12. Breeding practices and mating habits of sheep.

Practice/Habit n = 114	Frequency	Percentage
1. Stock selection		
Yes	105	92.1
No	9	7.9
2. Stock culling		
Yes	9	7.9
No	105	92.1
3. Age at first mating		
Male		
Uncontrolled	62	54.4
Eight months and below	27	23.7
Above eight months	25	21.9
Female		
Uncontrolled	62	54.4
Eight months & below	38	33.3
Above eight months	14	12.4
4. Male: Female ratio		
Below 1:30	54	47.4
1:30	3	2.5
Above 1:30	2	1.8
Not practiced	55	48.2
Mating season		
January — June	15	13.2
July — December	28	24.5
Year round	71	62.2
5. Mating time		
Day	38	33.3
Night	22	19.3
Day and night	14	12.3
Unknown	40	35.1
6. Mating system		
Upgrading	31.6	
No system	78	68.4

were unable to state the lambing rate and litter size of their flocks. Among those who knew, 16.6% and 11.4% claimed to have observed twice and once lambing per year, respectively. Only 29.8% of the farmers knew the average litter size of their ewes. Single births were observed to be common.

Diseases and flock health management. Infectious diseases (59.1%), metabolic disorders (13.1%), and accidents (27.3%) were among the three major causes of mortality reported by 99 sheep farmers (Table 13). Of the infectious diseases, diarrhea, and pneumonia were the most prevalent causes, followed by hemorrhagic septicemia. Bloat was the most common cause of mortality in sheep. Dog and snake bites were reported to be the most common accidents that caused death in sheep farms.

There was no definite pattern on the causes of mortality due to season. About 82.4% of the farmers did not keep mortality records. Among those who observed mortality, 19.3% claimed that most deaths occurred in July — December.

Of the 65 respondents, 83% reported the presence of endoparasites while 17% reported the presence of ectoparasites.

Table 13. Reported incidence of parasitism and other causes of mortality in sheep.

Parasites, Diseases, and other Causes of Mortality	Frequency	Percentage
A. Incidence of parasitism, n = 65		
1. Ectoparasites	11	16.92
2. Endoparasites	54	83.08
B. Other causes of mortality, n = 99		
1. Infectious diseases		
Diarrhea	21	21.70
Pneumonia	17	17.17
Hemorrhagic septicemia	8	8.08
FMD	6	6.06
Tetanus	2	2.02
Others		4.04
2. Metabolic disorder (bloat, cellophane disease)	15	13.13
3. Accidents (snake & dog bites, vehicular accidents)	26	27.27

Among the preventive health practices (Table 14), deworming was most widely practiced by farmers (46.5%), followed by vaccination (15.8%) and isolation of sick animals (14.1%). Deworming schedules were highly variable among the farms; some farmers gave dewormers only when needed while others gave at different frequencies per year. Very few farmers sprayed against ectoparasites.

Housing. Majority of the farmers (84.2%) provided shelter for their animals. The building structures were mainly made up of

Table 14. Herd health practices.

Practices	Adaptor		Nonadaptor	
(n = 114)	Frequency	Percentage	Frequency	Percentage
Deworming	53	46.5	61	53.5
Vaccination	18	15.8	96	84.2
Isolation of sick animals	16	14.1	98	85.9
Spraying	6	5.3	108	94.7

Table 15. Housing and fencing provisions found in sheep farms.

Provision	Frequency	Percentage
Housing, n = 114		
With	96	84.2
Without	18	15.8
Housing materials, n = 96		
a. Roofing:		
GI sheet	42	43.8
Local materials	54	56.2
b. Structure:		
Concrete	10	10.4
Local materials	86	89.6
Floor Space, n = 96		
Square meter/animal		
1	14	19.4
1-2	11	15.3
2	47	65.3
Floor structure, n = 96		
a. Ground level		
Soil	40	41.7
Concrete	15	15.6
b. Elevated		
Bamboo	31	32.3
Wood	10	10.4
Floor height, n = 96		
Ground	55	50.0
Below 1 meter	3	3.1
1 meter	31	32.3
1 meter	7	7.3
Fencing materials, n = 113		
Wire	57	50.0
Live fence	2	1.8
Local materials	21	18.4
None	33	29.8
Fence height, n = 80		
1 meter	17	21.3
1 meter	63	78.7

local materials, except for roofing where 43.8% of the farmers used galvanized iron sheets(Table 15).Shelters provided for sheep were either abandoned buildings intended for other animals or buildings commonly used with goats.

In 42.7% of the 96 farms, flooring was elevated at 1 m from the ground. Bamboo was more commonly used than wood as slatted flooring material. The floor space allowance varied between 1 and 2 m/animal.

About 70.2% of the farmers fenced their areas using wire with approximately 1 m height from the ground.

Other husbandry practices. Weaning, identification, tail docking, flushing, and hoof trimming were practiced by less than 10%

of the farmers (Table 16). Castration was practiced by only 26.3% of the farmers. Of the 34 farmers who claimed to shear their animals, 27.2% sheared once a year while 2.6% sheared twice a year.

Majority of the farmers (64.9%) simply let their animals loose to graze while 22.8% practiced semi-confinement. About 12.35 tethered their animals. Only 20 out of 114 farms kept records. Sheep raisers did not keep records nor did they have any definite production programs. Generally, sheep raisers did not follow recommended husbandry and health management.

Socioeconomics

Number of years raising sheep. Most of the farmers (47.7%) had been raising sheep for at least five years. Generally however, the sheep were taken cared of just like goats. The animals were either tethered or just let loose to feed on any available grasses or weeds in vacant lots or under plantation crops. Sheep were raised primarily in the backyard. They were being kept by the farmers for the sake of owning one and were being slaughtered during special occasions.

Farm location. Generally, sheep farms were very close to the main road (less than 3 km from the main road) and not more than 5 km from the public markets. Farmers kept their animals close to their houses for safety reasons.

Reasons for raising sheep. Sheep farms, as in any livestock projects, were usually owned individually by the smallhold farmers (78%) as shown in Table 17. Institutional herds comprised 15% of the total respondents raising sheep. Sheep from institutions were

Table 16. Husbandry practices adapted by sheep raisers.

Practice	Adaptor		Nonadaptor	
(n = 114)	Frequency	Percentage	Frequency	Percentage
Weaning	9	7.9	105	92.1
Identification	9	7.9	105	92.1
Castration	30	26.3	84	73.7
Tail docking	2	1.8	112	98.2
Flushing	2	1.8	112	98.2
Isolation prior to lambing	16	14.0	98	86.0
Lambing assistance	9	7.9	105	92.1
Shearing	34	29.8	80	70.2
Hoof trimming	11	9.6	103	90.4
Record keeping	20	17.6	94	82.4
Confinement[a]	26	22.8	74	64.9

[a]12.3% practiced tethering.

Table 17. Type of ownership and reasons for raising sheep.

Item	Frequency	Percentage
Ownership n = 113		
Sole proprietorship	88	78.0
Partnership	5	4.4
Corporation	3	2.6
Institutional farms	17	15.0
Reasons for raising sheep, n = 113		
Research/dispersal	10	9.0
Icome generation	38	33.6
Hobby/for home consumption	65	57.4

intended primarily for research purposes and as source of stocks for distribution to interested farmers.

Sheep were raised primarily for home consumption. Only about 34% of the farmer-cooperators considered sheep raising as a potential source of additional income. Local markets for sheep and/or mutton must therefore be developed to encourage farmers to raise the animals (utilizing the available farm by-products) to provide them additional income.

Marketing of sheep. Fifty-five (55%) of the sheep raisers have yet to sell their marketable sheep. In effect, more than 50% of the farmer cooperators did not have any experience on selling sheep despite the fact that most of them (70%) have been raising the animal for at least five years.

Farmers who have sold some of their stocks preferred cash as mode of payment. The animals were sold to local buyers and sheep raisers from the locality. The sheep were generally sold on a per head basis with a price range of ₱300 to ₱600 per head.

Extension support to sheep raisers. In the absence of a national program, technology transfer activities to improve sheep production were very minimal. Most sheep raisers (60%) just relied on the experiences of other successful farmers for information to improve management practices in raising sheep. Print extension materials, which were generally prepared from foreign countries, provided new information to progressive sheep raisers. Training programs on sheep management were offered basically by the Asian Goat and Sheep Research and Training Center for farmers in Mindanao.

The services of experienced extension agents to assist sheep raisers in implementing improved management practices are vital to accelerate the development of the sheep industry. However, a strong R & D manpower component for sheep commodity is not yet available to assist sheep raisers. In many cases, sheep farmers were more knowledgeable about sheep raising than many of the extension technicians in the field. This maybe the main reason why only a handful farmers (15%) approach extension

agents for information on sheep raising. Establishment of pilot projects in government farms with sizeable flock could accelerate technology transfer on improved sheep production.

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Socioeconomic Aspects of Sheep Production in the Philippines

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ABSTRACT

Sheep production in the Philippines has not been given its proper due in terms of research and development. To remedy the situation, sociological insights are therefore needed. In order to improve sheep production, it is necessary to situate it within the perspective of farming systems development. Essentially, the focus should be on crop-livestock integration. The full utilization of family members in sheep production should be underscored. The dynamic complementation of crop-livestock management systems must be studied carefully. The introduction of sheep production into the existing farming systems should take into consideration three major processes, namely: improvement, change, and innovation. In this connection, the role of extension becomes central. Hence, there is a need to know the full capabilities of extension workers to handle sheep production in addition to promoting farming systems development. In order to overcome the problems associated with sheep production management, three strategies are suggested: a) animal production management among small farmers; b) crop-livestock integration; and c) farmer's organization.

The need to constantly improve the well-being of the rural poor has always been in the forefront of development thinking. Two general conditions are given attention and these are increasing and improving man's sources of food and at the same time search-

ing for ways of increasing his opportunities to earn a living. The recent worldwide interest in farming systems development only testifies to those concerns and the emerging interest in sheep production in Third World countries like the Philippines is but an affirmation of the need to improve the state of human well-being.

It is rather unfortunate that sheep production in the Philippines has not been given its proper due in terms of research and development. As Baconawa (1988) stated, ". . . very little effort has been exerted to tap the potentials of sheep until recently." In fact, Baconawa (1988) further said that "very little, if anything, was done to rehabilitate the sheep population." For this reason then, this paper focuses its attention mainly on the sociological insights that may be utilized in improving research and development in sheep production in the Philippines.

Sheep Production as a Component of Farming Systems

The position taken in this paper is to situate sheep production within the perspective of farming systems development. In other words, the central orientation should be on crop-livestock integration. Since agricultural activities in the Philippines are still largely managed by farm families, the utilization of other members of the family in the actual management of sheep production will naturally complement the farm family orientation to agriculture. Hence, the actual agricultural division of labor among family members can be modified to include the management of sheep production.

It is perhaps in this regard that the challenge to research and development must be understood. The actual processes of labor allocation among farm families is not something that can be taken for granted because it is highly influenced by the goals, aspirations, values and attitudes of farmers. Most often, those who are concerned with technology transfer overlook these fundamental facts and would most of the time be naively surprised when farmers fail to adopt the technology which is considered good for them.

The understanding of the real life situation of the farmers is basic to any attempt of introducing any technology. As was already mentioned previously, the goals of the family should be given careful attention. What they want in life and how they plan to achieve their goals must be recognized because their attitudes towards the various life processes in the community are highly influenced by their goals and values. These should be understood in terms of the dominant goals and values prevailing in the community. In view of this, the introduction of any technology must be situated within the perspective of improving community goals and values and, whenever necessary, must be carefully planned to change those that are not aligned with the demands of the new technology.

In fact, it must also be recognized that there will be times

when new goals and values will have to be initiated in the community. Again, it was observed that "in the first place, farmers do not know which types and breeds of sheep would be most suitable to their places" (Baconawa 1988). It should be noted that this revelation is merely a small part in the total requirements of sheep production management. Just like other animals, sheep production has its own particular management requirements and these must be fitted to the patterns and dynamics of farm management existing in the farm.

What is being stressed here is the potential success of crop-livestock integration which can only materialize if the management requirements of various farm activities are made to complement one another. It is highly possible that some of the major difficulties faced by workers in promoting farming systems development stem from the obvious neglect of different technologies which are not made to complement each other especially on the matter of management demands. To be misunderstood, it is accepted that through cropping systems research, many technologies are in fact complementary. However, the major omission in this regard is the need to work out carefully the management complementation of different farm activities.

It is rather unfortunate that in promoting agricultural development, some experts have viewed farmers' tradition as inimical to development. This error must be corrected by recognizing that such a tradition is vital to the survival of the farmers. Not only do they have their own unique management styles; these traditions are in fact, complementary. In other words, approaches to technology transfer must be focused on three major processes. First consideration is improvement which requires that sufficient attention be given to improving the management styles of the farmers in introducing a technology. In this regard, it is important to start from where the farmers are. Before an innovation is introduced, an understanding of the present system of the farmers is a must. What are the major constraints and opportunities in the present systems? How can the major problems be overcome? It is in this connection that the active participation of the farmers must be solicited. Both internal and external resources must be pooled together so that the current systems of the farmers can be improved.

Second consideration is change, a process wherein it is but natural, in the course of improving the farmers' systems, that some strategies associated with solving the existing constraint require changing of some parts of the management systems. These changes must not radically depart from the present systems because they will likely create a major dislocation in the present system. In other words, the farmers may not be in a position to internalize the requirements of the new systems without unduly cutting themselves off from their traditional management styles.

Whenever possible, the changes must be made gradual and complementary to the existing systems.

Third consideration is innovation, which is taken to be literally new to be added to the existing systems of the farmers. In view of this, its ramifications to improvement and change must be duly accounted for. Briefly, therefore, these three major processes are in fact complementary and oftentimes go together. The sensitive planner must always be cognizant of their interrelationship. How these will in fact affect the existing systems of the farmers in major issue in agricultural development.

Problem Identification and Proposed Solutions

In the study done by Faylon et al. (1987), it was noted that "most of the farmers (47%) have been raising sheep for at least five years now. Generally, however, the sheep were taken care of just like goats. The animals are either tethered or just let loose to feed on any available grasses or weeds in vacant lots or under plantation crops. Sheep are raised primarily in the backyard. They are kept by the farmers for the sake of owning one and are being slaughtered on special occasions" (Faylon et al. 1988). This finding is important because the management of sheep is done similarly to the management of goats. Clearly then, any attempt to improve sheep management must begin from this management perspective. The three major management processes must be brought to bear in improving the actual sheep management of the farmers.

An example of change also comes from the finding of Faylon et al. (1988) when he revealed that "uncontrolled mating was evident in most farms" (68.8%). Only about 31.6% of the farms practised upgrading. Lack of farm facilities prevented farmers from implementing a sound mating system. Likewise, the incidence of inbreeding cannot be discounted as farmers do not have ready access to sources of replacement rams" (Faylon et al. 1988). It is rather clear that to overcome this problem, there is a strong need to change the management practices of the farmers. In terms of innovation, again Faylon noted that "due to the absence of farm records, most farmers (66.7%) cannot categorically state the lambing rate and litter size of their flock."

The problem associated with the farmers' decision-making becomes a crucial issue in sheep production management. The decision of the farmers to adopt sheep production is generally affected by what options are available to them. This again must be seen in terms of their major goals. Among the major questions that must be answered in this regard is this: Does the idea of sheep production belong to their existing knowledge of farm animals? What values and attitudes do they have about sheep? An answer to these questions is partly given by Faylon et al. (1988) when he found that sheep are treated by farmers as goats. The existing farm animal management of the farmers will greatly

influence their decision to adopt sheep into their current animal stock.

It is here where the role of extension becomes central. The education and training of extension personnel are vital to the success of sheep production management. However, at this point, it is important to determine the capability of extension to provide sheep production services to the farmers. Again, the findings of Faylon et al. (1988) are instructive. He avers that "in the absence of a national program, technology transfer activities to improve sheep production are very minimal. Most sheep raisers (60%) just rely on the experiences of other successful farmers for information to improve management practices in raising sheep.

In many cases, sheep farmers are more knowledgeable about sheep raising than many of the extension technicians in the field. Thus, it is clear that while the potentials of sheep production for farmers' nutrition and income are rather substantial, the project is currently being faced with multi-sectoral problems that must be confronted if it is to succeed. There is a need to develop a strong extension capability in order to meet the demands of sheep raisers in the country. Are the state colleges and universities in a position to train these extension personnel?

From the side of support services, what are the present capabilities of veterinarians to include sheep production management in their present responsibilities? How about the questions of credit supply for small sheep raisers? Who is to provide them with this service? Linked directly to this is the question of marketing. Again, the finding of Faylon et al. (1988) is quite telling in this regard. "Fifty five percent of the sheep raisers have yet to sell their marketable sheep. In effect, more than 50% of the cooperators do not have any experience of selling sheep despite the fact that 70% of them have been raising the animal for at least five years at the time of interview." It is clear that the problems facing sheep production in the Philippines are multi-level and no piecemeal solution should be attempted.

To overcome some of these problems, it is suggested that the following strategies be adopted:

Animal production management among small farmers. More than anything else, there is a need to obtain a comprehensive knowledge on how small farmers in the rural areas are actually managing their animal production. As much as possible, the entire range of the socioeconomic and technical aspects of animal production management should be well-documented. In other words, it is of central importance that the various systems being utilized by the farmers are known.

The need to do this is based on the notion that any modification to be implemented in the current patterns of animal management must always begin from what the small farmers are practising, the premise being the development must begin from the perspective of improving the current practices of the farmers.

This, of course, can only happen if and only if we are conversant with the state of knowledge on animal production management in the Philippines. Any changes and innovations to be implemented should always begin from this point of view. The need to impose certain modifications in the farmers' animal production management must very often, if not always, come from the farmers themselves.

It is important to be conscious of the management implications of changing the existing patterns of animal production among small farmers. Again, the socioeconomic and technical aspects of management should be looked into seriously. Once more, the finding of Faylon et al. (1988) regarding the blending of sheep and goat management into one is interesting because it shows that farmers' knowledge of goat management is also apparently used in managing sheep. This practise should be carefully documented because it could be used in promoting sheep production in the Philippines. It appears that, to some extent, farmers view these two types of animals as complementary.

Other animals that can be used to complement sheep production should be known. Care should be fully exercised in cases where the introduction of an animal in the farmers' animal production system of the farmers will create contradictory demands. At the moment, it seems that the best strategy is to fully utilize the existing labor supply in the rural areas, most especially family labor. The socioeconomics of new labor demands should be studied well because most farmers are resource-poor and risk-aversed.

Organization and management of support services for animal production. What is the present status of support services for animal production in the Philippines? What are their capabilities to support sheep production? Our small farmers are not wanting in negative experiences with support services. Adding sheep to the animal production may only increase their woes. In view of this, it is vital to examine carefully the organization and management of support services for animal production, especially sheep raising. If it is established that support services are wanting, then priority should be given to its improvement in terms of efficiency and effectiveness.

Crop-livestock integration. This is a basic farming systems strategy. At present, it seems that such integration has not fully materialized because oftentimes, the integration is only done on the physical plane. This means that those who are actively involved in farming systems development are provided with animals in addition to the technologies that will improve their agricultural production. It appears that at present, the various management requirements of crop-livestock integration have not been duly attended by experts. Once more, the interaction among improvement, change, and innovation in crop-livestock integration must be studied carefully, the main reason being that the success of in-

tegration is entirely dependent on the development of complementary management skills among small farmers involved in crop-livestock integration.

Farmers' organization. With the trends in farming systems development to encourage farmers' participation, it is but natural to likewise utilize the same strategy in promoting sheep production. The management needs of sheep raisers can be met effectively if they are organized. In this way, the delivery of support services will not be done on a case-to-case basis but more on what the raisers have collectively identified and prioritized. Through their organization, their management skills will likewise improve since mutual learning will be strengthened.

The types and levels of decision-making will also be improved. Perhaps, the extension of credit services to the sheep growers will be more viable because their repayment program will be managed by their organization. It is suggested that perhaps the best strategy in this regard is to support the development of animal producers' cooperatives. This organization will be strategic in the marketing of the animals, including animal products. The essence of crop-livestock integration necessitates the integration of farmers' activities and this can only be accomplished through the formation of strong farmers' organization.

It must be borne in mind that any form of integration will always require the expansion of support services and, as experience has shown, the individual needs of farmers are always difficult to meet. In view of this, services are always inadequate. While there is no denying that increasing support services is a must, many times, this appears next to being impossible because of the financial predicament of any service agencies. Hence, the needs of animal producers, when organized, can readily be met by organized support services extended by support agencies.

CONCLUSION

In the foregoing, an attempt was made to delineate and underscore the major issues associated with the potentials of sheep production for small farmers in the Philippines. At present, such potentials are faced with multi-level problems and unless these are confronted squarely by the different sectors involved in agriculture and rural development, then such potentials may not be fully realized.

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Sheep Production and Development in Thailand

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ABSTRACT

This paper presents an overview of the status of sheep production and national research and development program in Thailand. The development of the sheep breeds is reviewed, together with the main constraints to production. The objectives of sheep development conceived in Thailand during the Sixth Five-Year Socio-Economic Development plan from 1987 to 1991 are also presented in this paper.

Thailand is an agricultural country. The main subsistence occupation of the majority of its people is agriculture while a variety of agricultural products constitutes its important export goods. For this reason, in 1968 the Thailand government, planned a program to improve all types of agricultural activities to improve and increase both the quantity and quality of agricultural products for direct consumption, and for industrial and export purposes.

Livestock production is essentially a smallholder system for home consumption and for generating income. This backyard system of animal production not only generates supplementary cash income from the sale of animals, but also provides some security against crop failure from drought or pests. Likewise, animal production can utilize farm waste products as animal feed, and in the case of cattle and buffaloes, can provide draught power on the farm.

About 95% of Thai people are Buddhists while 4% are Moslem and 1% Christians (Key Statistics of Thailand). The majority of the animals raised are cattle, buffaloes, swine and

chicken. These animals play a very important role both for home consumption and export products.

Sheep and goat production are the main concern in the Moslem community especially in south Thailand. Chantalakhana (1984) reported that about 87% of the total production of sheep are raised in the southern region. Falvey (1986) reported that the population of sheep in the northern region was 1,600 heads in 1963, but the number of sheep in the northern region from the 1978 Agricultural Census report was 7,364 heads. According to the 1986 Agricultural Census report, the total number of sheep and goats in Thailand were 57,877 and 80,807 heads respectively (Table 1).

In 1985, the total population of sheep and goats were 138,684 heads (Table 1). Of the total population, only 1.2% of all animals raised were sheep and goat (0.5% sheep and 0.7% goat), while 43.0% were cattle and 55.7% buffaloes. Within the total population of sheep and goat raised of 138,684 heads, the percentages of sheep and goat population were 41.7% and 58.3%, respectively.

The average number of sheep and goat per holding in the southern region was three heads. The distribution of sheep in the north, northeast, central, and southern regions are 22.2%, 6.4%, 32.8%, and 38.5%, respectively, and the sheep raised per holding are 18.2, 4.2, 32.1, and 3.1, respectively (Table 2).

Table 1. Number of goats, sheep, buffaloes, and cattle (1976-1985).

Year	Sheep	Goat	Cattle	Buffalo	Total
1976	33,340	53,519	4,322,375	5,895,418	10,304,652
1977	19,652	59,136	4,341,152	5,827,462	10,247,402
1978	18,551	63,138	4,436,607	5,958,734	10,477,030
1979	31,755	66,503	4,275,825	6,027,895	10,401,978
1980	21,776	55,539	3,938,221	5,650,794	9,666,330
1981	21,357	37,561	4,468,796	6,124,019	10,651,733
1982	27,018	48,883	4,578,699	6,417,433	10,072,033
1983	32,785	58,520	4,832,570	6,354,349	11,278,224
1984	44,877	73,644	4,788,989	6,300,896	11,208,406
1985	57,877	80,807	4,828,983	6,249,926	11,217,593

Table 2. Number of sheep and goats by region in Thailand.[a]

Region	Sheep Number	%	Holding Number	%	Goat Number	%	Holding Number	%
North	7,364	22.2	405	18.2	5,039	5.9	988	5.1
Northeast	2,123	6.4	450	4.2	1,504	1.8	475	3.2
Central	10,870	32.8	338	32.2	4,277	5.0	257	16.6
South	12,754	38.5	4,112	3.1	73,909	87.2	23,364	3.2
Total	33,111	100	5,305	6.2	84,729	100	25,084	3.4

[a]Source: 1978 Agricultural Census Report.

Importance of Sheep Production in Thailand

Sheep production is in the hands of the Moslem community. Mutton is the main product, and this caters to the mutton trade among the Thai Moslems. Mutton is also sold in the Bangkok market especially in the supermarkets and the Pattaya market. The market is limited mainly for Moslem Thais and foreigners. In addition to the Moslem Thais, Buddhists are also sheep raisers, especially in the central western province of Kanchanaburi, Nakhon Pathom, Suphanburi, Ratchaburi, and Petchaburi provinces. This region is the main poverty region.

The prices of agricultural products are not stable and farmers seek new opportunities by raising animals giving preference to sheep and goats. The main reason for this is that the prices of sheep and goats are cheaper than those of the cattle or buffaloes. They are also very prolific and as a consequence, the population of sheep is rapidly increasing in the western provinces (Figure 1). The 1986 Agricultural Census of the Ministry of Agriculture and Cooperatives data show that in 1976-1985, the sheep population increased tremendously (Table 1).

Since 1942, livestock farming practices have been promoted by the government. Unfortunately, many serious disease problems have been lately faced and mortality rate increased. Emphasis was placed on methods of prevention and control of the serious disease problems by producing various preventive vaccines.

For the Sixth Five-Year National Socio-Economic Development Plan for 1987 to 1991, the Department of Livestock Development (DLD) indulges on policies to promote the economic animal production, with priority for cattle, buffalo, swine, ducks, and chicken, followed by sheep, goats, geese, turkey, and rabbit (Statistical Yearbook, 1987).

In the southern region, the policy is to promote cattle, sheep and goats, for export purposes. Sheep and goat production will be concentrated mainly in five provinces, namely: Nakhon Sithamraj, Songkhla, Satool, Patalung, and Pattani. Besides exporting potential, the government is determined to see that sheep and goat raising in the southern provinces will benefit the small farmers as well as provide a source of protein. The total population of sheep and goats in the southern region (Table 3) in 1978 was 86,663 heads (sheep — 12,754 head and goats — 73,909 heads).

The project of the DLD to increase farmers' economic animal production in the southern region aims to:

- improve cattle and buffalo breeds through artificial insemination (AI) techniques by about 7,200 heads per year and through natural services (using improved bulls) by about 80 heads per year;
- promote sheep and goat raising and breed improvement in five provinces of the southern region (Nakhon Srithamraj, Songkhla, Satool, Patalung, and Pattani);

Table 3. Table 3. Number of sheep and goats by region.[a]

Region	Sheep (heads)	Goat (heads)	Total (heads)	Sheep (%)	Goat (%)
North	7,364	5,039	12,403	59.37	40.62
Northeast	2,123	1,504	3,627	58.53	41.46
Central	10,870	4,277	15,147	71.76	28.23
South	12,745	73,909	86,654	14.70	85.29
Total	33,111	84,729	117,840	28.9	71.90

[a]Source: 1978 Agricultural Census Report.

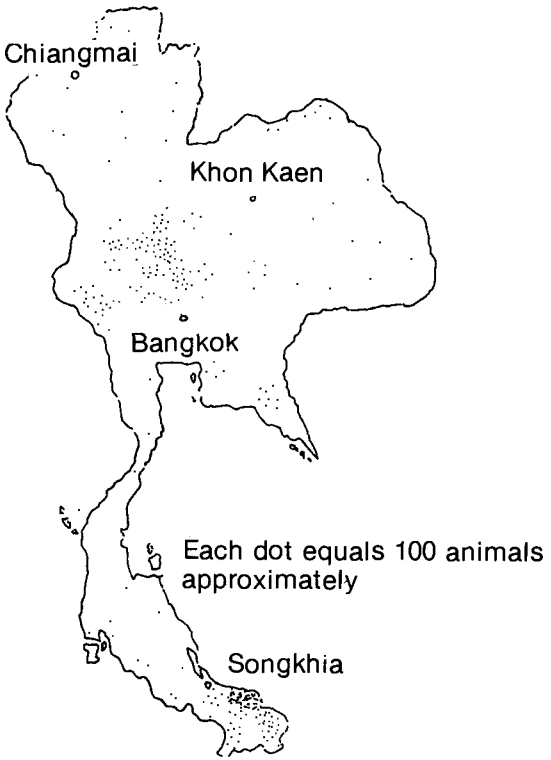

Fig. 1. Sheep distribution in Thailand, 1978.
Source: National Statistics Office
Office of the Prime Minister

- improve the natural pasture by 35,000 rai/year (5,600 ha). Within five years, this would be improved by about 175,000 rais (28,000 ha);
- set up sheep production training courses for farmers;
- establish livestock raising colonies (160 colonies/year);
- develop livestock marketing systems by setting the provincial livestock market for two provinces/year. Each provincial livestock market will be open for the farmers to bring their animals for sale monthly. Within five years, there will be 10 provincial livestock markets to be established.

For promoting sheep and goat raising, the DLD will select and group the raisers. Each group will consist of three members and about 10 sheep or goats to be raised. Training programs on sheep and goat production will be arranged for these farmers. Provincial livestock officers will visit these farmers at least once a month and will try to solve problems concerning sheep and goat production.

The anticipated results to be obtained from this project are as follows:

- National income from exporting the economic animals (cattle, buffaloes, sheep, and goat) will be more than 2,000 million baht per year.
- Cattle and buffaloes will be increased by about 66,100 heads and the farmers will earn more than 330 million baht.
- The sheep and goat population will be increased by about 40,000 heads and the number of farmers that will benefit from this project will be about 2,000.

The budget for the livestock development in Southern region for the period 1987 to 1991 is shown in Table 4.

In addition to this, the department of Animal Science of Kasetsart University has set a project to improve the sheep breeds through breeding and selection for meat purpose. This project has been finally supported by the Kasetsart University Research and Development Institute (KURDI) since 1986.

Breeds of Sheep Raised in Thailand

The origin of sheep in Thailand is unclear, but Falvey (1986) referred to the report of Coop (1976) and said that sheep probably

Table 4. Budget (million baht) for livestock development in the Southern region (1987-1991).

Activities	Fiscal Year					Total
	1980	1988	1989	1990	1991	
• Prevention and control of diseases	30.80	34.00	35.70	37.90	39.00	177.40
• Promotion of livestock farming practices						
— Cattle and buffalo	30.90	32.90	35.90	36.10	38.70	174.50
— Sheep and goat	0.44	0.44	0.44	0.44	0.44	2.20
• Economic evaluation	0.12	0.12	0.12	0.12	0.12	0.60
Total	62.26	67.46	72.16	74.56	78.56	354.70

Source: 1987 National Economic and Social Development Committee.

were present in Thailand for several hundred years now. The latter described the native sheep of Thailand as similar to the sheep of Indian breeds and Arabic breeds. Devendra (1982) reported that most of the sheep populations and sheep raising were concentrated in Indonesia, Malaysia, and the Philippines, so it might be possible that sheep breeds found in Thailand were similar to the breeds from Malaysia or Indonesia. Falvey (1986) also noted that some of the native sheep of Thailand might have come from Burma.

For the last two decades, exotic breeds have been imported from European countries. These breeds were German Merino, Polwarth, and Dorset Horn. All of these breeds have been used for crossing with native sheep to produce superior crossbreds.

Falvey (1986) reviewed sheep breeds and sheep farming practices in the northern region and in the highland of Thailand, and pointed that the indigenous breeds were crossed with many exotic breeds. He added that management practices of sheep were very low in standard.

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Discussion II

The second session dealt with country case studies, issues and problems to demonstrate the different ecological zones, types of production systems, prevailing patterns to sheep management, constraints, success, and experiences with sheep in national research and development programs. These were highlighted in nine country case studies that proved to be very valuable in illustrating the extent and variety of the issues.

The first paper described the environment (topography and climate) of Bangladesh. In this country, sheep and goats are sparsely distributed all over the land and usually owned by small farmers and landless peasants. Decreasing living standards and increasing poverty have resulted in increased number of sheep raised. Less than 1% of the land is available for raising sheep and is coupled with the very critical sheep shortages. The number of sheep raised per family ranges from 2 to 18.

The Bangladeshi sheep is used in a variety of production systems and valued primarily for mutton production. It also produces a hairy fleece. The most outstanding characteristics of this sheep is its prolificacy in which twins are common. The major problem is availability of sheep and strategies to improve sheep quality and numbers, including more extensive use of rice cropping by-products, agro-industrial by-products, and growth of leguminous trees and forages.

The second paper described the situation in China where more than half the territory was mountainous. This area accounted for about 40% of the total land area. Dr. Ye drew attention to several breeds of sheep in China namely, the Fat-rump Kazak, Thin-tailed Tibetan, and Fat-tailed Mongolian sheep. Among the most famous of these are the Wuzhumuxin, Tan, Tung, Han and Hu sheep.

Dr. Ye also outlined the research and development strategies for sheep which included conservation of the genetic resources, the development of fine wool sheep, studies on multiple births, improvement of mutton production, and development of rangeland and their management.

The third paper was presented by Dr. B. C. Patnayak. He indicated that there were as many as 40 breeds of sheep in India distributed in the North-Western and the Semi-arid region, Southern Peninsular, Eastern region and Northern temperate region. Much of the results of work undertaken in India referred to research carried out in the Central Sheep and Wool Research Institute (CSWRI).

The research and development activities focused mainly on breed improvement, feed resources development and nutrition, reproduction and adaptation, diseases, and wool size. Considerable progress has obviously been achieved but it was also clear that much of these results have not been extended to the farm level. A summary of the main recommendations for development programs cited in his paper are:

- Improvement of wool production with reference to quality and quantity.
- Development of dual-type or mutton-type sheep to augment meat production.
- Prophylactic improvement against parasitic diseases, important bacterial, and viral diseases.
- Development of marketing for wool and live animals through sheep and wool Board/Federations.
- Development of pasture and fodder trees production in drought prone areas.

Discussions centered on rotational versus in situ grazing, night grazing, dual-purpose breeds, feed constraints, artificial insemination, and extension of research results to farmers. It was indicated that crossbred rams are supplied to farms to improve their sheep.

The situation in Indonesia constituted the fourth paper. Sheep raised by poor rural farmers who own an average of two to five sheep. However, sheep production ranks less compared to that of other ruminants. A national research and development program has been initiated to accelerate production of sheep. The development program envisaged are large scale fattening of yearling lambs and integration of sheep under rubber.

The problem of efficient utilization of the prolific Javanese thin-tailed sheep with the Booroola gene generated much discussion. The question concerned their management in terms of the offsprings that were born and in terms of frequency of lambing intervals. It was suggested that control over lambing as well as sheep management is very necessary to ensure low mortality and high performance.

The fifth paper from Malaysia presented by Dr. A. Wahid reported a detailed assessment of the industry, its contribution and importance. The paper was unique for one important reason in comparison to other countries. This concerns the fact that Malaysia had a very low population of sheep relative to goats and has decided to embark on very large scale importation mainly from Australia. This importation approximates to between 5,000 to 6,000 sheep per year for the next five years.

It is envisaged that the accelerated imports, together with the natural increase, would meet the national requirement of 850,000

sheep for slaughter annually. Several participants expressed reservations about this program and indicated that they awaited the experiences in this country with much interest. Discussion also centered on the potential for increasing sheep production through integration with plantation crops.

The sixth country paper was presented by Dr. S. L. Pradhan from Nepal. The paper described the topography as well as the various production systems in the country. These ranged from tropical lowlands to alpine. Dr. Pradhan emphasized that Nepal has good prospects for sheep production but the research and development efforts to support these are very weak.

Several major constraints were identified: these included inadequate feed supplies, overgrazing and soil erosion, poor extension, and poisonous plants. He emphasized the need for more development programs to assist sheep farmers, the need for more wool production from sheep to support the cottage industries, and also exchange of information within the region.

The seventh and eighth papers were specific to the Philippines. The first was presented by Dr. P. S. Faylon on the status of sheep production and development. It highlighted the results of the study on the assesment of sheep production systems which was recently concluded based on a socioeconomic survey. It was apparent that the Philippines has had the influence of several exotic breeds of sheep over the years. These have resulted in various heterogenous sheep distributed in several parts of the country.

Dr. Faylon presented considerable data on the results of the survey. This survey has now resulted in a better understanding of the types and distribution of sheep, management systems, constraints to improvement, diseases and health, and the potential for improving performance at the farm level. More particularly, the results have enabled a definition of priority areas for future research and development of sheep. Discussion centered on the differential resistance between sheep and goats, use of exotic breeds, selection programs, strategy for pasture improvement, and prices of products between sheep and goats.

Dr. M. F. Bonifacio presented the next paper on socioeconomic aspects of the sheep production in the Philippines. Much of the description in his paper were related to the data generated during the socioeconomic survey of sheep in the Philippines. He emphasized that the focus of socioeconomic aspects should be on crop-livestock integrated systems and the utilization of family labour. Improvement, change and innovation are considered to be the three important components for the introduction of sheep into existing farming systems.

The last paper in this session was by Dr. B. Rengsirikul on the status of sheep production in Thailand. Of all the components of

the animal industries in that country, it was clear that sheep was the weakest. Dr. Rengsirikul emphasized however, that over the next Sixth Five Year Socioeconomic Development Plan, it is envisaged that the development of sheep will receive much more support. He also drew attention to the government policy to promote sheep and goat production for the benefit of animal farmers.

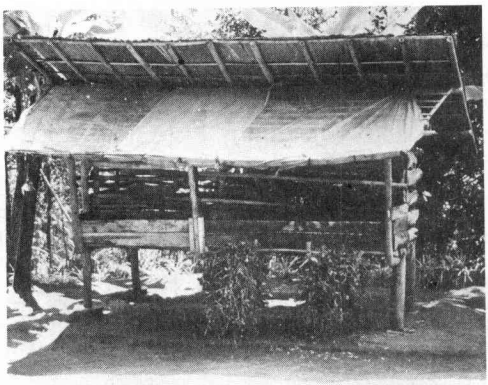

Plate 7. Typical housing for sheep in Java, Indonesia.

Plate 8. Sheep grazing under rubber trees in Indonesia.

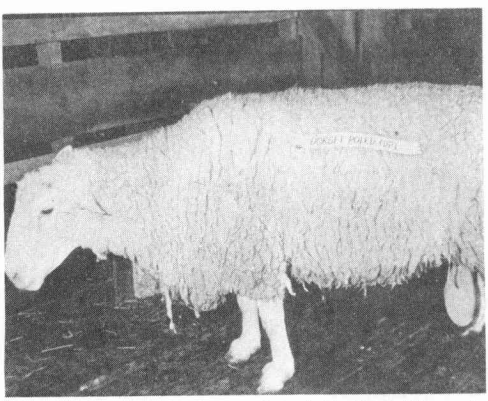

Plate 9. Imported purebred Polled Dorset ram in Malaysia.

Plate 10. Farmer with his sheep flock in Nepal.

Plate 11. Mixed flock of sheep in the Philippines. Note crossbred Barbados Blackbelly sheep in the foreground.

Plate 12. Indigenous sheep in Thailand.

Session III: Conclusions and Recommendations

Conclusions and Recommendations

The delegates noted that this meeting, specific to sheep, was the first one of its kind to be held in Asia and was convened at an opportune time when several countries are giving increased attention to the species. The meeting recognized the importance of sustaining research and development in tandem with this increased focus on sheep in Asia.

A total of 14 papers were presented, five resource and nine country situations (Bangladesh, China, India, Indonesia, Malaysia, Nepal, the Philippines, and Thailand), including two from the host country. These highlighted the state of the art in sheep production as well as the prevailing country case studies. These presentations provided an adequate coverage of sheep production in Asia and promoted wide discussions on specific issues, principles of production, problems, and possible solutions. In particular, working group discussions were held on various aspects of production in the context of the perceived requirements of individual countries. The conclusions and recommendations presented here represent the results of this total effort.

The conclusions and recommendations are presented by discipline.This approach enables the recommendation to be considered across systems and encourages multidisciplinary work and integration of effort, especially in the context of the totality of mixed farming systems so typical of many parts of Asia, in which sheep are only a subsystem. The situation will naturally vary from country to country and between the highlands, South, and Southeast Asia, therefore, adaptive research and development efforts are necessary. This need does not, however, detract from the priorities for this effort and the manner in which the available resources can be put to more efficient use.

In formulating the recommendations of this workshop, the recommendations with respect to sheep made at the 1986 workshop on small ruminant production systems in South and Southeast Asia held in Bogor, Indonesia, were recognized (see Devendra 1987). Attention is drawn in this proceedings to several pertinent sections concerning sheep production which inter alia include:

- Forage production;
- Integration of goats and sheep with tree crops;
- Effects of primary crop management on small ruminants;
- Effects of animal integration on the parent crop;
- Supplementation and fodder conservation;
- Housing;
- Health and diseases;
- Socioeconomic aspects; and
- Development and related issues.

To avoid any repetition of previous recommendations, the following summary will only reflect the more urgent and sheep-specific issues.

Breeding

The genetic improvement of sheep, along with nutrition, disease control, and management are all important aspects in increasing the quantity and efficiency of sheep production in Asia. In recent years, the avenues of genetic improvement have become more clearly defined and understood. These include the improvement of existing breeds, the creation of new breeds through crossbreeding followed by interbreeding, and the continued improvement of the new breeds. New methods of artificial insemination and sheep importation are beginning to influence crossbreeding programs.

The following recommendations were made:

- The attributes of breeds considered to be potentially valuable to the germplasm of the region must be confirmed and quantified. The following potential improved breeds merit more attention:
  - Indigenous Bangladeshi (Bangladesh)
  - Javanese thin-tailed (Indonesia)
  - Hu (China) for high lambing percentage (high prolificacy and short lambing interval)
  - Mandya and Muzzafarnagri (India) for mutton; Chokla (India) for fine wool
  - Magra and Marwari (India) for carpet wool.
- Countries wishing to expand and develop their local sheep industry should first assess the potential of their local breeds and the potential market for sheep and sheep products and second, should define the production objectives or goals (i.e., wool, meat, etc.), the selection objectives of the breeding program should therefore be considered.
- On the basis of the previous recommendation, it must be decided whether the objectives of the program will be met by improving the local breeds or through crossbreeding with exotic breeds (either temperate or tropical).

Improvement of local breeds. If the objectives of the crossbreeding program are to be accomplished through the improvement of local breeds, the following recommendations were made:

- Basic stock should be selected using as large a screening process as possible and should lead to the formation of a nucleus flock with a minimum of 200 ewes and 15 unrelated rams. The breeding program should realistically have a foreseeable term of 20 years or more.
- Local staff involved in any long-term breed improvement program, including those involving new breeds established from crossbreeding, should be exposed to improvement

programs in Australia, New Zealand, or India.
- In view of the emphasis on mutton production in most countries, crossbreeding to achieve improved performance and body size are important. There are several breeds that can be used for this purpose, but the Polled Dorset and Mandya are probably the most common. The final choice of the exotic breed will, of course,depend on the individual country, and should be made based on the production objective and prevailing conditions.

Crossbreeding. If the objectives of the crossbreeding program are to be achieved by improvement through crossbreeding, the following recommendations were made:
- The exotic breed(s) should be chosen on the basis of the best and most reliable information available. One or up to three exotic breeds may be chosen according to the capacity of the local research station. Assessment of the F1 progeny against a local control flock on the research station should be made on the basis of total productivity over several years or a lifetime. The best F1 cross can then be interbred to create a new breed (or back-crossed to an exotic or local breed if a 75:25 exotic is preferred and then interbred).
- A nucleus flock of the new breed should be established for further improvement through selection and to form the nucleus for ram production for the breed. Steps should be taken to increase ram production through the establishment of government breeding farms or by contractual arrangement with breeders.
- Some F1 and F2 rams should be distributed to local farmers to assess performance and acceptability under village management conditions.
- The replacement of the traditional method of importing a small number of ewes and rams to establish a purebred exotic flock with the importation and the use of frozen semen should be seriously considered.
- Where the increase in demand for sheep cannot readily be met by natural increases, large scale (> 5000) importation of exotic ewes should be considered. These ewes can then be mated with local rams to produce the F1 progeny. In this connection, countries should closely monitor the recent Malaysian experience in large scale importations.

Mating and Lambing Date

- Studies on the seasonal variation in ovulation rate and optimum time to mate ewes should be intensified.
- Trials should be conducted to measure the advantages and disadvantages of restricted seasonal breeding compared with unrestricted, year-round breeding.

Feed Resources

To ensure the more complete utilization of feed resources, the total availability of feeds (grasses, legumes, crop residues, agro-industrial by-products, and nonconventional feeds) must be inventorized. The following aspects merit special attention:

- Any assessment of nutritive value should concentrate on those feeds for which there is inadequate information.
- Feed evaluation need not be exhaustive and can be confined to the following main measurements: dry matter, organic matter, total nitrogen, in vitro digestibility, cell wall analysis, Ca, and P, using recommended methods of their determination. These measurements need to be supported by well-controlled feeding trials over a reasonably long duration.
- More research is needed on the utilization of feeds specifically by sheep.
- Leguminous forages, shrubs, and tree fodders need to be more completely documented with reference to types available, yields, utilization and economic benefits.
- Processing and the development of complete, low-cost, economic formulations based on indigenous feed ingredients need more research and development.

Feeding Systems

The workshop made the following recommendations with respect to feeding systems:

- More documentation is necessary on the efficiency of individual feeding systems (grazing, semi-intensive, and stall feeding).
- The comparative economic benefits of different feeding system need to be assessed relative to the objectives of production (meat, fiber, or both).
- Stall feeding is particularly suited to lamb finishing, especially where crop residues and by-product feeds are plentiful. This system has considerable potential and is suitable for commercial exploitation.
- More research is needed on the use of supplements and the methods of feeding them (mainly nitrogen and minerals) to ameliorate nutrient deficits.
- The potential value of urea-molasses block licks should be evaluated.
- Leguminous forages have considerable potential as supplements. Considering the varieties available dry matter is not adequately understood, and increasing productivity from sheep in these situations necessitate more detailed investigations.

Nutrient Requirement

The delegates of the workshop noted that there is an extreme paucity on information on the nutrient requirements of sheep in tropical environments. Recognizing the need for more information, it is recommended that more research on nutrient availability (energy, protein and minerals) for different functions (meat, fibre, or both) and physiological needs (maintenance, growth, pregnancy, and lactation) be conducted.

Management

Two aspects of sheep management were noted to be of special importance. Firstly, the forward planning of feed supplies and the matching of these supplies month by month with the predicted seasonal feed demands of the flock, taking into account the number and feed requirements of rams, ewes, and lambs and the physiological state of the ewes. Secondly, the optimum age and method of weaning in relation to postweaning gains and survival, the optimum age and timing for drenching for internal parasite control, and the optimum time of mating.

Two recommendations were made concerning the problems of sheep predation.

- Because problems of predation are more acute with sheep, there should be more control of the animals as well as more suitable housing.
- Associated with the problems of predation and good housing for sheep, more information is required on the types, effectiveness, suitability, and durability of low-cost fencing suitable for sheep.

Marketing

On the topic of marketing, the following recommendations were made.

- In view of the increasing interest in sheep and the lack of experience in sheep production, studies should be initiated to assess existing infrastructures and those needed for the optimum marketing of live sheep, meat, wool, skins and by-products. The perceived markets for sheep products will play a large role in defining the objectives of a breeding program.
- The development of a marketing infrastructure should include live animals and meats produced, the creation of slaughterhouse capacity, marketing through wholesalers, retailers, and supermarkets, and mass media support.
- More studies are needed on consumer preferences, tastes, and market demand for lamb and mutton.

Methodology and Technology

There was considerable discussion on the need for uniformity in experimental work, definition of methods use, and under which a study is performed. All these aspects vary widely both between and within countries. The following four recommendations were made.

- There is a need for uniformity in the use of experimental methods (e.g., analytical techniques, restricted or ad libitum feeding systems, type and number of animals used, and methods of results analysis).
- The economic analyses of data involving an input-output analyses are currently weak. Much more attention is needed on this aspect to ensure maximum product output.
- There is an urgent need to increase the amount of large scale, on farm work involving farmers. In the past, this issue has received inadequate attention and on-farm work is now a high priority area in the context of farming systems research.
- More precision is needed in the terms used for sheep production (i.e., lambing percentage, weaning percentage, litter size, interval between lambing, mortality, etc.)

General

Several other related topics were also discussed at the Workshop. These included the value of meetings, publication of articles on small ruminants, information exchange, and communication between countries in Asia. The value and formation of network specific to small ruminants to promote research and development activities in the region was also discussed and recommended.

Reference

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Workshop Synthesis

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It is an honour for me as a non-Asian to be invited to participate in this Asian Workshop, as it is for my two Australian associates. It is also a great pleasure to meet old friends and make new ones, all of us with a common interest in sheep. New Zealand is, in fact, increasingly becoming part of the Asian region.

This Workshop owes its origin and existence to the initiative of Dr. C. Devendra of the International Development Research Centre (IDRC), and represents the fourth of a series of Conferences and Workshops on small ruminants: Preparatory meeting at the FAO Headquarters in Bangkok, Thailand in 1986; Workshop on Small Ruminant Production Systems in South and Southeast Asia by IDRC in Bogor, Indonesia in 1986; Workshop on Goat Meat Production in Asia by IDRC in Tando Jam, Pakistan in 1988, and now this one specifically on sheep.

The workshop began with a two day field visit through Tarlac, Lingayen and Baguio. Such a tour was vital in conveying to us an impression of the landscape and conditions of farming in the Philippines and the circumstances under which sheep are bred, fed, and managed. It was much appreciated, and it helped me conclude that the sheep of this part of the country must have a common origin with those of Thailand, Malaysia, and Indonesia, and that results obtained from these sheep in any one of the countries should bear relationship with the sheep in the others.

The tour was followed by three days of paper presentations and discussions, initially on state-of-the art papers by discipline such as breeding, nutrition and animal health, and then by papers describing the sheep production systems and research and development in each of the participating countries. Without exception, these created much interests and lively discussions. The country papers likewise showed that in nearly everywhere in the region, there is a growing interest in sheep. If I were to single out two countries for special comment, it would be India and

China. In both countries, there is a great deal of research and development experience in sheep, much of which are with obvious relevance to the Asian region. These two countries have the most sheep in Asia and must become leaders of the region in terms of sheep production. I believe it's important that China be brought into this regional association of sheep breeding countries.

The Workshop will be judged on its immediate results and future achievements. For those present, it was a most useful review of the sheep industries, production systems, and research in the individual countries. It created an atmosphere of fellowship, cooperation and encouragement for the future and an eagerness to build up closer association and cooperation. The follow-up will be the publication of the proceedings and their recommendations. These will be made available for distribution to Director Generals of Agriculture, Livestock, Veterinary Services, and Directors of Research Institutions in the region. Participants will return to their respective countries and will lobby for increased emphasis and funding on sheep research and all other aspects of an expanding industry. Thus, it is hoped that we will maintain the pressure that small ruminants be given a more rightful share of funding for research and development.

The Workshop, I believe, is also a significant step towards information exchange on sheep; it is ultimately important in serving the needs of the Asian region in the collection and dissemination of information. It is also a focus for regional cooperation.

Finally, it is clear from the expansion of sheep numbers in recent years that increasingly, sheep are beginning to be seen as a viable and economic option for both smallholder and plantation or company owner. Without doubt, the Workshop will give a further impetus to this movement.

Those of us who have attended this Workshop have gained much. It is our duty, on returning home, to see that others will also share from the benefits.

Participants

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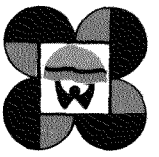


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