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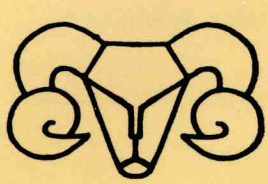
Small Ruminant Production Systems in South and Southeast Asia

Proceedings of a workshop held in Bogor, Indonesia, 6–10 October 1986



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Small Ruminant Production Systems in South and Southeast Asia

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Abstract This publication presents the results of a meeting held in Bogor, Indonesia, 6-10 October 1986, that focused specifically on the assessment of small ruminant production systems in South and Southeast Asia. It considered the prevailing circumstances, the innovations, and the strategies that are pertinent for stimulating increased productivity from goats and sheep. The present patterns of production were examined in detail with reference to characteristics of the small farms, existing management methods, and nature and components of the production systems. These systems include extensive systems, systems combining arable cropping, and systems integrated with tree cropping. The discussion of the systems were further highlighted by country case studies, issues and policies that considered the available production resources, especially the genetic and feed resources available, constraints to production, and potential means to achieve desirable improvements. An important session was devoted to examining research methodology, strategies for development appropriate to individual systems, and a conceptual framework for on-farm economic analysis. Together, these discussions enabled a definition of research protocols and the priorities for future direction that are likely to have a major impact on productivity from small ruminants.

Résumé L'ouvrage présente les conclusions d'une réunion tenue à Bogor, en Indonésie, du 6 au 10 octobre 1986, portant sur l'évaluation des systèmes de production touchant les petits ruminants en Asie du Sud et du Sud-Est. On y a brossé un tableau de la situation actuelle, des innovations et des stratégies susceptibles d'accroître la productivité dans l'élevage de la chèvre et du mouton. On a examiné en détail les méthodes actuelles de production dans la perspective propre aux petits exploitants, les éthodes actuelles de gestion, le type de systèmes de production et leurs éléments. Il s'agit ici des systèmes extensifs, des systèmes associant la culture des terres, et des systèmes intégrant la sylviculture. Les discussions ont été étayées d'études de cas, de problèmes et de politiques émanant des divers pays et portant sur les ressources disponibles pour la production, spécialement les ressources génétiques et fourragères, les contraintes à la production, et les possibilités d'amélioration qui existent. Une importante session fut consacrée à l'examen de la méthodologie de la recherche, des stratégies de développement convenant à chaque système, et d'un cadre conceptuel pour l'analyse économique des activités sur le terrain. Toutes ces réflexions ont permis de définir des plans de recherche et d'établir les priorités qui, dans l'avenir, auront vraisemblablement un impact majeur sur la productivité liée à l'élevage des petits ruminants.

Resumen Esta publicación presenta los resultados de la reunión celebrada en Bogor, Indonesia del 6 al 10 de octubre de 1986, cuyo temp principal fue la evaluación de los pequeños sistemas de producción de rumiantes en el

Sur y Sureste asiático. En la misma se analizaron las circunstancias imperantes, las innovaciones y las estrategias pertinentes para estimular la mayor productividad del ganado caprino y ovino. Se examinaron detenidamente los patrones actuales de producción con respecto a las características de las pequeñas granjas, a los métodos de manejo existentes y a la naturaleza y componentes de los sistemas de producción. Estos sistemas incluyen sistemas extensivos, sistemas que combinan el cultivo de tierras arables y sistemas integrados con plantaciones de árboles. La discusión de estos sistemas estuvo acompanada del análysis de etudios de casos en diferentes países, así como de problemas y políticas relacionados con los recursos de producción disponibles, especialmente los recursos genéticos y alimenticios disponibles, las limitantes de la producción y los posibles medios para obtener las majoras deseadas. Una importante sesión estuvo dedicada a examinar la metodología de las investigaciones, las estrategias para el desarrollo apropiadas para cada sistema individual, y un marco conceptual para la realización de análisis económicos en las granjas. En su conjunto, estas discusiones permitieron definir los protocolos de investigación y las prioridades para el futuro, que probablemente habrán de tener importantes repercusiones sobre la productividad de los pequeños rumiantes.

CONTENTS

INTEGRATION OF SMALL RUMINANTS AND TREE CROPPING IN SOUTH INDIA

G. Mukundan and S. Balakrishnan

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Abstract *This paper discusses various features of small ruminants (sheep and goats) in the four states of south India: Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh. From 1972 to 1982, while the population of sheep remained more or less stable, the goat population increased by about 30%. Out of about 13.3 x 10^6 sheep and goats slaughtered in India, the southern states accounted for more than 39%.*

The traditional system of rearing through migration declined considerably because of fewer areas being used for grazing, more intensive cultivation, or a reduction in migratory habits and the popularity of keeping fewer animals, particularly in the poorer sections of the society. There is considerable scope for the planned exploitation of the existing tree crops and herbage. The estimated herbage in Kerala is greater than 2.1 x 10^6. There is considerable potential for the interculture of fodder crops in plantation and other cash crops. The productivity of meat and milk can also be considerably improved through genetic manipulation and scientific management. A comprehensive approach is needed to face the challenges in the development of small ruminant production.

India can be conveniently divided into two geological areas: the peninsular region of south India, comprising the Deccan plateau and its adjuncts, and the extrapeninsular region of north India, comprising the Himalayan mountains and the extensive Indogangetic plain. South India has two principal mountain ranges: the western ghats, which cover the eastern fringe of the west coast plains and catch the full force of monsoon winds, thus precipitating heavy rains on the west coat, and the eastern ghats, irregularly scattered over the east

coast of India and forming the boundary of the east coast plains.

Because of the unique geographic situation of south India, there is a rich and varied vegetation, typically tropical in nature. Two broad agroclimatic zones can be identified: the wet undulating coastal region dominated by tree crops and the fairly long coastal plains dominated by cereal crops. The wet zone covers the state of Kerala, the western part of the state of Karnataka, and the southern part of Tamil Nadu. The dry zone is composed of a major portion of Tamil Nadu, Karnataka, and Andhra Pradesh. In this paper, the status of small ruminants (sheep and goats) in relation to tree crops in the four southern states of Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh will be discussed, with special emphasis on the situation in Kerala.

IMPORTANCE OF SMALL RUMINANTS

In south India, the sheep and goat populations account for 43 and 24%, respectively, of the total number of sheep and goats in the country. The goat population is denser in the wet zone, particularly on the western coast; most sheep are found in the dry regions. The two species contribute considerably to meat production in India and the share of total meat produced is presented in Table 1. From a total of 13.24×10^6 slaughtered animals during 1977-78, the four southern states accounted for 5.15×10^6 or about 39%. At present, the per capita availability of meat is only 25 g compared with a per capita nutritional requirement of 40 g. To meet this demand, small ruminants must play a major role.

On the west coast, milk production is the most important function of goats. In Kerala, nearly 8% of the total milk produced, i.e., 1.08×10^6 t (1984), is obtained from goats. Sample surveys conducted in other states do not give any values for milk production by goats, but perhaps their contribution to state milk production is negligible compared with that of cattle and buffalo. From experiments conducted in Kerala, it is evident that productivity of native goats could be more than doubled by the introduction of cross breeding with the Saanen breeds (Mukundan et al. 1983).

In addition to being a highly palatable and nutritious protein food, with their wool, sheep provide warm and protective clothing. In this region, especially in the coastal

Table 1. Number of small ruminants slaughtered and meat produced in south India, 1977-78.

State	Sheep			Goat			Total meat from livestock ($t \times 10^3$)
	No. slaughtered ($\times 10^3$)	Meat production ($t \times 10^3$)	% of total meat	No. slaughtered ($\times 10^3$)	Meat production ($t \times 10^3$)	% of total meat	
Kerala	77	0.82	2.7	209	3.06	10.0	30.71
Karnataka	418	4.23	33.6	266	2.90	23.1	12.58
Tamil Nadu	1090	11.84	37.4	1068	11.15	35.2	31.64
Andhra Pradesh	1085	15.97	31.4	934	14.60	28.7	50.92
South India	2670	32.86	26.1	2477	31.71	25.2	125.85
All India	7876	81.30	25.4	5362	63.30	19.8	319.68

Source: Statistical Bulletin, Animal Husbandry Department, Government of Tamil Nadu, India.

areas, half of the sheep produce no wool and the rest produce extremely coarse, hairy, and coloured fleece used in the production of coarse sheets to the benefit of the lower income groups. In terms of enriching the soil, goat manure is twice as rich in plant nutrients as cow dung.

Sheep and goats earn foreign exchange primarily through the export of skins. India exported 13 t of raw sheep and lamb skins and 5824 t of processed sheep and goat skins in addition to by-products during 1979-80 (Government of India 1980).

POPULATION CHANGES

Changes in sheep and goat populations in the four states based on quinquennial censuses of 1972, 1977, and 1982 are noted in Table 2. The sheep population has remained fairly constant from 1972 to 1982. The situation regarding goats, however, shows a steady increase of 28% over the same period. Except in Kerala, sheep outnumber goats in all the states of south India. Considering the overall population in south India, the populations of sheep and goats seem to be almost equal.

The density of sheep in south India is about 28 sheep/km^2 and the goat density is about 27 goats/km^2, showing little difference between the two species. For the rest of India, however, there is an obvious difference in small ruminant densities, with 13 sheep/km^2 and 22 goats/km^2. More than 90% of all sheep and goats are found in rural areas.

The sex ratio based on the number of males for every 1000 females decreased in both the sheep and goat populations with increasing age of the animals. Perhaps the phenomenon is comparable to that noticed in other livestock; however, the overall sex ratios in this region are 382:1000 and 408:1000 for sheep and goats, respectively. The higher ratio in goats may be because of a deviation in management noticed in the case of goats when they were kept for milking and the higher number of breeding males per unit of breeding females. For breeding purposes, the ratio is more than satisfactory. The increase in goat population, therefore, may be because of its greater prolificacy through the frequency of twins and triplets as compared with sheep.

In this region, there are 14 recognized sheep breeds and 3 recognized goat breeds. The sheep breeds include Deccani,

Table 2. Population changes in small ruminants of south India, 1972-1982.

	Kerala			Karnataka			Tamil Nadu			Andhra Pradesh		
	1972	1977	1982	1972	1977	1982	1972	1977	1982	1972	1977	1982
Sheep												
Total (x 10^3)	10	3	7	4662	4536	4792	5393	5289	5537	8251	7064	7507
Density	0.26	0.08	0.18	24.3	23.6	25.0	41.5	40.7	42.6	29.8	25.5	27.1
Goats												
Total (x 10^3)	1468	1683	2004	3726	3388	4546	3954	4202	5246	4308	4364	5534
Density	37.6	43.2	51.4	19.4	17.6	23.7	30.4	32.3	40.4	15.6	15.8	20.0
Total sheep and goats (x 10^3)	1478	1686	2011	8388	7924	9338	9347	9491	10783	12559	11428	13041
Total livestock (x 10^3)	4936	5319	5644	21965	21800	26148	23433	24146	26186	32786	31472	35736
% of sheep to total livestock	0.2	0.05	0.12	21.2	20.8	18.3	23.0	21.9	21.1	25.2	22.4	21.0
% of goats to total livestock	29.7	31.6	35.5	17.0	15.5	17.4	16.9	17.4	20.6	13.1	13.9	15.5

Source: Thirteenth Quinquennial Livestock Census, 1982, Animal Husbandry Department, Governments of Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh, India.

Nellore, Bellary, Hassan, Mandya, Mecheri, Kilakarsal, Vempu, Coimbatore, Nilgiris, Ramnad white, Madras red, Tiruchy black, and Kenguri; the important goat breeds are Osmanabadi, Kannai adu, and Malabari. Origin (home tract), population size, flock size, growth, reproduction and production parameters, and physical confirmation of these breeds have been documented by Acharya and Bhat (1984).

REARING OF SMALL RUMINANTS

As mentioned earlier, one of the objectives of sheep and goat rearing in this region is to produce meat economically. In certain parts of south India, sheep and goats are maintained for wool and milk production, respectively. Depending upon the objectives, different systems of management are followed by the sheep and goat owners.

Sheep are more used to browsing, whereas goats thrive mainly on tree leaves. Perhaps the locational differences might have encouraged these preferences. As tree crops are less dense in the semi-arid areas and browsing facilities are limited in area and duration, the migration of flocks was common.

Most sheep are reared under the "nomadic" system of management because sheep-rearing areas are mostly semi-arid and feed resources are exhausted very early after the cessation of monsoon rains. In the nomadic system, the migration of sheep for grazing can be classified as interstate nomadic or semi-migratory. Shepherds owning interstate nomadic flocks may be either landless or those who have been hired by the larger flock owners. The former group of shepherds must adopt the nomadic system because they have no landholdings of their own; the latter group consists of traditional shepherds who prefer to migrate from place to place looking for available grazing land. During the agricultural off-season, sheep are herded together at night in the fields, the manure helping to fertilize the fields. They are penned by using bamboo or thorn fencing and are moved from one field to another.

Income from the sheep in this system comes from the sale of surplus sheep or from the manure deposited on the cultivable land belonging to large-scale farmers in the camping areas. In semimigration, the shepherds follow definite grazing patterns for about 5 months each year during the summer until the onset of the rainy season. Rituals are performed to fix the starting

and ending dates of migration and to keep the flock free from diseases during the course of their migration. The migratory system helps the sheep owners to generate income without any personal investment. Shepherds are paid in kind with food grains for the services rendered to the farmers by way of folding the sheep in the fields for manure.

Sheep are housed during the monsoon season and during the winter. In the summer, the animals are grazed in the early hours of the morning. During the day, they are sheltered under mango trees and other shade-tree species. In well-organized farms maintained by the government and a few wealthy farmers, sheds with proper ventilation and sanitary conditions are provided.

Sheep graze extensively on the available forest lands, hill slopes, waysides, riverbeds, and on stubbles in the postharvest fields. Individual sheep holdings range from 5 to 100 head under the flock system. The rams are always grouped with the ewes at a ratio of 1:10, respectively. Most breeds can breed all year round; but breeding is done seasonally because of the migratory nature of the flock.

The management practices for goats in south India are similar to those of sheep, except that goats are more confined than sheep. Because goats are kept in the wet regions, they need dry housing; therefore, sheds on stilts are erected adjacent to the owner's house with an extension of the roof. The floor is elevated about 1-1.5 m to facilitate cleaning. Another floor underneath the slatted one is provided; it is here that the urine and dung are collected. Palm leaves or tiles are used as roofing materials and bamboo or wooden slates are used for flooring. Facilities for feeding concentrates and roughage are also provided in the goat house. In drier parts of this region, ground level houses are constructed by a few organized farmers. This type of housing is about 2-3 m high at the front and 1-1.5 m high at the back. Usually, a thatched roof with mud flooring is common to these houses.

In the semi-intensive system, goats are tethered in a different place each day so that a variety of plants are available. It is a convenient method because it offers better control and requires minimal labour and utilization of the local forage. Often, two to five goats are maintained by households, particularly as a supplementary occupation for the women.

The major portion of the goat population is found in the rural areas and raised by the poorer socioeconomic sections of the community. Most of the flocks consist of two to five goats grazed on marginal lands and consuming agricultural by-products and kitchen waste. No concentrate feeding is generally practiced except when the animals are in milk. At kidding, the female is given the necessary attention. In this system, all the owners may not keep their own bucks, so the females are taken to breeding bucks maintained separately by certain farmers.

CROPPING SYSTEM

The physiographical features of south India favour the growth of different types of irrigated and nonirrigated tree crops. In India, tree crops occupy about 2% of the area cultivated under all crops and account for sizeable export earnings. Crops such as tea, coffee, cashew nuts, etc., contribute to exports, whereas crops such as coconut, arecanut, rubber, cocoa, fruit trees, etc., cater to internal consumption, i.e., the domestic and industrial markets.

Tree crops, in general, afford considerable scope for improving returns per unit area, time, and inputs as compared with annuals. In intermixed and multistoried cropping and mixed farming, efficient soil harvesting, solar energy, and air space utilization are possible with tree crops and, unlike annuals, most of the tree crops remain in the field for many years. Their physiological adaptability is much better than annuals, so much so that crop losses are minimal. By using the mixed and intercropping pattern, the risk can be further minimized. Tree crops, therefore, with their potential for intensive management, represent one of the best means to stabilize income (Nelliat 1978). Important tree crops and areas in hectares under each tree crop, of Kerala, Karnataka, and Tamil Nadu are presented in Table 3.

The literature shows that no systematic efforts have been made to assess the extent of herbage produced interspaced among tree crops, under natural conditions. A preliminary sample survey, however, was conducted by the authors on the production of natural herbage in a lean season under various tree crops grown on the Kerala Agricultural University farms. It is estimated that 1520-2200 kg/ha of natural herbage is grown producing on average 300-450 kg dry matter (DM)/ha. The tree

Table 3. Areas of important tree crops in south India (ha x 10^3).

Crop	Kerala	Karnataka	Tamil Nadu
Cashew	141.277	55.028	60.828
Jack	61.918	8.099	2.061
Mango	62.574	53.351	37.073
Coconut	662.657	295.651	61.016
Rubber	215.474	NA	12.534
Arecanut	60.816	73.663	NA
Pepper	108.073	7.576	0.491
Total	1312.789	49.368	174.003

Note: NA, not available.
Source: Statistics for Planning, Directorate of Economics and Statistics, Governments of Kerala and of Karnataka, India. Season and Crop Reports, Department of Statistics, Government of Tamil Nadu, India.

crops included in the survey and estimated total production in Kerala are given in Table 4.

Bavappa (1974) reported that 23% of soil on an area basis alone is being effectively used by the coconut roots in a unit area of plantation. For depth, 80% of the roots are confined to a 31-120 cm layer of the soil. For the canopy, the light utilization by coconut comes to only about 50%. These findings indicate that both the soil and the aboveground space in a coconut plantation can support a number of other crops. Based on findings from the studies mentioned, experiments conducted at the Central Plantation Crops Research Institute, Kasaragode, showed that the fodder grasses guatemala (Tripsacum laxum),

Table 4. Estimation of natural herbage production in Kerala.

Crop	Area of Kerala state (ha)	Herbage production (kg/ha)	Total herbage production (t)
Cashew	141277	2200	310809.4
Pepper	108073	2820	304765.9
Mango	62574	2200	137706.8
Rubber	215474	1620	349067.9
Homestead (marginal 1 ha)	687400	1520	1044848.0
Total	-	-	2147198.0

hybrid napier (var. NB 21), and guinea grass (Panicum maximum) annually yield 50-60 t/ha of green fodder under coconut shade and the legumes Brazilian lucerne (Stylosanthes gracilis) and cowpea (Vigna unguiculata) produce about 30 t/ha annually. At a feeding rate of 30-35 kg of green fodder to one animal per day, four milch cattle can be maintained on 1 ha of a coconut plantation (Nair et al. 1976). On an animal unit basis, this is equivalent to 24-28 small ruminants/ha. This study indicates a significant potential for growing fodder artificially as well as naturally to overcome fodder shortage periods caused by the diminishing grazing-pasture lands.

Tree crops provide feeds for livestock through agricultural by-products. If these products are properly collected and processed, they will replace costly concentrates to a great extent. Some of the agricultural by-products available from the tree crops of this region are coconut cake, rubber seed cake, mango seed kernel, spent coffee, tamarind seed, and mango and jack fruit skins. The chemical composition and nutritive value of these by-products are reported by Sampath (1984).

PRODUCTIVITY LIMITATIONS AND CONSTRAINTS

A low level of productivity is caused mainly by the inadequate provision of feed and attention to nutritional requirements, lack of efficient scientific management, diseases and pests, and poor genetic potential as a result of the absence of a selection and breeding program and very little research support. Added to these constraints are difficulties encountered with marketing and the full utilization of products and the failure to exploit the full potential use of animal by-products.

Small ruminant production remains in the hands of low-income, landless, or small-scale, subsistence farmers who either do not own any land or possess low-return holdings, resulting in small ruminants feeding only on natural vegetation and crop stubbles supplemented with tree loppings. Intensive agricultural production has led to the depletion of grazing lands together with an increase in the number of the animals, which has resulted in an increase in the density of livestock per unit of grazing area.

The problem of adequately meeting the nutritional requirements of an estimated 36×10^6 small ruminants is a challenge in itself. Singh and Singh (1983) reviewed the feed situation and reported that about 6.5×10^6 ha of land will have to be brought under developed pastures, consisting of grasses and legumes, to meet the total dry matter requirement of about 13×10^6 t to maintain the total sheep population of the country. In relation to the entire country, small ruminants in south India face intense stress because of the higher density of livestock and more areas under cultivation. There is no possibility of sparing any cultivable land for goat and sheep grazing.

In certain parts of Tamil Nadu, specifically Nilgiris, toxic pasture weeds are thought to seriously affect the health of sheep (Pachiappan et al. 1983). Hepatitis, gastroenteritis, and nervous disorders are the complaints commonly attributed to toxic weeds, which include Echium plantagineum, Cycas spp., Euphorbia, Delphinium, Lobelia inflata, and Oxalis cernua. Thorny weeds, such as Ulex europeus, Rubus moulueanus, and Rubus race-mousus, pose health risks too; they also leave vegetable burrs on the wool. Another group of weeds called "killer weeds," including Juncas, Erogrostis curivella, and Cyprus spp., are fatal when their tender shoots are eaten. In Nilgiris, Bracken fern, canary grasses, perennial rye grasses,

panic grasses, and Kikiyu grasses cause various kinds of disorders in the animal.

The intensive afforestation program has eliminated the grazing areas necessary for the migratory sheep and goats, thus disturbing management practices followed for centuries. The reduction in pasture lands is caused by urbanization and the ever-increasing housing needs of the human population.

Land left for grazing has been overgrazed, causing a depletion of vegetation and, consequently, a seriously reduced carrying capacity. The usually low and erratic rainfall together with extreme ambient temperatures and the use of water resources for agricultural irrigation purposes are the inherent physical hazards making efficient land use a difficult proposition in the semi-arid regions. Sheep grazing has been the traditional occupation of many families and with the scope for economic advancement, the number of persons available to carry out this traditional occupation is rapidly declining. Instead, the system of rearing only a few goats or sheep by households is becoming more popular.

The general health of the animals is low most of the time and poor health has a direct bearing on the animal's performance, output, and life span. In this country, several devastating diseases, such as pox, enterotoxemia, pasteurellosis, anthrax, rinderpest, and foot-and-mouth disease, are widespread. There are also several chronic diseases, such as Johne's disease, brucellosis, parasitic infestations, that hamper the productivity of the animals. Also, several new diseases, such as bluetongue, pare influenza-3 infection, mycoplasmosis, chlamydosis, etc., are beginning to threaten the sheep industry. In both lambs and kids, pneumonia and enteritis are the main causes of death. The introduction of exotic genes increased the mortality rate of young animals.

No large-scale, genetic improvement program has been undertaken by the government in small ruminant production. The main constraints are imperfections in the artificial insemination techniques and maintenance of exotic germ plasm. No attempts have been made to improve the native breeds of sheep and goats through selection.

INNOVATIVE CHANGES AFFECTING THE PRODUCTION SYSTEM

To increase the productivity of small ruminants, the existing constraints should be removed and new technological changes should be introduced. A decision should be made on the priority of constraints to be removed depending upon the availability of labour, material, and money.

Because there is hardly any further scope for expansion as a result of the pressure caused by intensive crop production, the extensive system of management should be gradually replaced by the intensive or semi-intensive system of management. Areas in the semi-arid zone that cannot support cattle and buffalo will have to be identified and could be utilized for small ruminant production with low investment.

Legislation protecting and encouraging crop and cattle production has already been enacted. Rural pasture lands, therefore, should consequently be protected through legislation and forest lands should be available for controlled grazing of small animals. Rural pasture land should be improved through reseeding with nutritious, perennial, and high-yielding grasses and legumes.

Because they are efficient converters of coarse fodder, sheep and goats should be fed with fodders that contain a major portion of such unconventional ingredients as tree leaves, bushes, and harmless weeds growing under tree crops. In south India, tree leaves of Acacia spp., Syzyguim spp., Batula spp., Cellis spp., Albezia spp., Sesbania grandiflora, Babul, Murungai, Mango, and Leucaena leucocephala are widely used as fodder supplements to small ruminants (Pachiappan et al. 1983).

An approximate balance between livestock numbers and fodder resources could be achieved by increasing the large-scale plantation of fodder trees and their planned management. These trees can be grown in pasture lands, waste lands, on riverbanks and bunds of ponds, canals, and agricultural fields. A system should be developed to lop the trees periodically without endangering them but also to ensure that future demand will be met. Natural herbage growing under plantation tree crops should be collected and conserved in the form of hay. Wherever possible, controlled grazing underneath tree canopies should be practiced on a rotational basis. Fodder cultivation under plantation crops should be encouraged by the government. Some tree leaves contain tannin and mimosin, which are harmful

to animal health and productivity. A suitable processing method must be developed to ensure safe consumption and maximum utilization of tree leaves.

Efforts to identify and utilize agricultural by-products should be intensified. Production and consumption of a balanced livestock feed mixture based on maximum use of by-products should be developed in a coordinated manner. Animal health facilities should also be strengthened and action should be taken to develop vaccines against emerging diseases and to protect the animals from ecto- and endoparasitic infestation.

Large-scale government farms should be strengthened to produce sufficient numbers of superior breeding rams and bucks. At the same time, a system should be developed to produce breeding males other than those on the government farm. Incentives should be considered to encourage large-scale operators to increase the number of pure and exotic breeds to raise the general quality of all breeds. These crossbreeds could then be sold locally at competitive prices. Steps should also be taken to preserve the rapidly disappearing, valuable breeds of Mandya and Nilgiris sheep. Artificial cattle insemination facilities should be developed and frozen semen techniques for sheep and goats should also be developed and popularized.

Cooperative societies should be formed to take care of all aspects of husbandry practices and product marketing. This system has already been initiated on a small scale in some states. Well-designed slaughter houses should be established to minimize waste and maximize productivity per animal. Long-distance travel should be discouraged to avoid losses caused by death and weight loss. The sheep and goat products should be disposed of through regulated markets like other agricultural commodities. Any attempt to increase the productivity of small ruminants, however, must take into account the fact that small ruminants depend heavily upon the responses of the whole agricultural sector to change economic and technological forces and should, therefore, be studied as part of an integrated system.

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