STRATEGIES OTHER THAN BREEDING FOR THE DEVELOPMENT OF SMALL RUMINANTS

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Abstract *This paper discusses strategies other than breeding that are important to the development and contribution of small ruminants. These include, for example, precise production objectives, choice of species, reproductive efficiency, feeding and nutrition, exploring the avenues of production, and the components of infrastructure, research, linkages, and training. The choice of species for a particular production system is determined by such factors as the availability and quality of feed resources, feeding behaviour, availability of animals, survivability, relative price of meats, market outlets, and biomass production. The principal strategy should aim at increasing per animal productivity through making maximum use of the available feeds and improved efficiency in feeding and nutrition, in which increased use of crop residues and agroindustrial by-products, dietary nitrogen sources, and strategic use of supplementary protein sources are especially important. Where possible, fodder production should be increased to sustain year-round feeding. Of the avenues of production, the highest priority should be directed to systems integrated with tree cropping, followed by intensive small feeding systems that can make more use of the large reservoir of fibrous feeds. The* 20.3×10^6 *ha presently under permanent tree crops is underutilized; it is estimated that this area can support an additional* 81×10^6 *goats or sheep. Attention is drawn to the urgent need to take advantage of the large market potential for goat meat and mutton in the Near East, commensurate with more intensive stall feeding systems of production. Possibilities of how further improvements can make a significant impact on correcting the widening gap between production and consumption of food supply from small ruminants are discussed.*

Two previous papers in this workshop have discussed the types of prevailing production systems in South and Southeast Asia, the constraints that currently exist (Devendra, this volume), and the breeding strategies that need to be pursued within these systems (Bradford et al., this volume).

To complement these papers, it is relevant to consider all other aspects of development that concern the future of goats and sheep. This paper will focus on those strategies other than breeding that are important to the development and contribution of both species. Such strategies have been previously discussed (Devendra 1980, 1985a).

In general, it is especially important in seeking a high efficiency in specific feeding systems and in productivity to maintain an appropriate species, to aim for a realistic potential level of production, to take advantage of the available dietary ingredients, and to identify the objectives clearly in terms of production and profitability. In this, it is particularly important to understand the abilities of each species, their feeding behaviour, their response within individual environments, and their potential productivity in the context of efficient utilization of the production resources.

PRODUCTION OBJECTIVES

It is essential to have clear production objectives. Without these, it is impossible to maximize productivity from both species as well as ensure complete utilization of goat and sheep genetic resources. It is also imperative to relate the production objectives to the available production resources, prevailing market demand, consumer preferences, and the marketing strategies that may be required to link up with the market outlets. The following considerations are pertinent (adapted from Turner 1972).

Characteristics of the Products

Meat

Throughout the Asian region, goat meat and mutton are in very high demand. The demand for both outweighs supplies and this is reflected in high prices, especially of goat meat, and increased imports of mutton from Australia and New Zealand.

Quantity - Total amount of lean meat in the carcass (measured by live weight before slaughter). Growth rate, in

the case of lambs, is related to efficiency of production. Total number of animals available for slaughter is likely to be more important than amount of meat in each animal. Total weight of offspring weaned per year per female is important.

Quality - Quantity and distribution of fat (excess undesirable).

Milk

Quantity - Total yield, lactation, length, persistency, and number of lactations.

Quality - Milk composition (butter fat and nonfat solids).

Carpet wool

Quantity - Clean wool per head.

Quality - Average fibre diameter (coarse fibre desirable). Presence of a proportion of medullated fibres (hair). Absence (or a very small proportion) of kemp (shed fibres or ones with the medulla occupying 90% of the diameter). Staple length. Percentage of clean scoured yield.

CHOICE OF SPECIES

The choice of species and, indeed, breed within a species is determined by several factors. The following factors are relevant: availability and quality of feed resources, feeding behaviour, availability of animals, survivability, relative price of meats, market outlets for meats, and biomass production.

A consideration of the appropriate species is important in relation to the resources available, the environment, and the market demand for specific products. In general, intensive systems will be influenced by the availability and quality of forage and, in turn, the choice of species. With the more extensive systems, both species are often herded together; a higher proportion in these mixed herds is an indication of superior survivability by goats and of an ability to cope with feed shortages.

While the husbandry of goats and sheep is complementary, both species have some distinctive characteristics. It is important that these features are recognized in the choice of animals appropriate to individual production systems. Both

species are often run together in traditional management systems; however, where there is a specific demand for products from one or the other species or when the prevailing situation favours a particular species, a single, appropriate species is chosen. Goats favour drier conditions and areas with abundant browse. Sheep, by virtue of their less inquisitive habits, are more suited to areas with more herbage for grazing.

Unlike the semi-arid and arid regions where many species (sheep, goats, and camels, but rarely cattle) are reared together in essentially nomadic and transhumant pastoralist systems, in humid tropical Asia, goats and sheep are run together and the use of both species is a distinct possibility for both practical and economic reasons. In very arid environments, however, goats tend to survive longest under the extreme climatic conditions and the deteriorating feeding conditions.

In terms of meat production, the question of the number of kids or lambs born and the amount of meat that can be sold annually from the breeding flock is very real and affects the choice of species. This is also influenced by the relative price of meats and the market demand for the product. Biomass production is dictated by a number of biological factors, including age at first breeding, interval between parturitions, litter size, lifetime productivity, and mortality.

REPRODUCTIVE EFFICIENCY

The task of maximizing numbers and ensuring survival is a particularly important strategy to increase the productivity of both species. It is also an important component of producing numbers for breeding and marketing reasons. Thus, improvements to reproductive efficiency can significantly influence the objective of increasing numbers born and product outputs. Reproductive rate is the all too important factor and the build up of numbers is associated with the following components: age at first mating (females), productive life span of males and females, annual mortality in the breeding flock, and number of young females reared per 100 breeding females. The last component is, in turn, influenced by percent of breeding females failing to bear, percent of breeding females producing multiple births, frequency of parturition, and mortality rate up to first mating.

Based on the breeds available (Devendra 1986), there are at least four breeds each of goats and sheep that are dis-

tinctly prolific. Much more use can be made of all these breeds to increase the contribution from both species.

Increasing fertility or number of offspring born per female per kidding or lambing is important because this significantly influences the profit margins. This point was demonstrated in calculations with 80, 100, 120, and 140% rates of fertility for goats in Malaysia. The gross margin of profit per flock or per breeding doe increased with fertility level and type of feeding system (Devendra 1976). Lifetime productivity is essential and females must be retained in the flock long enough (5-7 years of age) to express their genetic capacity.

The significance of varying litter size because of inherent genetic capacity is reflected in a comparison between goats and sheep in Malaysia in terms of biomass production. Biomass production is the net effect of combining the inherent biological qualities in the species as well as good husbandry. It is influenced by such factors as age at first breeding, length of reproductive cycle, interval between parturitions, litter size, lifetime productivity, and mortality. It is, therefore, of interest to compare the relative abilities of both species to produce biomass, a portion of which is sold for profit as meat (Table 1). It is evident that although the average live weight of adult does or ewes is the same, litter size is an important determinant of biomass production when other factors such as the level of husbandry and mortality rates are similar. In this case, goats produced about 82% more biomass than sheep in Malaysia.

FEEDING AND NUTRITION

Attention to feeding and nutrition, and the development of suitable strategies that can alleviate the prevailing low efficiency of production represents a particularly important strategy. Once the production objectives have been defined and the appropriate choice of species has been made, the efficiency with which the production resources are used and the response of the species to this efficiency, in terms of increased per animal productivity, will be largely dictated by the level of feeding and nutrition. In this context, the attention to feeding and nutrition is the most important single factor that affects production, including reproductive efficiency. While breeding and selection programs are long term, the benefits of improved feeding and nutrition are spectacular and relatively

Table 1. Comparative biomass production between indigenous goats and sheep in Malaysia.

Species	Avg live weight of female	Litter size	Survivability at 12 months[a]	Avg weight at slaughter (kg)	Biomass production[b] (kg)
Goats	22	1.8	1.44	20	28.8
Sheep	22	1.1	0.88	18	15.8

Source: Devendra (1985b).
[a] Mortality rate is 20%.
[b] Survivability x average weight at slaughter.

immediate. It is relevant, therefore, to consider this topic in some detail.

Nutritional strategies are the most important nongenetic factors that can influence future small ruminant productivity in the Asian region. Once a breed or species has been identified, the efficient utilization of the available feed resources is the most important next step in addressing productivity.

The justification for emphasizing feeding and nutrition is seen in the results of two studies in India and Malaysia (Tables 2 and 3). In India, in both breeds, the differences in the average milk yield per lactation between the high and low planes of nutrition were very high, between 226 and 315% (Table 2). It is significant to note that with the low plane of nutrition the effect was to curtail milk production. In Malaysia, a comparison of adult goats of approximately similar ages from the rural areas and those reared "under" experimental conditions gave very high differences (Table 3).

The following four strategies are considered important.

Increased Utilization of Crop Residues and Agroindustrial By-products

More intensive use must be made of the large amounts of lignocellulosic materials and other agroindustrial by-products, simply because these are the cheapest and most widely available

Table 2. Effects of nutrition on lactation milk yields (litres) of two dairy breeds of goats (Barbari and Jamnapari) in India.

Lactation number	Barbari			Jamnapari		
	MH[a]	LL[b]	Difference (%)	HH[c]	LL[b]	Difference (%)
1	101.0	27.8	263.3	153.7	44.0	249.3
2	129.7	30.3	328.1	196.0	58.4	235.6
3	100.4	21.7	362.7	131.8	45.2	191.6
4	106.8	-	-	128.0	-	-
5	109.2	-	-	-	-	-
Mean	110.4	26.6	315.0	160.5	49.2	226.2

Source: Adapted from Sachdeva et al. (1974).
[a] Medium-high plane of nutrition.
[b] Low-low plane of nutrition.
[c] High-high plane of nutrition.

feeds for ruminants. This conclusion has been previously emphasized (FAO 1982; Mahadevan 1982). For successful application, acceptable feeding systems are simple, practical, within the limits of the farmers' capacity and resource availability, convincing, and consistently reproduceable. Moderate to low levels of animal performance may be biologically inefficient, but could be more economically viable than high levels of performance, especially with the existing limitations of small farm systems.

Not enough use is being made of the various crop residues and agroindustrial by-products to feed both goats and sheep. This is possibly due to an inadequate use of intensive feeding systems such as that which has been successfully demonstrated for rice by-products or maize by-products fed with Leucaena leucocephala in the Philippines (Rasjid and Perez 1980; Magay 1982) and sugarcane by-products fed to goats in Fiji (Hussein et al. 1983).

Table 3. Magnitude of improvement feasible in indigenous Katjang goats from rural araes as a result of improved nutritional management in Malaysia.

Parameter	Rural goats[a]	Experimental goats[a]	Improvement feasible (%)
Live weight at slaughter (kg)	18.6	28.6	53.8
Hot carcass weight (kg)	8.2	14.7	79.3
Dressing (%)	44.2	51.3	7.1
Weight of meat (kg)	5.5	8.1	47.3
Meat-bone ratio	4.1	4.9	19.5
Forequarter (kg)	1.2	2.9	108.3
Hind leg (kg)	1.2	2.2	83.3
Total edible weight (kg)	13.2	18.2	36.8
Total saleable weight (kg)	17.9	24.0	34.1

Source: Devendra (1979).
[a] Adult goats about 3 years of age.

One of the problems related to alternative nutritional strategies is the choice of options. In many parts of Southeast Asia, in situations where mainly rice straw exists, the priority is finding the best means of converting rice straw to a useful animal product. Rice straw will continue to be used by cattle and buffalo, with their higher production potential (meat, milk, and draft power). This does not, however, preclude small ruminants, since using rice straw as a small ruminant feed on experiment stations has been effective. The central aim is higher levels of production, since energy requirements for maintenance account for most of consumption, particularly with animals of low production.

In light of recent Asian results, the choice of options also needs special attention with respect to feeding systems: i.e., urea treatment of rice straw and urea-molasses block

licks (UMBL). Rice straw may also be improved by microbial degradation.

Improving the nutrition of sheep and goats would also reduce disease incidence and mortality. This, in turn, should reduce economic losses.

Increased Forage Cultivation on Available Land

Where possible, there should be increased cultivation of forages, grasses, and legumes on available land. This can be undertaken in any waste or uncultivated land, rice bunds, or fence lines. The use of leguminous forages like leucaena (L. leucocephala) or sesbania (Sesbania grandiflora) is underestimated and much more use could be made of these, especially as supplements (Devendra 1984). Leucaena leucocephala is the most widely used forage for feeding ruminants in Southeast Asia (Devendra 1986) and, even during droughts, provides an excellent source of fodder and dietary nitrogen; it can also be used as a fence line. The presence of such forage reserves forms an important component of integrated agriculture in small farms and goes a long way toward furnishing much-needed nutrients to enhance intake and animal performance. Throughout the Asian region, there exists a variety of tree leaves whose use is underestimated (Table 4), especially for feeding goats (Devendra 1983a).

The basic strategy is to produce sufficient amounts of good-quality feed available year round (Devendra 1986). On small farms, the demand for food crops supercedes production of feeds for livestock. Thus, innovative measures are needed for meeting nutrient requirements of livestock from various forages and residues from food-crop production. This approach also has the associated advantage of enabling seasonal surpluses (e.g., cereal straws or silages) to be preserved for subsequent use when feeds are in short supply, such as during dry seasons and droughts.

Increasing the Use of Dietary Nitrogen Sources

Associated with the first two strategies is the important need to concurrently increase the use of dietary nitrogen sources, especially nonprotein nitrogen (NPN) sources and proteinaceous forages. Examples of the benefits of this strategy are seen in the results of two previous studies (Tables 5 and 6).

Table 4. Some important tree leaves and browse plants in South and Southeast Asia.

Common name	Botanical name
Bangladesh, India, and Pakistan	
Anjan	*Hardwickia binnata*
Ardu	*Ailanthus excelsa* Roxb.
Babul	*Acacia arabica*
Bauhinia	*Bauhinia* spp.
Banana	*Musa* spp.
Bargad or banyan	*Ficus bengalensis*
Beri	*Ziziuphus jujuba*
Dhaincha	*Seshania aculeaton*
Gular	*Ficus glomerata*
Imli	*Tamarindus indica*
Jackfruit	*Artocarpus heterophyllus*
Jamun	*Engeinia jambolana*
Kheiri	*Prosopis cineraria*
Khair	*Acacia catechu*
Khanthal	*Artocarpus integrifolia*
Mulberry	*Morus indica*
Pakar	*Ficus infectoria*
Pipal leaves	*Ficus religiosa*
Neem	*Azadirachta indica*
Sainjan	*Moringa oleifera*
Siras	*Albizzia lebbeck*
Indonesia, Malaysia, Philippines, and Sri Lanka	
Banana	*Musa* spp.
Banyan	*Ficus bengalensis*
Canna	*Canna* spp.
Cassava	*Manihot esculenta* Crantz
Gliricidia	*Gliricidia maculata*
Hibiscus	*Hibiscus rosa-sinensis*
Ipil-ipil	*Leucaena leucocephala*
Jackfruit	*Artocarpus heterophyllus*
Lantana	*Lantana* spp.
Passion fruit	*Passiflora edulis* f. *flarcarps*
Pigeon pea	*Cajanus cajan*
Singapore rhododendron	*Melastoma malabathricum*

Table 5. Effect of feeding untreated and urea-ammonia treated grand rice straw on the average daily weight gain of young goats.

Treatment[a]	Daily live weight gain (g)	
	9 weeks	13 weeks
75% URS, 25% CL	53a	45a
50% URS, 50% CL	91b	92b
75% TRS, 25% CL	93b	84b
50% TRS, 50% CL	105b	101b
100% TRS	11c	27a
SE	10.3	10.4

Note: Means in the same columns followed by a different letter differ significantly ($P < 0.05$).

Source: Adapted from Winugroho and Chaniago (1983).

[a] URS, untreated rice straw; TRS, treated rice straw; CL, cassava leaves; SE, standard error.

In the study of Winugroho and Chaniago (1983), goats were fed untreated and urea-ammonia treated straw supplemented with cassava leaves in Indonesia (Table 5). The inclusion of up to 50% cassava leaves with treated or untreated rice straw, while stimulating increased weight gain, was not statistically different between treatments over 9 and 13 weeks experimental durations. It follows that the inclusion of cassava leaves with untreated rice straw is cheaper than its inclusion with treated straw. It was concluded that grinding and urea-ammonia treatment of rice straw enabled goats to maintain weight. However, the inclusion of cassava leaves in diets with untreated and treated rice straw enabled pelleting of the feeds and allowed the goats to gain weight.

The study of Devendra (1983) involved another example of feeding a proteinaceous, leguminous forage, Leucaena leaves, in balance trials with sheep. Increasing levels of Leucaena forage (10-60%) were used to substitute the basal rice straw

Table 6. Intake and digestibility of chopped rice straw (RS) supplemented with varying levels of Leucaena leaves (L).

Parameter[a]	RS (control)	RS + 10% L	RS + 20% L	RS + 30% L	RS + 40% L	RS + 50% L	RS + 60% L
Fresh intake (g/day)	741.3a	890.7ab	967.7ab	1158.7ab	1446.0bc	1475.7bc	1300.7bc
DMI/kg 0.75 (g/day)	59.9a	58.9a	53.2a	59.9a	68.5b	70.7b	59.9a
DMI (% body weight)	2.7a	2.6a	2.6a	2.8a	3.1a	3.1a	2.7a
DM digestibility (% of intake)	42.2a	58.5b	46.7b	49.5b	50.5b	53.2c	49.6b
OM digestibility (%)	50.9a	51.3a	49.5a	52.5b	53.3b	55.5b	52.4b
CP digestibility (%)	19.7a	40.5b	47.2c	49.6c	52.0c	66.2d	50.5c
Energy digestibility (%)	40.4a	46.4b	46.3b	52.1c	51.5c	54.7c	46.2b
N retention (% of intake)	-0.1a	20.2b	16.4b	23.6b	31.5c	27.5c	30.8c

Note: Means in the same row followed by a different letter(s) differ significantly ($P < 0.05$).

Source: Devendra (1983).

[a] DMI, dry matter intake; DM, dry matter; OM, organic matter; CP, crude protein.

feed. Dry matter intake (DMI), crude protein and energy digestibilities, and N retention were all improved. The calculated increase in metabolizable energy (ME) intake because of Leucaena supplementation ranged from 16.2% with the 10% inclusion to 86.2% for the 50% Leucaena leaf inclusion (Table 6). N retention also increased with increasing Leucaena level, reaching a maximum at the 40% level of inclusion; this was concluded to be the optimum level.

Concerning NPN sources, much more use could be made of urea and poultry litter, both of which are relatively cheap and within reach of farmers. It has been estimated there is an annual production of approximately 13.1×10^6 kg poultry litter, equivalent to 3.2×10^2 kg crude protein, in Asia and the South Pacific (Devendra 1985c). A good proportion of this can also be incorporated in diets for goats and sheep.

Increasing the use of NPN sources can be achieved by employing one of several methods appropriate to a particular situation. Some applicable methods are spraying to pasture, spraying or addition to hay, addition of NPN to a liquid trough in association with molasses, using NPN-molasses block lick, inclusion in drinking water, and addition to cereals or concentrates.

Of these, the incorporation of urea into cereal straws to release ammonia, the spraying of ammonia directly into the cereal straws, and the use of urea-molasses block licks (UMBL) has had considerable success. These innovations are significant in that they represent two major success stories in Asia.

The success of UMBL is mainly because of their attractiveness and taste to the livestock. The blocks are a potentially effective means of making NPN such as urea (15-20%) continuously available, and fortified with macro- and microminerals and other nutrients essential to both the microbes and the animal. The possibility of overingestion of the flock and the danger of toxicity appear to be remote.

Much of the early work in this area has been confined to buffalo and cattle in India, the Philippines, and Indonesia. Recently, however, an attempt has been made to extend the use of UMBL to small ruminants; three recent preliminary experiments on this possibility, conducted by Soetanto (1986) in Indonesia, are possibly the first of their kind. In experiment 1, the results of digestibility studies with sheep given waffered sugarcane tops (WST) with or without UMBL with

0, 3, or 6% urea and 500 g Leucaena indicated that there was an increase in the dry matter disappearance in sacco of WST. The results, however, were not significant. In experiment 2, four growing lambs were placed on each of three treatments: control (+300 g fish meal), WST + UMBL (3% urea), and WST + UMBL (6% urea). The results indicated that UMBL significantly stimulated ($P<0.01$) live weight gain (Table 7). Experiment 3 was similar to experiment 2, using goats instead. This experiment was terminated, however, because of ill health of the goats. These preliminary studies suggest that the use of UMBL can be extended to goats, especially in extensive situations where the feeds are coarse and sparse. This strategy should be substantially expanded in terms of future effort.

Strategic Use of Supplementary Protein Sources

Strategic use of protein supplements, often the main limiting factor in efficient feeding and nutrition of ruminants, also merits some consideration. Its economic use for both goat meat and mutton production must be carefully considered, especially in relation to breed type and potential for growth. With milk production, however, judicious supplementation is necessary ensuring that the value of the milk produced is higher than the cost of the supplements used.

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 and concentrates to a control browsing situation. Treatments, as would be expected, significantly stimulated daily live weight gains and also affected dressing percentages ($P<0.05$). The net returns indicated that the supplementary feeding with forages gave the highest margin of profits, followed by concentrates, and, finally, the combined effect (Table 8). The results emphasize the value of green forages and question the necessity of feeding concentrates for meat production from sheep in this experiment.

An alternative situation involves the strategy to arrest live weight losses during drought. This has been well demonstrated by Vearasilp (1981), who showed quite clearly that when high-quality Leucaena or Gliricidia was included between 10 and 20% of dietary dry matter in a rice straw based diet, live weight losses by sheep were small over a 45-day period.

The strategy to use scarce concentrates carefully implies that protein concentrates like coconut cake, groundnut cake,

Table 7. The effect of urea-molasses block licks (UMBL) supplementation on feed intake and daily gain of lambs in Indonesia.

Diet[b]	DM[a] intake (g/day)		OM[a] intake (g/day)		Daily live weight gain (g)
	WST[c]	UMBL	WST[c]	UMBL	
A	224.94	88.74	186.27	81.07	-35.40
B	236.64	91.81	209.57	83.87	18.57
C	283.27	116.69	234.15	106.47	23.60

Source: Adapted from Soetanto (1986).
[a] DM, dry matter; OM, organic matter.
[b] A, natural grass ad lib + 300 g fish meal; B, UMBL + 3% urea; C, UMBL + 6% urea.
[c] WST, waffered sugarcane tops.

soybean meal, palm kernel cake, and fish meal, all of which are commonly found in most countries, can be conserved and preferentially utilized more efficiently by nonruminants. Some of these ingredients may need to be protected for local use rather than be exported.

EXPLOITING THE AVENUES OF PRODUCTION

Three main types of production systems have been previously described (Mahadevan and Devendra 1985). Of these, exploiting systems integrated with tree cropping appears to have potential for substantially increasing the productivity of goats or sheep.

There currently exists in South and Southeast Asia 20.3×10^6 ha of land under permanent crops (FAO 1984). This area is essentially unused and is potentially valuable if some of it can be integrated with either goats or sheep for meat production using the available knowledge and suitable interventions. Assuming an average stocking rate of four goats or sheep per hectare, which is typical of stocking rates involving

Table 8. Performance of weaner kids in a semi-arid environment in India.

Parameter	Browsing (B)[a]	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
Avg daily gain (g)	19.4	41.7	111.0	108.2
Dressing (%)	45.7	44.5	48.2	49.1
Returns per kid per 90 days	-	9.0	3.6	0.2

Source: Parthasarathy et al. (1983).
[a] For 7 h daily.

natural vegetation under coconuts and rubber based on a review of the literature (Devendra 1985b), and if only half this land area (10×10^6 ha) was integrated with one of the species, the corresponding number of goat or sheep equivalents is 40×10^6. At an approximate slaughter weight of 20 kg, the potential biomass production is 800,000 t, which represents about 79% of the combined current production of goat meat and mutton from goats and sheep in South and Southeast Asia. It is patently clear, therefore, that the avenue of production can be exploited much more fully and merits a high priority in research and development programs.

Likewise, a system that should be more fully investigated is intensive stall feeding or the "cut and carry" system. This system is favoured by increasing demographic pressures, reduced grazing land, and the presence of considerable quantities of crop residues and agroindustrial by-products, including nonconventional feeds. The available crop residues and nonconventional feeds are not being used adequately in intensive feeding systems; their use must be substantially expanded.

For both systems in particular and all systems in general, there must be multidisciplinary effort and an application of the information that is already on hand to achieve the final objective of maximizing productivity from both species.

EXPORT MARKETS

A major initiative that requires attention and one that has not been given the attention it deserves is the question of export markets for goat meat and mutton. Admittedly, the first priority is to maximize production of meat from both goats and sheep to meet national targets. Markets beyond national boundaries, however, can also be considered. Market potential in the Near East is enormous and warrants an immediate initiative. This initiative must consider the following aspects: type of meat required (goat meat or mutton); methods of slaughter, processing, and transportation; live animals or frozen carcasses; aspects of carcass quality and taste preferences; and economic benefits of the export trade.

These considerations and the quest to increase productivity from small ruminants through more intensive systems of management encourage yet another aspect of the production system that has not been adequatly considered in the past: commercialization of large-scale meat production comparable to beef enterprises. This aspect has not been given the attention it deserves; to take advantage of the available dietary ingredients, much more research and development are required. The inherent advantages of this approach include a more complete utilization of the available feeds, the development of more intensive systems of production including better use of the meat breeds, and an expanded production of meat in quantitative and qualitative terms for both the national and especially international markets in the Near East.

Some consideration has already been given toward meeting this objective, especially in Pakistan and India, but further progress must be sustained. In Pakistan, large sheep feed lots are now being examined in Buluchistan and the Northwest Frontier Province using mainly nonconventional feeds, such as depathogenized poultry litter, concurrent with the development of slaughter facilities. Such initiatives can conceivably also be expanded to include other countries in Asia, provided the production resources can be coupled to economic meat production from small ruminants. Perhaps the overriding consideration in this initiative is the element of urgency that is required to

grasp the existing demand potential in the Near East. Once this initiative has been grasped, it will be necessary to sustain production and strive toward improving the quality of the meat produced to meet consumer preferences.

INFRASTRUCTURE, RESEARCH, LINKAGES, AND TRAINING

A strong infrastructure is essential to support research and development programs. Continuing research is vital to sustain progress not only nationally, but regionally, in which linkages can promote further progress. Large-scale, on-farm testing is also necessary and, for the results to be accepted, they must be convincing, consistently reproduceable, and within the limits of the farmer's capacity and resource availability. Inherent within all these strategies is suitable training to ensure the effectiveness of the total effort.

One aspect of the support services that needs revamping in many countries is the extension services. Often the application of useful knowledge is impeded by inadequate extension services. Adequate extension services are an integral part of all development programs, including disease diagnosis and animal health provision, sale, marketing arrangements, and producer and marketing cooperatives.

CONCLUSIONS

There are a number of possible strategies that can be employed to increase productivity and, hence, the potential contribution of small ruminants. Some of these possibilities are clearly more important than others and, therefore, justify urgent attention: definition of production objectives, reproductive efficiency, improved nutritional management, and exploiting the avenues of production. Of these, the highest priority must be given to exploiting systems integrated with tree cropping more completely.

It has been reported (CGIAR 1985) that the projections for the demand for sheep and goat products up to the year 2000 indicate that the gap between production and consumption is increasing faster than for other food commodities. This conclusion is presumably based on current trends in population growth and prevailing patterns of consumption of goat meat and mutton. This trend is likely to result in 29 and 21% increases in the goat and sheep populations, respectively, by the year

Table 9. Projected goat and sheep populations (millions) in South and Southeast Asia and the South Pacific.

Category	1984[a]	1986[b]	2000[b]	2000[c]	Normal increase[d] (%)	Potential increase[d] (%)
Goats	136.2	142.0	183.7	236.3	29.4	66.4
Sheep	73.2	75.2	90.8	140.1	20.8	86.3

[a] Source: FAO (1984).
[b] Based on annual growth rates of 2.1 and 1.5% for goats and sheep, respectively.
[c] Potential increase because of integration of goats and sheep with permanent crops (see text for explanation).
[d] From the base year, 1986.

2000 (Table 9). However, if innovative improvements could be immediately made to focus on the more potentially important production systems such as integration with tree cropping involving the 20.3 x 10^6 ha under permanent crops, goat and sheep populations could increase by 66 and 86%, respectively, by the year 2000. This increase could make a major impact on food production and significantly alleviate the prevailing low levels of production.

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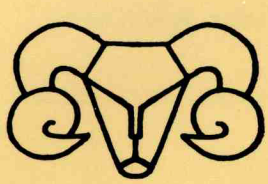

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Devendra, C.

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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. Ottawa, Ont. IDRC, 1987. xii + 414 p. : ill.

/Animal production/, /goats/, /sheep/, /mixed farming/, /small farms/, /South Asia/, /Southeast Asia/ — /feed/, /crops/, /research methods/, /economic analysis/, /animal diseases/, /case studies/.

UDC: 636.3(5) ISBN: 0-88936-493-1

Technical Editor: W.M. Carman

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IDRC-256e

Small Ruminant Production Systems in South and Southeast Asia

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

Editor: C. Devendra

Cosponsored by the
International Development Research Centre
and the
Small Ruminant Collaborative Research Support Program

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.

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