SMALL RUMINANT PRODUCTION: SYSTEMS FOR SUSTAINABILITY

SPONSORED BY

THE AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR RESEARCH AND DEVELOPMENT, OFFICE OF AGRICULTURE

IN COLLABORATION WITH

V INTERNATIONAL CONFERENCE ON GOATS

28-29 FEBRUARY 1992
PARK HOTEL, NEW DELHI
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INTRODUCTION

Small ruminants have the potential to play an important role in economic development. For as the developmental focus shifts to free market systems, privatization and value-added industries, small ruminants fit naturally into this type of developmental scene. As governments change to these types of priorities there is an opportunity to promote and initiate development and research efforts which deal with small ruminants.

Before the full advantage of small ruminants can be realized there are several developmental constraints which encompass the areas of insufficient investment, and biological and socio-economic factors. Raising the priority of small ruminants so that greater investments can be garnered requires elevating them on government agendas. This will require reversing the previously held conceptions about small ruminants and livestock projects in general. Biological and socio-economic research and extension efforts must use a systems approach in the improvement of small ruminant production. That is, promote a greater appreciation so that components such as nutrition, health, marketing and women are inextricably together, and to effectively implement change in one component requires an understanding of how the other components will react.

There has been a misconception that small ruminants, especially goats, are the major biotic factor responsible for ecological degradation and desertification. But have these species caused desertification or rather is it that they are one of the few species which can utilize the desert. Some feel that small ruminants should be removed from the ecologically fragile areas. But it is not clear if massive destocking will have a positive ecological response. Furthermore, such attempts at destocking will create serious economic problems to the smallholder who depends upon these species as an integrated component of their crop farming or as large flocks which are produced in a migratory production system. Therefore such actions will require much more thought and evaluation than what has been given to this important issue to date.

In planning and implementation of small ruminant development programmes, the involvement of the farmers and private voluntary organizations implementing such programmes has not received adequate attention. By ignoring this important income generating component of the farming system those interested in increasing the economic well-being of smallholders are overlooking the greatest economic potential which these people have at their disposal.

To address the previously mentioned issues the Second International Workshop on Small Ruminant Production was held. Discussions were centered on developmental issues of planning and implementing small ruminant programmes. The workshop brought together private voluntary organizations and technical personnel from research institutions and universities from the developing and developed world. It was organized in conjunction with the V International Conference on Goats. The workshop involved presentation of technology statements related to various aspects of production and
socio-economics and presentations of case studies. The participants were divided into three groups:

- Systems
- Technology
- Reaching farmers

In these groups participants discussed the aspects of small ruminant production as a subsystem of agricultural production systems. Within these groups participants discussed approaches for improving production and economics of production, how to transfer information on farmer problems to researchers, and how to transfer technological innovations from the research community to farmers.

It is hoped that these proceedings will accomplish several goals. First, it will provide a literature base for the various topics presented at the workshop and second, it will serve as a springboard for increasing the awareness of the need to integrate animal production, environmental stability and economic development.
SUMMARY OF RECOMMENDATIONS

1. There is a serious misconception about the role of small ruminants and especially goats in ecological degradation. As a result of uninformed opinions, development planners are not supporting goat development programmes. It is essential that these types of misconceptions be removed. There is sufficient evidence available to show that goats are no more responsible for environmental degradation than other agricultural practices. In fact, goats may be more complementary to environmental stability than previously assumed. This is due to their dietary preference for browse and plant species which are unpalatable to other animal species. This then suggests that goats can be used as a tool to manipulate vegetation and therefore help to maintain plant biodiversity.

2. In many regions of the world small ruminant populations are rapidly growing. This is the result of a number of factors. But principally it is a revealing condition that people engaged in agriculture can turn to these animals not only for sustenance but also income. However, increasing human populations, small ruminant profitability and a lack of concerted efforts by host country governments and donors may be contributing to a situation of natural resource abuse. It is necessary then to bring the number of animals (of all species) into line with the feed resources available. To achieve this goal will mean a more intensive involvement with the small ruminants sector than previously exhibited by all concerned.

3. There is a clear need for greater attention to be placed upon the role small ruminants play in generating income. Marketing systems and infrastructure have to be developed to enhance the economic advantage these species convey not only to smallholders but also to national economies.

4. Efforts at improving production through genetics have not had the impact as had been hoped for. The scientific and development communities have principally concentrated upon breed substitution or crossbreeding programmes. Although these approaches have perceived advantages, but if management and nutrient resources are lacking these efforts become largely unproductive. Therefore breeding and genetics efforts should concentrate upon utilizing and enhancing indigenous breeds. If crossbreeding or breed substitution is deemed desirable, careful evaluation of new genetic resources through on-farm testing should be done first.

5. To successfully plan programmes which focus on small ruminants will require the development of projects which are not only multidisciplinary but also interdisciplinary. Projects of this nature have not been successfully designed at this point in time. These types of projects will require a much higher level of integration than has previously been attempted in development programmes. In designing this type of project, programme planners will have to analyze the present production system.
SUMMARY OF RECOMMENDATIONS

This not only includes biological aspect but also an evaluation of farmer's resources, constraints and objectives. In addition, the analysis will have to include cultural and biological linkages for the marketing and processing of the products. Proposed interventions then have to be evaluated in the context of their impact on the entire production system.
INAUGURAL ADDRESS : SHRI P.G. MURALIDHARAN

Secretary to Government of India, Ministry of Agriculture,
Department of Animal Husbandry and Dairying

I welcome the distinguished delegates to this International Workshop on Small Ruminant Production: Systems for Sustainability.

Livestock farming in most developing economies continues to be a small sector unorganized rural activity, closely associated with and as an integral part of a sound system of diversified agriculture. Livestock is a key element in raising farm productivity, and it would be difficult to conceive of sustained increases in small holder production in most areas without paying sufficient attention to livestock development. The positive role of livestock in the development of sustainable land use cannot also be underestimated.

In certain parts of India like the arid, semi-arid and desert regions, crop farming alone cannot provide sufficient income for the economic well-being of the farmers, mainly due to the poor productivity of land for crop production. These areas offer very good scope for the rearing of livestock, especially sheep and goats.

Sheep and goats make a very important contribution to the survival of the relatively vulnerable sections of society; they also meet the requirements of various industries besides helping to earn valuable foreign exchange through the export of meat. In many developing countries, sheep and goat rearing continues to be in the hands of poor, landless and to some extent small and marginal farmers who raise their animals on natural vegetation and stubbles, supplemented by tree loppings. Small ruminants are sources of meat, skin, fibre, milk and manure and often are the sole or subsidiary source of sustenance for the rural poor. A comparative study of sheep and goat rearing and that of cattle in ecologically fragile zones would indicate that, within the desired grazing pressure, sheep and goat are more economical and less harmful than the large ruminants.

The system of sheep and goat rearing in India is different from the one followed in many other developed/developing countries; due to the existing land use pattern, the rearing of these animals has to be in smaller units, except in migratory herds. Hence, the improvement of common pasture land and sub-marginal land assumes added importance for the development of small ruminants.

Sheep and goat breeds of the country, especially in the ecologically fragile zones, constitute unique genetic material which is rare and calls for careful preservation and development. Low fertility, small size, light weight and higher utilization of coarse fibres are some forms of adaptation of these breeds to the ecologically fragile zones.

The main thrust of the policy on sheep development in India has been on the improvement of wool, both in regard to its quality and quantity. Crossbreeding of indigenous sheep, especially non-descript ones, is resorted to bring about qualitative and quantitative
improvement in wool production. To achieve this, exotic breeds of sheep have been imported and multiplied in different parts of the country. In a situation characterized by adverse climatic and suboptimal managemental inputs some of these breeds have not been able to perform well enough to contribute substantially towards the improvement of indigenous breeds. Selective breeding is also being carried out among important indigenous breeds for medium and strong wool and mutton. Development of dual purpose and mutton type of sheep with a view to augmenting meat production in the country has also been receiving attention. In fact, the major reasons for low productivity of sheep in the country are the lack of organized efforts for genetic improvement, inadequate grazing resources, disease problems and inadequate marketing facilities. We would be addressing these problems more seriously.

The population of goats in the country increased from a level of nearly 47 million in 1951 to 96 million in 1382. Now, it is estimated to be around 110 million. This increase in number has occurred in spite of the fact that no special goat development programmes were being implemented and that nearly 40% of the goat population is slaughtered every year. The striking feature of distribution of goats in India is that the activity of goat rearing is sustained in many different kinds of environment — dry, hot, wet or cold, high mountains or low lying plains. The activity is also associated with different farming systems — crop based or animal based, pastoral or sedentary, single animal or mixed herds, small scale or large scale. The per head requirement of nutrients in respect of goats is relatively low. They also suit the resources of small farmers with marginal grazing lands, which cannot, in any case, sustain large animals throughout the production cycle. In spite of this, the development of goat in some countries has suffered on account of two conflicting views about the role of goat in land use. While one school of thought holds that the goat is the major cause of denudation of forests and rangelands causing soil erosion and that their multiplication should be restricted, the other view considers this blame as unfair and unscientific as the goat consumes only the scrub left over from grazing by cattle. Goats can survive in ecologically fragile zones, where other livestock fail to maintain themselves. In fact, a study in one of the States of the country, Rajasthan, has revealed that goat is not responsible for the fragility of the ecology. On the other hand, it has been brought out that goat is the last element in the chain of factors that causes environmental degradation. Part of the concentration of sheep and goats in dry and wastelands can be explained by the fact that over a period of time, on account of the development of irrigated agriculture, sheep and goats migrated from irrigated to dry areas. Perhaps it is for this reason that we find a high degree of correlation between available wasteland and goat population in different states of the country.

For promoting goat development in the country, the questions that would need to be addressed would relate to the type and scale of goat enterprises in order to promote better management within the existing resources. One scenario is that the existing extensive goat husbandry system would be replaced by an intensive or semi-intensive system of goat husbandry over a period of time with greater confinement of animals to restricted areas. This may be desirable in ecologically fragile areas for preventing further degradation and for providing fair opportunity for regeneration of biomass cover. While this may be an advantage from an environmental perspective the imperative need for increasing commercial returns from goat husbandry in terms of milk, meat, skin, hair etc. cannot also
be overlooked. Although there has been a growing awareness of environmental issues in the field of development of small ruminants, there is still no reliable database, technology, land use planning or appropriate legislation in most of the developing countries.

The degradation of renewable natural resources is the main environmental problem in developing countries. A consequence of changes in land use, which have been triggered by rapidly changing political and socio-economic conditions, environmental degradation threatens the very subsistence of population in large parts of the Third World. To stop environmental degradation and to restore ecological sustainability, a new approach to livestock production would be needed. This would encompass both traditional and modern production systems. Resource management would involve complex and manifold relations, involving technology, institutions and social, political and economic factors. It requires processes of change that would affect all sections of the society. This is an area where, I am sure, the NGOs can provide a very important link. One of the common features of successful and sustainable projects is a high degree of target participation. This could be achieved by strengthening of organizations representing the target groups concerned. This would underline the importance of what is commonly known as empowerment. Active participation of population, right from the project planning stage, is an absolute precondition for sustainability. Strengthening and supporting of farmers' organizations to improve their bargaining power should be an explicit goal of development efforts. Farmers' organizations could play a key role in input and credit supply, health care training, extension, processing and marketing. The position of women within the farmers' organizations should receive special attention and their active participation at all levels should be ensured.

Biotechnology offers very good scope for developing sustainable small ruminant systems. However, successful application of biotechnology in developing countries would depend upon the recognition of unique climatic conditions, constraints in the availability of feed and fodder, breed differences and availability of trained personnel, laboratory facilities and financial resources.

In spite of the knowledge now available on various aspects of the development of small ruminant production systems, the efforts in involving suitable development programmes, especially involving private and voluntary agencies, are yet to acquire the desired momentum. International donor agencies have of late shown more interest in supporting private and voluntary efforts in taking up small ruminant development programmes, as these mainly benefit the disadvantaged sections of society. I am confident that this workshop will help evolve appropriate strategies for the planning and implementation of such programmes. I am grateful to the USAID Bureau for Science and Technology for supporting the effort by organizing this international workshop in conjunction with the Fifth International Conference on Goats, thus taking advantage of the presence of a large number of distinguished scientists from all over the world.

I have great pleasure in inaugurating the Workshop.
Small ruminants (goats and sheep) are very valuable renewable resources in Asia and the Pacific. They are found across all agro-ecological zones without exception, and constitute important components of farming systems throughout the region. Together with their involvement in farming systems, these resources are intimately linked to the socio-economic status of poor farming families in rural areas.

Within the various agro-ecological zones, there exist variable populations of a bewildering variety of goats and sheep that demonstrate ability to adapt, survive and reproduce within the climatic extremes. They are found, compared to other ruminant species, uniquely distributed in all types of agro-ecological conditions throughout Asia: from the high altitude of Himalayas, arid and semi-arid areas of Pakistan, India and Mongolia, to the high rainfall, high humidity countries that are characteristic of most parts of South-East Asia. In these situations, both species perform a number of primary and secondary functions which are extremely important to the small farmers and landless peasants. This contribution is significant to total farm income, the stability of farming systems, and human nutrition all of which directly benefit the livelihood of poor people.

The intention in this paper is to focus on the current status and contribution of small ruminants in Asia and the Pacific and how well these resources are being presently used. In particular, the paper draws attention to those issues that are worthy of increased research and development attention, the opportunities for increasing the current level of contribution, and alludes to future emphasis and direction.

Goat and sheep resources

Table 1 indicates that goats and sheep in Asia and the Pacific account for about 53% and 21%, respectively, of the total world population of these species. India, China, Pakistan, Bangladesh and Indonesia have major reservoirs of both goats and sheep, and these countries accounted for about 90% and 95%, respectively, of these species in Asia. The ratio of sheep to goats is about 1:1. The rates of growth of the individual species over the last 10 years from 1980 to 1990 were 2.0% and 0.9%, indicating that the goat population is growing faster than the sheep population in Asia and the Pacific. It is of further interest to note that goats and sheep account for between 22.3 and 24.1% of the
total population of grazing ruminants (buffaloes, cattle, goats and sheep).

Table 1. Goat and sheep resources of Asia and the Pacific regions (RAPA/FAO, 1930)

<table>
<thead>
<tr>
<th>Species</th>
<th>Population ($10^6$)</th>
<th>As % of total world population</th>
<th>Rate of growth/year (1980-1990)</th>
<th>As % of total grazing ruminants in Asia*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goats</td>
<td>294.4</td>
<td>52.9</td>
<td>2.0</td>
<td>24.1</td>
</tr>
<tr>
<td>Sheep</td>
<td>254.3</td>
<td>21.3</td>
<td>0.9</td>
<td>22.3</td>
</tr>
</tbody>
</table>

* Buffaloes + cattle + goats + sheep.

Productivity

Table 2 summarizes the extent of the different types of products from each species. Goats produced approximately 58.9% of goat meat and sheep 19.1% of mutton and lamb as percentage of total world production. Corresponding contributions for milk were 35.8% and 15.2% for goats and sheep, respectively, as percentage of the total world contribution.

Both goat meat and mutton are extremely important, and are widely consumed. Between the two meats, current supplies are inadequate to meet the demand. The situation is such that considerable opportunities exist for increasing the current level of supply. With specific reference to goat meat, an analysis of past and projected trends (Devendra, 1987a) suggests the following conclusions:

1. Inadequate supplies of goat meat have resulted in a trend towards the increased price of per unit of goat meat relative to all other meats. This is reflected in many countries especially in South-East Asia (Devendra, 1979).
2. There have been increased imports of feral goat meat notably from Australia and New Zealand to markets in the Near East and the West Indies.
3. The high price of goat meat has encouraged unscrupulous substitution by imported mutton from poorer quality sheep.
4. Inadequate goat meat supplies have also resulted in the increased price of live goats, including breeding animals.
5. The demand for goat meat has encouraged increased slaughter of breeding animals with a consequent erosion of the base population in quantitative and qualitative terms.
6. The reduced availability of improved breeding animals has also resulted in some countries to shift from goat to sheep production.
Turning to wool, sheep produced 11.2% of the total world production of greasy wool. Fresh skins are an important by-product of goat and sheep production and the extent of the contribution, as percentage of total world population, was 57.4 and 17.4% respectively.

Table 2. Productivity of goats and sheep in Asia and the Pacific (RAPA/FAO, 1990)

<table>
<thead>
<tr>
<th>Species</th>
<th>Meat (10^3 MT)</th>
<th>Milk* (10^3 MT)</th>
<th>Wool greasy* (10^3 MT)</th>
<th>Skins* fresh (10^3 MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goats</td>
<td>1476</td>
<td>2835</td>
<td>256.6</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>316</td>
<td>1341</td>
<td>357.7</td>
<td>223.3</td>
</tr>
</tbody>
</table>

+ From FAO (1989).

Breeds

Given the high concentrations of goat and sheep populations, it is pertinent to draw attention to the types available. Asia is a very important reservoir of widely different and well adapted indigenous goat and sheep breeds. They are very diverse, and classification is not easy especially since there has been considerable crossbreeding between the breeds. The goats are extremely varied, and are concentrated mainly in the north-east and the north-west in the Ganges and along the Himalayas, throughout the Sind and the Punjab and in the mountain valleys of Baluchistan and around Kashmir. Although there is a diversity of breeds and type of goats, there are certain external features which are prominent. Black is a dominant colour and horns, where present, are usually scimitar-shaped. Scimitar-horned goats have been found in vase fragments near Baghdad going back to about 3000 B.C., and ceramic art involving goats around 1000 B.C. are known to be associated with the Indus Civilization and the Chalcolithic cultures of central India.

Table 3 identifies the more important indigenous goat breeds in Asia with reference to such specialized attributes as milk, meat, prolificacy, cashmere, pashmina and skin production. The breeds have potential "improver" capacity, and have above average productivity in one way or other, or because they are specially adapted to a particular environment. A total of 47 important indigenous breeds are identified which are worthy of more research and development.

Table 3. Important indigenous goat breeds in Asia

<table>
<thead>
<tr>
<th>Speciality</th>
<th>Country</th>
<th>Breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Medium milk yield</td>
<td>India</td>
<td>Beetal and Jamunapari</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Damani, Dera Din Pannah, Kamori</td>
</tr>
<tr>
<td>(2) Meat*</td>
<td>Bangladesh</td>
<td>Black Bengal</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>Banjiao, Chengdu Ma, Du An, Fuqing, Guizbou White, Haimen, Huai, Leizhou, Longlin, MaTou, Shanxi White</td>
</tr>
</tbody>
</table>
Likewise, Table 4 lists the more important indigenous sheep breeds in Asia with reference to milk, mutton, fine wool, carpet wool, carpet wool and prolificacy. A total of 15 important indigenous breeds are identified.

Table 4. Important indigenous sheep breeds in Asia

<table>
<thead>
<tr>
<th>Speciality</th>
<th>Country</th>
<th>Breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Pakistan</td>
<td>Damani</td>
</tr>
<tr>
<td>Mutton</td>
<td>India</td>
<td>Mandya, Muzaffarnagri, Balkhi, Rakshani, Kag‘hani, Dumbi</td>
</tr>
<tr>
<td>Fine wool</td>
<td>India</td>
<td>Chokla</td>
</tr>
<tr>
<td>Carpet wool</td>
<td>India</td>
<td>Magra, Marwari</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Baluchi, Buchi</td>
</tr>
<tr>
<td>Prolificacy</td>
<td>China</td>
<td>Hu</td>
</tr>
<tr>
<td></td>
<td>Bangladesh</td>
<td>Bangladeshi</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>Javanese thin-tail</td>
</tr>
</tbody>
</table>

It is stressed that both Tables 2 and 3 are not exhaustive, simply because of a lack of more complete information. It is quite likely that many more potentially important goat and sheep breeds are present in Asia which are worthy of more investigations and documentation.

**Significance of ownership**

Goats and sheep are raised with several objectives to serve the material, cultural and recreational needs of farmers with the following advantages (Devendra, 1980; Devendra and Burns, 1983).
(1) **Income.** Important means of earning supplementary income.

(2) **Food.** Provides animal proteins (milk and meat) that are important for the nutritional well-being of peasants.

(3) **Security.** Sources of investment, security and stability.

(4) **Employment.** Creation of employment including effective utilization of unpaid family labour.

(5) **Fertilizer:** Contribute to farm fertility by the return of dung and urine.

(6) **By-product utilization.** They enable economic utilization of non-marketable crop residues.

(7) **Social values.** The ownership of animals has been shown to increase cohesiveness in village activities.

(8) **Recreation.** Socio-economic impact of animal ownership also includes a recreational contribution to small farmers.

**Small ruminant production systems**

Small ruminant production systems in Asia have endured in relation to the overall pattern of crop production and farming systems. They are especially dependent on the agro-ecological environment and as ruminants, must always depend on vegetation or crops for their feed base, these systems can be categorized as follows:

(1) **Extensive systems**

(2) **Systems combining arable cropping**
   - Roadside, communal and arable grazing systems
   - Tethering
   - Cut-and-carry feeding

(3) **Systems integrated with tree cropping**

These production systems are unlikely to change in Asia and the Pacific in the foreseeable future. New proposed systems and returns from them would have to be demonstrably superior and changes from them would need to be supported by major shifts in the use of resources to which there is access and can be efficiently utilized (Mahadevan and Devendra, 1986; Devendra, 1989). However, it is quite predictable that there will be increasing intensification and with it, a shift within the prevailing systems, especially from the first to the second. This situation is particularly likely in countries where land would be increasingly limiting in the face of increasing human and animal populations. Changes must therefore be introduced gradually, consistent with economic benefit, and low risk in systems that ensure stability. The principal aim is to make maximum use of the basic feed
resources available. This means using available crop residues and low quality roughages to maximum advantage. In addition, delivery systems should be developed for the essential supplementary feeds (leguminous forages, agro-industrial by-products and other feed concentrates not directly used by pigs and poultry).

Table 5 sets out the extent of permanent pastures available and also land under forests and woodlands. Also given in the table is the corresponding magnitude of the ruminant livestock units available, based on calculations from FAO data. Of particular significance is the marked imbalance between the total ruminant livestock units and available permanent pastures in Asia compared to the other regions. It is in this region, to include centrally planned economies, more than any other, that there exists acute feed shortages to meet the requirements of ruminants, such that continuing low per animal performance is more the rule rather than the exception. The importance of making maximum use of all available feed resources thus assumes far greater importance, and is a particularly important strategy in this situation.

### Table 5. Extent and distribution of permanent pastures, forests and woodlands, and ruminant livestock (FAO, 1986)

<table>
<thead>
<tr>
<th>Region</th>
<th>Permanent pastures $(10^6)$</th>
<th>Forest and woodlands $(10^3)$</th>
<th>Ruminant livestock units $(10^3)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing market economies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Africa</td>
<td>631.2</td>
<td>645.7</td>
<td>138.4</td>
</tr>
<tr>
<td>Asia and the Far East</td>
<td>109.8</td>
<td>220.5</td>
<td>356.3</td>
</tr>
<tr>
<td>Latin America</td>
<td>512.7</td>
<td>928.8</td>
<td>253.2</td>
</tr>
<tr>
<td>Near East</td>
<td>267.6</td>
<td>95.2</td>
<td>67.0</td>
</tr>
<tr>
<td>Total</td>
<td>1521.3</td>
<td>1890.2</td>
<td>814.9</td>
</tr>
<tr>
<td>Asian centrally planned economies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>409.8</td>
<td>188.6</td>
<td>100.5</td>
</tr>
<tr>
<td>Total developing countries</td>
<td>1931.1</td>
<td>1078.8</td>
<td>915.4</td>
</tr>
<tr>
<td>World total</td>
<td>3170.8</td>
<td>4086.6</td>
<td>1319.6</td>
</tr>
<tr>
<td>As % of world total</td>
<td>60.9</td>
<td>50.9</td>
<td>69.4</td>
</tr>
</tbody>
</table>

+ Refer to 1975 data.

** Conversion factors: Buffalo 1.0, cattle 0.8, goats and sheep 0.1.

The forest and woodlands have also been included in the table to provide a reminder about the potential importance of the herbage available under these perennial tree crops, including also the use of some of the more important leaves. These feed resources have not been adequately utilized in the past for want of adequate methodology to facilitate the process of integration, involving appropriate choice of species, objectives of production that can ensure high productivity from the land due to the combined thrust of both animal and crop association. In South, South-East and the Pacific Islands for example, there
exists about $20 \times 10^6$ha under tree crops. Even if only half of this crop area is utilized by animals, the number of animal equivalents that can be carried, and productivity from them, assumes considerable magnitude (Devendra, 1986, 1990).

**Development strategies**

A number of development strategies are worthy of emphasis and attention in the future. These are as follows:

1) Clear production objectives

   i) Meat: Goat meat and mutton

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

      Growth rate, is related to efficiency of production in both kids and lambs. Total number of animals available for slaughter; and the amount of meat yield per animal are equally important.

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

   ii) Milk:

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

      Quality - Average butterfat per cent and solids-not-fat content.

   iii) 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.

The parameters identified for carpet wool would also apply to fine wool.

**Whole commodity systems research**

If the "improver" breeds are going to be more widely utilized, and the potential contribution from goats and sheep are to be realized, a systems' perspective is essential in which interdisciplinary team efforts can ensure that all aspects of production will be considered. The components in this task include a holistic view of how the resources are managed efficiently, the development of appropriate methodology and links with post-production aspects. More than anything else, the approach will promote sustainable and environmentally sound production systems, and also provide for the efficient management of the natural resources.
Post-production aspects

The value of efficient systems to produce goat meat is futile, if this is not matched with distinct links with post-production systems in which there is organized collection, transportation and marketing of goats, to include products and by-products from them. These aspects are generally very neglected throughout the developing countries resulting in several implications:

i) **Reduced revenue to farmers.** Observations in several countries in Asia suggest that farmers generally receive 55-60% of the total value of the animal, the remaining 40-45% going to middlemen and or butchers whose total effort in terms of production process time is about 1-2 days.

ii) **Reduced revenue from the sale of animals as well as their products.** These involve the meat, skins, by-products and derivation of value-added products from skins. Recent studies in India on goats transported for over 400 km for 15-38 hr indicated weight losses of 9-10%, which in quantitative terms is quite high. This figure excludes losses due to the effects on poor quality products, by-products and herd wastage (Naidu et al., 1991).

iii) The quality of the animals slaughtered specifically for goat meat production is doubtful. In several countries, animals from unknown background and production systems with no reference to consumer preferences are slaughtered at random. The majority of animals sold (70-80%) are 1-2 years old.

iv) Where demand for goat meat is high and consumption is widespread, and organized programmes are not in place, there is serious erosion of the breeding population in which increasingly younger animals are slaughtered. The net effect is reduced output of goat meat. Surveys in two states in India indicated that 50-73% of the goats slaughtered were below 6 months of age, and 26-50% of 6-12 months of age (Naidu et al., 1991).

The sale process and price paid for goats is very variable, as also the methods of collection and transportation. Invariably, the price paid by the middlemen is arbitrary and subjective, and is associated with apparent size, age, sex, castration, constitution and value of skins. Probably because of size, males generally fetch higher prices than females. Animals in poor constitution receive the lowest prices. Slaughter methods are generally appalling in most countries, especially in rural areas, and so also the use of the by-products. All these components of the post-production systems merit urgent considerable research and development attention.

The components in post-production that merit attention are:

- **Collection** — Methods of collection including transportation are important and affect slaughter weight.
- **Handling** — Includes mode, duration of transportation, and management during it.
SMALL RUMINANTS IN ASIA AND PACIFIC: DEVENDRA

- Marketing: Distinct presence and its capacity; what are its requirements.
- Slaughter facilities: Size, adequacy, hygiene, strategic location, and methods to salvage by-products.
- Consumer requirements: Nature, extent and characteristics. These need to be addressed in relation to changing trends.

Utilization of research results

There exists in Asia a considerable wealth of information on various aspects of the husbandry of both goats and sheep, over and above the information available from elsewhere. If progress is to be made, and the objective is to increase the contribution from these species, it is most imperative that there is increased utilization of the available information. The justification for this is associated with:

i) necessity to meet the immediate needs of farmers who represent the target clients,
ii) research is expensive and resources to support it are increasingly scarce,
iii) avoidance of duplicating research, to repeal by both national and international agencies what is already known; and
iv) moral obligation of scientists to ensure that the results of research are meaningful, relevant and applicable at the farm level.

On-farm validation of results

Associated with above, there is a critical need to undertake concerted on-farm research and development activities that are consistent with the objectives of production and the quest to improve the welfare of poor rural people.

The value of research results lie in their extension and validation in real farm situations. This is best done through participatory research with farmers. Practical procedures for conducting on-farm animal research have recently been published (Amir and Knipscheer, 1989).

In addition to these, attention is drawn to a number of other recommendations for research and development in goats in sheep in three recent proceedings of useful meetings (Devendra, 1987b; Devendra, 1988; and Devendra and Faylon, 1989).

It is envisaged (FAO, 1988) that by the turn of this century, there will be little suitable land for increasing the area of arable crops. The quantity of crop residues will therefore remain static, and if the production of meat, milk and draught power are to be maximized, more intensive systems of production and increasingly higher per animal output is essential. Advances can only be achieved through making available new technologies, diffusion of knowledge, and ensuring application in which on-farm experimentation and development was crucial.
The measurement of impact is important in on-farm research to address the beneficial value of the derived technology with reference to such criteria as value added; real benefits to small farmers, peasants and landless labourers; income generation; pollution control, and possible expansion in animal production activities.

**Network for small ruminants**

Many of the development strategies are directly concerned with national programmes. In order to sustain and synergise these activities, as well as enable sharing of the experiences and promote information exchange, a network for small ruminants in Asia was established in 1989.

The International Development Research Centre (IDRC) took the leadership in launching this network called the Small Ruminant Production Systems Network for Asia (SRUPNA), which is also supported by other donor agencies. SRUPNA has the following objectives:

- Increase the exchange of information
- Provide training on small ruminant production
- Establish effective mechanisms for promoting the exchange of germplasm
- Promote and utilize research results
- Support and strengthen national research programme
- Publish a small ruminant newsletter

Members of SRUPNA will include scientists, extensionists, policy makers and individuals involved with small ruminants in Asia. Thirteen countries in Asia are members of this network.

The information arm of SRUPNA is the Asian Small Ruminant Information Centre (ASRIC). The functions of ASRIC include:

- Collaborating with the Co-ordination Unit of SRUPNA on the publication of a Small Ruminant Newsletter to provide a means of information exchange
- Setting up of a working group on identification and standardization of minimum data sets useful for research on small ruminants and technology transfer
- Acting as SRUPNA's resource centre with a clearly defined role to provide information products and services, particularly to scientists in the network
- Establishing of a micro-computer data base (bibliographic references, SDI services and Directory of Asian Scientists engaged in research on small ruminants) for distribution to participants.

The Co-ordinating unit of SRUPNA is the Central Research Institute for Animal Sciences (CRIAS) in Bogor, Indonesia. ASRIC is located at the Central Sheep and Wool Research Institute (CSWRI) in Avikanagar, Rajasthan, India.
CONCLUSIONS

The contribution of small ruminants in Asia is currently constrained by inefficient utilization and management of the available breeds. Given the fact that the prevailing production systems are unlikely to change in the foreseeable future, more concerted effort is necessary to improve the situation with more innovative management. The opportunities for doing so are enormous, and is associated with potential improvements in productivity. Particularly emphasis needs to be given to the more important development strategies identified.

REFERENCES


THE IMPORTANCE OF SMALL RUMINANTS — A DONOR’S PERSPECTIVE

HARVEY BLACKBURN

The perception of how small ruminants can impact development efforts has been improving among the donor community. What was once seen as a poria is now a vehicle for economic growth. Although the donor’s view of small ruminants is changing there is a need to more clearly establish the role of sheep and goats in development. It is imperative that scientists and PVO/NGO communities put forth an effort to enhance the opportunities for small ruminant activity. Why is such an effort necessary? During the 1980s the donor community divested itself of much of their livestock activities. The reason for this divestiture was a history of projects which were not viewed as being successful. Granted many of these projects were poorly designed and did not emphasize the most appropriate component of the livestock production system. For example, many projects did not include small ruminant components, even though sheep and goats were more important to the producers than were cattle.

As a result of divestiture, funding for livestock activities has decreased. To reinitiate livestock activities means that proposed projects will have to be competitive with all other aspects of development. Given livestock’s checkered history the justification for new and/or additional efforts will have to be clear, quantifiable and show promise of success.

It has been my observation that small ruminants projects are not always viewed with the same lack of confidence that cattle projects are. This is the result of not being a popular project focus in the 70s and 80s and the increased awareness of how women and small ruminants are closely linked. Prior to 1980s small ruminant activities by donors were limited, a result of a cattle bias and a perception that small ruminants were solely responsible for environmental degradation. However, the 80s was a decade of transition. During this time there was a realization that small ruminants were important to smallholders both on a subsistence level and as a source of income. Furthermore, attitudes about the role of small ruminants in degrading the environment was beginning to change towards a realization that poverty causes environmental degradation and not any particular type of livestock or agricultural practice. If this is indeed the case there is a window of opportunity for small ruminant projects. The question then becomes one of how to capital ‘ze on the situation.

ECONOMIC GROWTH

One of the most important rationales for donors to support livestock activities is the impact which the livestock sector has on economic growth. Fig. 1 demonstrates on a global basis
IMPORTANCE OF SMALL RUMINANTS: BLACKBURN

Fig. 1. Regression of GNP on crop or livestock production values

how increasing value of livestock products positively impacts GNP. However on the same
graph it can be seen that the same positive relationship between crops and GNP does
not exist. This point is often overlooked by donors when they view agriculture as a whole.
To further elaborate on the impact livestock have on economies, Fig. 2 shows how
incomes grew in East Asia and the corresponding growth in the dollar amount of livestock
products consumed and the amount imported. There are two important points in Fig. 2.
One is the positive association between income and livestock consumption. Second is
the growth of livestock imports. The growth in imports indicates that domestic livestock
products are not being produced in sufficient quantities to satisfy domestic demand. This
lag effect is perhaps one area which donors have over-looked in their evaluation of the
livestock sector.

Additional information quantifying the impact of livestock is becoming available; it will
allow us to know their true importance. In a recent publication by IFPRI (1990) the
multiplier effects for agricultural products in the state of Punjab are given. This is one of
the few publications documenting how livestock and their products produce job oppor-
tunities throughout a nation's or region's economy.

**Employment multipliers per unit of output in the Punjab economy**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1969-70</th>
<th>1979-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>1.13</td>
<td>1.11</td>
</tr>
<tr>
<td>Rice</td>
<td>1.11</td>
<td>1.04</td>
</tr>
<tr>
<td>Animal husbandry</td>
<td>1.13</td>
<td>1.17</td>
</tr>
<tr>
<td>Dairy products</td>
<td>15.72</td>
<td>7.51</td>
</tr>
<tr>
<td>Grain mill products</td>
<td>12.02</td>
<td>5.25</td>
</tr>
</tbody>
</table>
Fig. 2. Relationship between income growth and consumption of livestock products in East Asia.
Although the examples of economic impact are not specific to small ruminants there can be no doubt that much of the economic significance of the livestock sector is a result of viable or potentially viable small ruminant sub-sectors. For example, in Mali 32% of producers' cash income is generated with small ruminants (Debrah and Sissoko, 1990). When one examines the long-term increase in the demand of red meat it quickly becomes apparent that small ruminants will play a crucial role in meeting the demand. The competitive advantage which small ruminants will have is due to their low capital input, high reproductive rates and cultural acceptability of their products.

**EVOLUTION IN PROJECT DESIGN**

If small ruminant programmes have an opportunity to receive increased attention from the donor community how can they avoid the problems observed with livestock projects in the 70s? Earlier projects were designed and implemented as disparate and single components of the production system or the livestock's biology. In other words they concentrated upon health or nutrition and did not consider breeding, or marketing. However, as previously noted this approach has not been successful. The following is a summarization of why livestock projects did not achieve the desired level of success (Cartwright and Blackburn, 1989).

1. Failure of financial support for a sufficiently long term.
2. Change of design and objectives before project completion.
3. Great diversity of the socioeconomic and physical environments.
4. Failure to analyze and utilize data.
5. Lack of infrastructure to support improvement programmes as designed.
6. Projects being based on disciplinary rather than total production systems designs.
7. Socioeconomic interactions with livestock production systems which are based on mixed farming, not being understood or appreciated.

In the early 80s there was a growing appreciation that livestock projects should be multidisciplinary. This change of philosophy was in part due to realization that single component projects were not effective in developing the livestock sector. As a result multidisciplinary or farming system projects were initiated. A notable example of this multidisciplinary approach has been the Small Ruminant Collaborative Research Support programme (SR CRSP). This programme has incorporated most disciplines which are involved with biological (genetics, nutrition, health) and social aspects (sociology and economics) of small ruminant production. This type of project was a major step in changing the way livestock activities are conceived.

Although the SR CRSP represents a major shift in the way projects are designed and implemented, the project still lacks a truly systematic approach in the way small ruminant research is conducted. That is to say a greater emphasis on the interaction between components of the systems (e.g., nutrition, health and forage resources) is necessary to promote viable sustained project activities. In the evolutionary process of project design, projects embracing a system approach are the next logical and necessary steps if small ruminant projects
are going to have sustained, environmentally sound impacts. Designing and implementing projects which follow a systems approach will require a greater degree of flexibility and an appreciation that generalized solutions are not appropriate. Rather interventions to a production system have to be customized. This customization will have to consider the resources of the system and how they can be optimally applied in the context of social and economic conditions.

An example of how interventions have to be customized for various producers comes from SR-CRSP results in Kenya. Fig. 3 shows how using a dual-purpose goat (DPG) and improved forage resources had a dramatic effect on smallholders who owned approximately 0.69 ha. However these interventions had little impact on the incomes of farmers who owned larger farms. This implies that other technologies may be needed if DPG production is going to have a dramatic impact on larger farmers as on those with 0.69 ha farms.

The next section describes how small ruminant activities employing a systems approach fit into the developmental process of a particular country or region.

![Graph showing income impact by farm size and technology](image)

**Technology**
- Small 0.69 ha
- Medium 1.39 ha
- Large 3 ha

Fig. 3. Impact of DPG and new forages on income by farm size and technology.

**STRATEGIC DEVELOPMENT OF THE SMALL RUMINANT SECTOR**

Livestock sector development plans must be designed in a long-term and holistic context. As previously mentioned, successful long-term small ruminant development policies are dependent upon alleviation of technical, social and economic constraints within the limitations of the natural resource base. Also key in the development strategy is the fact that production systems have many local optima which provide beneficial outputs from small ruminants. These optima are achieved by combining appropriate levels of technical,
IMPORTANCE OF SMALL RUMINANTS: BLACKBURN

social and economic intervention. This suggests there are alternative paths of development for the sector, in any particular region or country, which may lead to the same result. Therefore as a country moves along a particular path there will be the need for a sequencing of appropriate combinations of technologies as the development process proceeds.

Fig. 4 conceptualizes this approach. In this diagram time is implicit in the phase of development (X-axis). It is assumed that some span of time passes when the livestock sector moves from phase 1 to phase 2. However, the length of time between phases can vary across countries or regions. Within each phase there are specific production practices (or packages) which are feasible and can be employed in the production system. As a livestock sector develops, entering a new phase, a new combination of technologies should be employed to promote progress in the sector.

The objective of a strategic plan for livestock is to locate interventions for the appropriate phase of development and then determine how and when to move the sector to a new phase with different sets of interventions. Planners and implementors must be aware that the rate of improvement in the livestock sector will not be constant. Series 1 and 4 demonstrate this concept. Planners should also be cognizant that production packages may play out and result in a sector decline, as is the case of series 2. In these types of situations it is necessary to place more emphasis on other types of technologies and make a lateral jump. The difficulty in making such a jump is that productivity may suffer for a short time during the transition.

As Fig. 4 demonstrates development should be viewed as a continuum, a series of building blocks dependent upon previously established foundations. This may seem obvious, but when various donor programmes have been evaluated it is apparent that many livestock projects have tried to skip development steps. Without previous foundations to support the jump in technology or policy these projects have failed. Likewise by not considering the normal environmental fluctuations which occur these development efforts have also failed. For example, livestock projects conducted in sub-Saharan Africa which did not incorporate drought strategies in the project design.

Throughout this development process there is a great need for collaboration among participants. Improved collaboration will occur when the organizations involved have a greater understanding of their collaborators' view point. Donors must have consistent goals, a commitment to sustained funding and an appreciation of the time frame necessary to implement small ruminant activities. The research community should be sensitized to the needs, capabilities of host country institutions as well as bringing to bear their scientific disciplines. The PVO community has a large role to play in the dissemination of technology to host country institutions or directly to the farmer. To do this effectively an understanding of potential interventions created by the research community must be achieved.
Fig. 4. Development paths livestock industries follow when different technologies exist.
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GENERALIZED COMPONENTS LEADING TO IMPROVED SMALL RUMINANT SYSTEMS

Several interventions which can improve the productivity of small ruminants are presented. The integration of small ruminants and cropping systems has great potential in all phases of development, although the level of integration will vary depending upon the development phase of the livestock and crop industries. Smallholders benefit from this integration as can farmers with greater financial resources. For as incomes rise so will the level of expertise and the ability of farmers to increase their level of productivity and the resources they control.

Mixed farming and livestock activities

Closely associated with mixed cropping and livestock production systems is the greater integration of owning and producing mixed livestock species. Optimal combinations of different livestock species can have positive impacts on environmental stability as well as risk aversion for livestock owners. Often such diversification benefits different family members. For instance small ruminant production and women.

Nutritional limitation centres around cyclical weather patterns which assures that nutritional quality of forage will decrease during portion of the year thereby lowering animal productivity. Strategies incorporating fodder banks, leguminous trees, new grass varieties and preservation of crop aftermath; to supplement animal diets can be developed in the context of production packages.

Genetic improvement

Genetic improvement strategies are slow to be brought into effect but once the production potential of the animal population is improved the benefits of such activities have long-lasting effects. Presently efforts concerning the potential advantages in indigenous populations need exploring and their combination with various exotic varieties. World Bank estimates indicate that only 3% of the African cattle population has had any sort of systematic animal breeding practised on the population.

Improved management

Controlling these various potentials and combinations is the ability of the farmer to manage these resources. This entails an understanding of the potential benefits and the ability to exploit the opportunities these potentials have. To make new technology packages easily accepted by the farmer, time and labour constraints will have to be addressed. Effective extension networks or formation of producer groups would be an avenue to address these problems.

Policy and economics

Economically there are numerous opportunities for the livestock sector to contribute to national economies. A healthy livestock sector will not only generate income for the owners, but it will have multiplier effects throughout the economy. This means agribusiness opportunities will develop hand in hand with increasing animal productivity.

Clearly an environment conducive to livestock sector development will have to be established through government policy. When policies are applied they should be based upon the status
or health of the livestock sector. For instance a primary policy which should be resolved in the early phases of livestock development is land tenure. As animal industries develop trade barriers, price regulation and infrastructure issues will have to be resolved.

CONCLUSIONS

Clearly small ruminants play and will continue to play important roles in developing countries. The opportunities for the development community to utilize these animals is diverse in ecological and socio-economic terms.

This paper has made several key points about small ruminant activities in developing countries. Project design must be viewed in holistic terms and at several hierarchical levels. On the lowest level, integration of all biological factors impacting the system should be accounted for. Biological considerations must then feed forward and be taken into consideration in the formulation of economic and natural resource policy. The emphasis of these factors must change as the development process continues.

Perhaps the greatest impact small ruminants can make in the economic development of developing countries is toward improving farmers' net income. Although this concept is always present in the back of our minds, those involved with small ruminant development have perhaps concentrated too much upon the subsistence aspects of small ruminant production and utilization. Small ruminants can be used to foster policy changes, development and marketing channels and be the focus of value-added industries. This does not mean that one skips developmental steps but rather the economic prospects are brought into sharper focus in the planning and implementation of livestock activities so that at some stage of development full advantage of economic potential can be achieved.

For sustainable agriculture to be more than a hot new phrase to add to our vernacular, requires a viable livestock component to encourage: crop rotations, maximum utilization of crop aftermath, increasing soil stability and fertility, and raising levels of net income. Within the livestock sector small ruminants have a clear advantage due to their size, reproduction and cost. With well thought out development activities these species can serve as an engine of development within an integrated sustainable systems.

REFERENCES


B. TECHNOLOGY STATEMENTS
BREEDING STRATEGIES FOR SMALL RUMINANTS

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Small ruminants are numerically more important species of livestock in developing countries. About 95% of goats and 53% of sheep are in developing countries. These species contribute to subsistence of small farmers and landless rural poor who predominantly maintain these species. These species contribute to marketable commodities such as meat, milk, fibre, skin, pelts and manure. In higher altitudes animals of these species are also used as pack animals. These species especially goat are used as a biological control for brush and undesirable forbs. They also act as seeding machine spreading more uniformly the grasses, legumes and tree seeds. These species have also a religious and cultural importance and contribute to income generation, capital storage, employment generation and improving household nutrition. They also contribute to sustainable crop production through providing fluid cash for purchase of off-farm inputs and through their valuable organic manure.

GENETIC RESOURCES

There are 271 important descript breeds of sheep and 107 important descript breeds of goats. In case of sheep they belong to carpet wool, apparel wool, mutton, dairy, meat, fibre and pelt types or their various combinations; and in goats to dairy, meat, fibre and pelt types or their various combinations, meat being an important component in economics of production of most of the breeds of goats except highly specialized dairy breeds of goats. In addition to the important descript breeds of these two species, there are a large number of descript but less important breeds and non-descript populations. No attempt to describe all the small ruminant genetic resources of the world has been made. The few recent attempts made under the auspices of the FAO are "Breeds of Sheep and Goats in India", "Livestock Breeds of China", "Small Ruminants in Near East" (Vols I & II), "Sheep and Goats in Pakistan" and "Awassi Sheep". There is serious need to describe and evaluate the existing genetic resources in terms of their population, population trends, flock size and structure, ecology, feed resources, management practices, body size and weight, conformation and production characteristics. Such evaluation should be supported by gene marker characters. This will allow determining intra- and inter-breed variability, and such evaluation along with comparative performance of breeds will help in deciding on the breed(s) that should be raised in a particular ecology or should be used as improver breed(s). This is also necessary for taking steps for their conservation.
BREEDING STRATEGY

The breeding strategy will involve decisions on objectives and approaches in bringing genetic improvement. This will also depend upon socio-economic and ecological considerations, existing genetic resources, their productivity, possibility of their improvement through selection within a breed, grading with indigenous improver breeds, or replacing an indigenous breed within existing breed if it is arising from similar ecological region and thus will be adaptable, or crossbreeding for evolving new breed combining the adaptation and hardiness of local breed(s) and higher productivity of the exotic breed(s).

Breeding objectives

(a) Goat: Major breeding objectives can be for milk, meat and fibre (cashmere and mohair) or their combinations. For milk production major consideration will be given to lactation yield, lactation length and milk composition specially fat and solids-not-fat (SNF). In some cases where the milk is converted into products like cheese, protein content may need to be determined and considered in selection.

In meat production, live-weight gains, efficiency of feed conversion, carcass yield and quality, reproductive performance, survival and milk yield of the dam are important characters. These can be more easily considered together if we take kg of kid weaned/doe a year.

In fibre production the greasy fleece weight, scoured fleece yield, fibre diameter and length are important characters. The greasy fleece weight is more easily recordable whereas determining the yield and fibre characteristics would require laboratory facilities. These characters to some extent can be evaluated subjectively through visual and tactile observations but objective evaluation is more desirable.

(b) Sheep: Major breeding objectives can be apparel wool, carpet wool, pelt and milk production. In apparel wool, major characteristics of importance are greasy fleece weight, scoured fleece yield and average fibre diameter. In carpet wool, greasy fleece weight, scoured fleece yield, average fibre diameter and percentage of heterotypic and completely medullated fibres are characters of interest.

In mutton, body-weight gain, efficiency of feed conversion, carcass yield and quality, reproductive performance and lamb survival are major characters of importance. However, kg of lamb weaned/ewe a year can be used as an index combining most of these characters.

In pelt, size, colour and quality in terms of type and tightness of curls and lustre are important.

In milk, lactation yield, lactation length and milk composition in terms of fat and solids-not-fat (SNF) are important.

Breeding approach

Breeding approach may involve: (i) Selection within a local breed, (ii) grading a local breed with superior indigenous breed(s), (iii) crossbreeding with exotic breeds for evolving new breeds.
combining adaptation and hardiness of the indigenous breed and higher productivity of the exotic, and (iv) replacement of an indigenous breed with an exotic breed of higher productivity.

The breeding approach (breeding plan which involves selection and mating system) will have to be decided on the basis of the performance of local breed, the size, the genetic variability in the characters of interest, physical environment and feed resources available to sustain higher production. Decision will also depend upon the demand for the products in markets close to the centre of production and distant markets, and handling, processing and marketing infrastructure available. There is every likelihood that increased production or improvement in quality without assessing market demand and developing, handling and marketing system may lead to serious economic privation to the producers. This can be exemplified by the experience from Mexico on increasing milk production in goats. There was little market for goat milk in the area where improvement in milk production was attempted and thus there was a serious problem in its disposal. However, the nearby market had a large demand for home-made cheese and the conversion of milk into cheese led to the disposal of the milk at remunerative prices and economic returns to the producers. Similarly in southern Rajasthan in India, where attempt was made to improve wool quality, absence of system of separating improved wool from that produced by local sheep and absence of incentive prices for better quality wool led to disenchantment of the sheep breeders towards the programme. The local market required coarse carpet wool for making felting products and the improved quality of wool was not suitable for the purpose.

Selection criteria

Selection criteria will depend upon the phenotypic and genetic variances in and covariances among important characters, their relative economic values and source of information.

Among reproductive traits the age at first kidding and kidding interval have moderate to high heritabilities; litter size and preweaning survival have low heritabilities. Body weights, growth rate, carcass yield and quality have reasonably high heritabilities. Milk yield and milk composition have medium heritabilities. The greasy fleece weight and fleece quality (as reflected by average fibre diameter and percentage of medullated fibres) are highly heritable. Most of these characters except reproduction and survival have large phenotypic variability allowing superior animals to be identified reasonably easily both through subjective and objective assessment although the latter should be preferred. Attempts have been made to develop selection criteria for the two species for improving production for various economic traits based largely on Indian experience:

(i) For improving milk production in goats, selection based on age at first kidding and first lactation milk yield combined into an index will provide maximum gains in reproduction and milk production.

(ii) For improving meat production both in sheep and goats, selection on 6-month body weight alone among lambs/ kids born as twins, to the extent possible, may be most feasible and bring reasonable genetic progress in meat production through improving reproduction, body weight gains and carcass yield.

(iii) For improving fleece production in carpet wool sheep, selection on the basis of the first
6-monthly greasy fleece weight and average fibre diameter/percentage of medullated fibres will allow improvement in fleece production and quality. More intensive selection in these breeds over time will yield fleece which are usable for apparel production.

(iv) For improving apparel wool production, selection based on first 6-monthly greasy fleece weight and average fibre diameter will allow maximum genetic improvement in wool production and quality.

Performance recording

The institution of selection would require identification of animals, and recording of their pedigree and their performance. In small flock situation with essentially uneducated farmers, it is difficult to convince them of the need for such recording. On-station recording is more convenient, but the population size is generally small to provide sufficient intensity of selection and even accuracy of selection, especially where progeny performance is the criterion, is low. Further, it does not allow production of required number of superior males. The subjective assessment in the farmers' flocks done by the farmers themselves does result in some improvement. Objective assessment both in terms of quantity and quality would be more desirable in determining genetic merit especially of the males to be used as breeders. In addition to production, reproduction and survival are also important traits and will need recording and consideration in selection. This could be done through selecting among sire families.

The recording of performance of pedigreed progenies of a large number of sires is extremely important when selecting for milk, the milk having medium heritability and being limited to the female sex. On-farm recording of dairy goats is being practised in Europe and America where large commercial dairy herds are maintained under intensive management. Once a month AM-PM milk recording is sufficient to determine lactation yield. The recording may start after first fortnight. In case of goats which are suckled, the milk recording may be done by separating the kids on the day of recording or the recording be started after the weaning especially in dual-purpose goats (milk and meat).

In case of meat production, recording of body-weight at weaning and around 6 months of age may be sufficient. Where there are possibilities of studying individual feedlot performance, the fortnightly body weight gain along with fortnightly feed consumption, efficiency of feed conversion, carcass yield and quality could also be recorded and involved in selection of breeders specially males. For improving prolificacy in meat breeds selection of males from larger litters and on their body weight at six months can help in improving mothering ability and reproductive performance in addition to body weight gains.

In case of improving fibre production, recording of first 6-monthly or preferably annual greasy fleece weight/cashmere production and assessment of fleece quality of at least all available males would be desirable.

In case of pelt production, recording of pelt size and pelt quality in terms of colour, type of curls and their tightness would be necessary.
Determining breeding value

Determining breeding value of animals available for selection will require adjustment of their performance records for important non-genetic factors such as in case of milk, herd, age at first kidding season of kidding and lactation length. This can, however, be done only in on-station recorded population. Major selection will be possible in the male. As large percentage of young females will have to be retained as replacement of the adult females dying or culled, the milk being limited to female sex, and milk yield having low to medium heritability, the selection of male will have to be made on the basis of the performance of dam, collateral relatives, viz. sisters and daughters. The selection based on the progeny performance specially when progenies are born and raised in a number of flocks, so that there is no confounding between herd management and genetic merits of sires, would be most desirable. This can be possible through rotation of sires among flocks or through use of the same sires in a number of flocks using artificial insemination.

Similarly in case of meat production, the selection for carcass yield and quality will have to be essentially made on the collateral relatives (sibs). Improvement in prolificacy would require selection on the basis of early sexual maturity of the dam and the young out of larger litter size.

In case of fibre, since both the yield and quality are highly heritable and are expressed on both the sexes, individual selection would be appropriate.

Although major efforts in genetic improvement is usually made in maximizing accuracy of selection, in large population increasing the intensity of selection and decreasing generation interval through quicker generation turn-over may be more profitable.

ORGANIZATION OF BREEDING OPERATIONS

Gain through selection per unit time is a function of accuracy, intensity of selection and generation interval. Major emphasis in most selection schemes has been on maximizing accuracy of selection by identifying indices which have highest correlation with aggregate genetic worth/breeding value which cannot exceed 1.0. However, intensity of selection can be raised by choosing highly deviant animals from the population mean especially in larger populations. Such individuals could be 2-3 standard deviation superior to the population. Maximizing the use of such animals along with reducing generation interval may allow faster genetic gains.

Selection in farmers' flock

Through recording of performance of a large number of farmers' flocks preferably through objective assessment, flocks which are superior than average can be identified and used as flocks for producing genetically superior breeding males which could subsequently be distributed to the flocks which are inferior to the average of the population. This will require identification of superior males and females based on the characters of importance and mating them to produce male progeny, getting them reared in the farmers' flocks and/or in rearing centres for young males and making them available to the flocks to be improved on
Selection in institutional flocks

Institutional flocks may be established through selection of superior males and females from farmers' flocks. This is the usual system of genetic improvement in majority of developing countries where the government has responsibility for providing superior breeding males to the flock owners. Such flocks are properly recorded and performance data are utilized in selecting the breeding males and females. The best males are retained in the institutional flock for breeding with elite females for producing young males to go in for testing; the rest of them are made available to the flock owners. In majority of cases the flock size is rather small allowing a few males to be used for breeding and management, and thus the performance may not be better than in the private flocks and males produced on such farms are not thus acceptable to the farmers. The number of males available are also rather small than those required. In case of selection for milk the number of daughters per sire is usually small and considering the reproductive performance, the age by which the progeny performance becomes available, the male is too old to breed. The selection in such small institutional flocks is essentially based on the dam's performance or at best sister's performance.

Identifying superior males and females from farmers' flocks and utilizing the technique of Multiple Ovulation Embryo Transfer (MOET) a large number of superior males from such selected breeders can be produced. This can be done either in the farmers' flocks themselves or in institutional farms.

Selection in open nucleus flocks

It may be desirable to organize farmers' into co-operative group breeding schemes. Open nucleus flocks can be established through selection of better performing animals on the basis of objective assessment from the farmers' flock and utilized for producing breeding males through intensive selection and their distribution to the co-operating and other farmers. Keeping nucleus flock open would help in reducing in-breeding and increasing selection intensity through continuous introduction of superior animals from the farmers' flocks. After distribution of the males to the co-operating flocks, the rest could be distributed to the other flocks to be improved. Subsequently, flocks of co-operating farmers could also be utilized in breeding males using the selected males from the nucleus (multiplier flocks). The use of MOET can help in improving genetic gains through selection especially in case of dairy sheep and goats where selection of males can be based on the performance of collateral relatives (full and half sisters) rather than the progeny. Such a selection scheme will bring faster genetic progress specially through reducing the generation interval, although the accuracy of selection is slightly lower than based on progeny performance. These selected breeding males could be more extensively utilized through artificial insemination with frozen semen.

Grading with superior indigenous breeds

This will require similar approach as described earlier for producing superior males and their distribution to the flocks to be improved. This could be done within the farmers' flocks or in institutional farms. There are a number of superior breeds of goats in India, for example Jamunapari, Beetal and Barbari which have been utilized with success for improving body size,
milk yield and prolificacy in medium and small size breeds. Similarly in case of sheep for improving carpet wool production and quality, breeds like Magra and Nali (superior carpet wool breeds) have been extensively utilized in upgrading low quality wool producing and hairy breeds.

**Crossbreeding with exotic breeds**

For improving milk production in indigenous goat breeds a number of specialized dairy breeds such as Alpine, Toggenberg, Saanen and Anglo-Nubian from Europe and North America are available and have been extensively utilized. The results indicate that there is substantial improvement of crossbreds in milk production and reproductive performance specially age at first kidding although there is a slight decline in prolificacy. Halfbreds have the best performance and there is little to gain by increasing exotic inheritance beyond 50% from one or more than one exotic dairy breeds.

In sheep, crossing of indigenous hairy and inferior carpet wool breeds with exotic fine wool breeds leads to the improvement in carpet wool production and quality. Similarly crossbreeding with superior carpet wool breeds leads to the improvement in wool production and quality towards apparel wool.

Although in temperate ecologies there has been improvement in wool production and quality beyond 50% level of superior exotic inheritance and fine wool inheritance is being stabilized at 75%, in majority of arid and semi-arid hot ecologies, there is little improvement in wool production beyond 50% exotic inheritance although there is some further improvement in quality. The breeds that have been more extensively utilized in improving carpet and apparel wool production and quality are Rambouillet and Merino.

In case of meat production, cross breeding with exotic mutton breeds especially Suffolk and Dorset has resulted in improved body weight gains, efficiency of feed conversion in feed lot and carcass yield and quality. Such crossbreeding has also resulted in concomitant improvement in wool production and quality specially in inferior carpet wool breeds.

Crossbreeding indigenous coarse carpet wool breeds with Karakul and stabilizing Karakul inheritance at 75% has resulted in pelt type similar to that in Karakul.

**MOET and artificial insemination**

In the two small ruminant species, for bringing quicker genetic improvement specially for milk, it will be essential that similar approach as in dairy cattle both in selection as well as in extensive utilization of selected breeders is followed. For the purpose, utilization of embryo technology and artificial insemination with frozen semen will be necessary. Extensive research and development effort has been made in developing method for long-term preservation of semen both in sheep and goat with variable success. This is an area which would need serious attention in case quicker genetic improvement in these two species is desired. Similarly, making genetic progress through selection in the indigenous breeds or their crossbreds with exotic breeds in developing countries where performance recording in farmers' flocks on continuous basis is not currently being practised and is difficult, if not impossible, the utilization
SUMMARY AND CONCLUSIONS

Small ruminants are numerically more important species of livestock in developing countries where 95% of the goats and 53% of the sheep are found. These species have economic, social and cultural value, and in addition to contributing to food, fibre, skins and manure, contribute to ecological regeneration and provide sustainability to crop production.

There is a need for proper description and evaluation of existing genetic resources and determining the need for their conservation and identifying breed(s) which need to be utilized for production in different ecologies, or can be used as improver breed(s).

The breeding strategy involves decision on the objectives and approaches in bringing genetic improvement. Goats would need improvement for milk/meat/fibre (cashmere and mohair) or their different combinations. Sheep would need improvement for apparel wool/ carpet wool/ meat/ pelt / milk production or their different combinations. The paper describes important characters related to these production objectives which need to be considered in developing recording system and subsequent breeding approach.

The breeding approach may involve selection within a local breed, upgrading a local breed with superior indigenous breed, crossbreeding with exotic breed(s) for evolving new breed and replacement of a local breed by superior indigenous breed or an exotic breed. The breeding plan involves decision on selection criterion and mating system. Majority of characters related to important production objectives in sheep and goat except reproduction and survival are medium to highly heritable and will respond reasonably well to selection. Selection criteria for various production objectives based on the existing data on genetic and phenotypic parameters have been described. The major problem in utilizing such selection criteria is the availability of performance records. There is a little performance recording in the farmers' flocks and a few institutional flocks where such performance recording is available, do not provide desired accuracy and intensity of selection and also do not produce superior males in required numbers.

In majority of selection schemes major emphasis is laid on maximizing accuracy of selection. In fact, maximizing intensity through selecting extreme animals through simple recording system in the farmers' flocks and reducing generation interval through quicker generation turn-over may bring faster genetic progress. Simple recording systems in farmers' flock need to be developed and used for selection. Alternatively nucleus breeding flock with selected males and females from farmers' flocks may be established. Such flocks may be kept open and utilization of MOET may allow a large number of males to be tested for their breeding value in case of milk and production of a large number of superior males for other important production objectives. Such superior males if utilized through artificial insemination with frozen semen will bring rapid genetic improvement in the existing breeds.
Grading of a local breed with superior indigenous breed(s) can be easier and less problematic approach. This will, however, require similar approach in producing superior males by an improver breed(s) as for selection within a breed.

Crossbreeding experience for evolving superior breeds for milk production in goats and carpet wool, apparel wool and meat breeds in sheep do indicate the possibility of involving tropical and temperate breeds in such evolutionary crossbreeding.

The major thrust in improving these two species should be on developing simple recording system in farmers' flocks, establishing open nuclei preferably under co-operative group breeding schemes, use of MOET in generating superior breeding males and their extensive utilization through artificial insemination preferably using frozen semen.
NUTRITION AND FEED RESOURCES FOR SMALL RUMINANTS

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Small ruminants specially sheep and goats play an important role in the rural economy of the developing countries of the world. These 2 species thrive well under the conditions of diverse vegetation and feed scarcity in arid and semi-arid areas. Out of about 520 m goat population in the world (1988), 296 m are found in the Asian continent. The latter contribute approximately 45% of the total goat milk and 57% of total goat meat produced in the world. Out of about 1,137 m sheep in the world, about 30% is found in Asia. Although these 2 species constitute a large proportion of the total livestock, their productivity is low, specially in the developing countries due to lack of proper nutrition and feed. While sufficient advances have been made in the industrialized countries on nutrition of sheep, the work is limited with regard to the nutrition and availability of feed resources and their nutritional value for various production functions of goats. The problem of proper nutrition of small ruminants is increasing day by day due to shrinkage, depletion of vegetation cover and continuous neglect of the grazing land. Added to this no attention is given to the appropriate land use and grazing management.

The population of sheep and goats in India is estimated at 53 and 105 m, respectively, according to the 1987 census. This population requires approximately 64 m tonnes of dry fodder and about 16 m tonnes of concentrate to sustain their production levels. For dry fodder requirement the small ruminant species have to depend upon the natural grazing resources available in the common grazing land, wasteland, harvested fields, hillocks and the mountaneous regions. Forage production level from such land needs to be considerably increased for supporting this large population of small ruminants.

NUTRITIONAL PECULIARITIES

Both sheep and goats are better adapted to hot-arid and semi-arid climates. They can thrive even with scanty vegetation and maintain themselves longer during the scarcity of feed and water. Goats prefer browsing whereas sheep prefer grazing, thus providing less competition with each other on the rangeland. Both the species are essentially grazing animals and thrive on a variety of grasses, weeds and shrubs. Goats are more adaptive and hardy compared to sheep, and can withstand the effects of drought better than sheep. Goats have higher fibre digestibility than sheep and have better capacity to tolerate toxic materials or anti-nutritional
factors present in various feed resources. The comparative feeding behaviour and metabolism in sheep and goats are summarized (Table 1) by Devendra (1988).

NUTRIENT REQUIREMENTS

For developing the feeding strategy with the available feed resources, it is necessary to know about the nutrient requirements and the nutritive value of the available feed resources. Research on nutrient requirements on small ruminants has been much limited. However, quite a bit of research has been done on sheep nutrition in the industrialized countries, mainly in temperate regions. But in tropical regions detailed investigations need to be considered to develop innovative feeding practices suitable to small farm systems having extensive type of management. The nutrient requirements for goats were considered similar to those of sheep until separate requirement tables were published by NRC (1981). In recent years the goat has received attention of the research scientists all over the world.

Studies on nutrient requirements of sheep in tropical region were reviewed by Krishna (1990), Kearn (1982), Patnayak (1982, 1981) and Yousri (1977), and of goats by Saraswat and Sengar (1990), Haenlein (1991) and Sengar (1981). The results showed quite a variability in the requirements of different nutrients recommended by different researchers. The information was, however, compiled and general recommendations were prescribed for sheep (ARC, 1980; Kearn, 1982; NRC, 1985; ICAR, 1985). In goats the energy and protein requirements were summarized by Saraswat and Sengar (1960) and the mineral requirements by Haenlein (1991). The consolidation requirement tables were published by NRC (1981) and ICAR (1985).

Table 1. Comparative feeding behaviour and metabolism in goats and sheep. Source: Devendra (1988)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Goats</th>
<th>Sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Bipedal stance and walk longer distances</td>
<td>Walk shorter distances</td>
</tr>
<tr>
<td>Feeding pattern</td>
<td>Browser, more selective</td>
<td>Grazer, less selective</td>
</tr>
<tr>
<td>Browse and tree leaves</td>
<td>Relished</td>
<td>Less relished</td>
</tr>
<tr>
<td>Variety in feeds</td>
<td>Greater preference</td>
<td>Lesser preference</td>
</tr>
<tr>
<td>Taste sensation</td>
<td>More discerning</td>
<td>Less discerning</td>
</tr>
<tr>
<td>Salivary secretion rate</td>
<td>Greater</td>
<td>Moderate</td>
</tr>
<tr>
<td>Recycling of urea in saliva</td>
<td>Greater</td>
<td>Lesser</td>
</tr>
<tr>
<td>Dry-matter intake</td>
<td>3% of BW</td>
<td>3% of BW</td>
</tr>
<tr>
<td>for meat</td>
<td>4.6% of BW</td>
<td>3% of BW</td>
</tr>
<tr>
<td>for lactation</td>
<td>Higher with coarse roughages</td>
<td>Less efficient</td>
</tr>
<tr>
<td>Digestive efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>retention time</td>
<td>Long</td>
<td>Short</td>
</tr>
</tbody>
</table>
The energy requirements were recommended in terms of digestible energy (NRC), metabolizable energy (ARC, 1980; Kearl, 1982) and TDN (NRC, 1981; Kearl, 1982; ICAR, 1985). These units are, however, inter-convertible. The protein requirement was given in terms of total protein (NRC, 1985), digestible crude protein (Kearl, 1982; ICAR, 1985), g digestible protein per MCal digestible energy (NRC) and rumen degradable protein and undegradable protein (ARC, 1980). The mineral requirements are, in general, prescribed as percentages in diet dry matter. There is also quite a bit of variability in the values, which are probably due to feeding practices, type of feeds and production level of the animals in different regions/countries. On the basis of figures recommended by various workers, the overall average requirements of energy for goats are 131 Kcal DE/W\(^{0.75}\)kg, 7.8 Kcal/DE g gain, 219 Kcal DE/W\(^{0.75}\) and 1,675 Kcal DE/kg 4% FCM for maintenance, growth, pregnancy and lactation respectively. The protein requirement of goats are 2.4 g/kg W\(^{0.75}\), 6.1 g/kg W\(^{0.75}\) and 58.6 g/kg 4% milk, for maintenance, pregnancy and lactation respectively. The DM requirement is 95 g/kg W\(^{0.75}\). For sheep the energy requirements on an average have worked out as 125 Kcal DE/W\(^{0.75}\), 195 Kcal DE/W\(^{0.75}\) and 236 Kcal DE/W\(^{0.75}\) (100 g gain/day) and 285 Kcal DE/W\(^{0.75}\) (150 g gain) for maintenance, pregnancy, lactation and growth respectively. The dry-matter requirement for maintenance is 69 g/kg W\(^{0.75}\).

Devendra (1991) reported that sheep and goats in India, require about 1.39 million MJ of metabolizable energy per annum on the basis of daily ME requirement per head of 424 KJ per kg metabolic weight. The daily and annual requirements of energy per head of small ruminant for an average weight of 30 kg are 6.5 MJ and 2,380 MJ metabolizable energy respectively. The extensive grazing management practices require 20% more energy than the above requirement. The total energy requirement for small ruminants is hardly about 0.26% of the total energy requirement for large ruminants per annum. The small ruminants are always deficient in energy. The total energy deficit for all ruminants in India is estimated at 26 to 34%. It is difficult to assess the extent of energy available to small ruminants because of their sole dependence on natural grazing land. Hence it is not possible to calculate the extent of deficiency of energy resources for the small ruminants.
Table 2. Percentage proximate composition and nutritive value of some grasses and legumes found in arid and semi-arid zones

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Common name</th>
<th>Crude protein</th>
<th>Crude fibre</th>
<th>Nitrogen</th>
<th>Ether extract</th>
<th>Total ash</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>DM intake/100 kg bw</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aristida funiculata</td>
<td>Llampala</td>
<td>2.39</td>
<td>33.20</td>
<td>53.81</td>
<td>1.11</td>
<td>9.49</td>
<td>0.80</td>
<td>0.27</td>
<td>1.55</td>
</tr>
<tr>
<td>Cenchrus ciliaris</td>
<td>Anjan</td>
<td>5.50</td>
<td>33.90</td>
<td>50.70</td>
<td>1.20</td>
<td>8.79</td>
<td>1.00</td>
<td>0.15</td>
<td>3.00</td>
</tr>
<tr>
<td>Dicanthus annulatum</td>
<td>Karad</td>
<td>2.40</td>
<td>35.77</td>
<td>49.84</td>
<td>2.01</td>
<td>7.63</td>
<td>0.28</td>
<td>0.14</td>
<td>-</td>
</tr>
<tr>
<td>Eleusine flagellifera</td>
<td>Tantia</td>
<td>5.55</td>
<td>29.18</td>
<td>51.40</td>
<td>1.73</td>
<td>12.01</td>
<td>0.54</td>
<td>0.14</td>
<td>-</td>
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<tr>
<td>Lasiurus sindicus</td>
<td>Sevan</td>
<td>5.98</td>
<td>38.03</td>
<td>44.72</td>
<td>-</td>
<td>0.32</td>
<td>0.32</td>
<td>1.09</td>
<td>-</td>
</tr>
<tr>
<td>Panicum antidotale</td>
<td>Blue</td>
<td>7.26</td>
<td>40.47</td>
<td>43.11</td>
<td>1.15</td>
<td>7.97</td>
<td>0.39</td>
<td>0.09</td>
<td>2.80</td>
</tr>
<tr>
<td>Cynodon dactylon</td>
<td>Doob</td>
<td>5.00</td>
<td>5.00</td>
<td>51.60</td>
<td>1.13</td>
<td>9.36</td>
<td>0.52</td>
<td>0.37</td>
<td>-</td>
</tr>
<tr>
<td>Brachytrium ramosa</td>
<td>Kuri</td>
<td>9.43</td>
<td>28.53</td>
<td>43.92</td>
<td>0.78</td>
<td>17.34</td>
<td>0.45</td>
<td>0.35</td>
<td>-</td>
</tr>
<tr>
<td>Sesima nervosum</td>
<td>-</td>
<td>8.55</td>
<td>29.21</td>
<td>38.44</td>
<td>-</td>
<td>0.81</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Eragrostis</td>
<td>Doar love</td>
<td>6.78</td>
<td>37.00</td>
<td>48.37</td>
<td>1.44</td>
<td>6.44</td>
<td>0.38</td>
<td>0.29</td>
<td>-</td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolichos lablab</td>
<td>Rawan</td>
<td>14.19</td>
<td>28.08</td>
<td>39.43</td>
<td>3.50</td>
<td>14.80</td>
<td>1.98</td>
<td>0.26</td>
<td>-</td>
</tr>
<tr>
<td>Phaseolus atropurpureus</td>
<td>Siratro</td>
<td>23.0</td>
<td>30.4</td>
<td>29.70</td>
<td>6.6</td>
<td>10.20</td>
<td>1.18</td>
<td>0.28</td>
<td>2.34</td>
</tr>
<tr>
<td>(Pod stage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Indigofera enneaphylla</td>
<td>Bekaria</td>
<td>14.8</td>
<td>25.6</td>
<td>46.4</td>
<td>2.0</td>
<td>11.3</td>
<td>3.4</td>
<td>0.17</td>
<td>4.4</td>
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<tr>
<td>Indigofera cordifolia</td>
<td>Bekaria</td>
<td>12.2</td>
<td>26.0</td>
<td>47.5</td>
<td>1.6</td>
<td>12.7</td>
<td>5.1</td>
<td>0.15</td>
<td>3.9</td>
</tr>
<tr>
<td>Tribulus terrestris</td>
<td>Gokhru</td>
<td>12.1</td>
<td>27.8</td>
<td>40.8</td>
<td>2.6</td>
<td>16.7</td>
<td>4.2</td>
<td>0.24</td>
<td>3.4</td>
</tr>
<tr>
<td>Vigna unguiculata</td>
<td>Cowpea</td>
<td>8.83</td>
<td>43.25</td>
<td>38.77</td>
<td>1.09</td>
<td>8.06</td>
<td>0.72</td>
<td>0.27</td>
<td>2.10</td>
</tr>
<tr>
<td>Vigna aconitifolia</td>
<td>Dew gram</td>
<td>8.90</td>
<td>29.07</td>
<td>45.89</td>
<td>1.74</td>
<td>14.40</td>
<td>1.96</td>
<td>0.12</td>
<td>3.04</td>
</tr>
<tr>
<td>Cyamopsis tetragonoloba</td>
<td>Cluster-bean</td>
<td>8.93</td>
<td>26.85</td>
<td>54.34</td>
<td>1.29</td>
<td>8.59</td>
<td>1.50</td>
<td>0.42</td>
<td>2.44</td>
</tr>
</tbody>
</table>
Table 3. Proximate composition (%) and nutritive value of top feeds of arid and semi-arid regions used for small ruminants (dry-matter basis)

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Local name</th>
<th>Crude protein</th>
<th>Ether extract</th>
<th>Crude fibre</th>
<th>Nitrogen-free extract</th>
<th>Total carbohydrates</th>
<th>Dry-matter intake 100 kg wt (kg)</th>
<th>DCP</th>
<th>TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ailanthus excelsa</td>
<td>Ardu</td>
<td>19.56</td>
<td>3.68</td>
<td>13.52</td>
<td>47.74</td>
<td>61.26</td>
<td>3.80</td>
<td>16.24</td>
<td>63.80</td>
</tr>
<tr>
<td>Terminalia arjuna</td>
<td>Arjun</td>
<td>10.94</td>
<td>3.08</td>
<td>12.95</td>
<td>62.62</td>
<td>75.57</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>cacia arabica</td>
<td>Babool pods</td>
<td>10.95</td>
<td>0.97</td>
<td>13.75</td>
<td>58.03</td>
<td>71.79</td>
<td>2.28</td>
<td>5.73</td>
<td>62.35</td>
</tr>
<tr>
<td>Aegle marmelos</td>
<td>Bel</td>
<td>15.13</td>
<td>1.54</td>
<td>16.45</td>
<td>52.83</td>
<td>69.28</td>
<td>3.92</td>
<td>10.76</td>
<td>56.65</td>
</tr>
<tr>
<td>Ficus glomerata</td>
<td>Gular</td>
<td>11.16</td>
<td>2.43</td>
<td>12.27</td>
<td>59.00</td>
<td>71.27</td>
<td>-</td>
<td>6.69</td>
<td>53.82</td>
</tr>
<tr>
<td>Inga dulcis</td>
<td>Imli</td>
<td>20.17</td>
<td>7.54</td>
<td>19.82</td>
<td>43.04</td>
<td>62.86</td>
<td>2.25</td>
<td>14.43</td>
<td>59.38</td>
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<tr>
<td>Gymnosporia spinosa</td>
<td>Kenkera</td>
<td>9.43</td>
<td>3.59</td>
<td>15.33</td>
<td>59.03</td>
<td>74.36</td>
<td>3.71</td>
<td>2.66</td>
<td>33.16</td>
</tr>
<tr>
<td>Bauhinia variegata</td>
<td>Kachnar</td>
<td>13.81</td>
<td>1.98</td>
<td>26.11</td>
<td>51.83</td>
<td>77.94</td>
<td>3.33</td>
<td>4.98</td>
<td>47.90</td>
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<tr>
<td>Prosopis cineraria</td>
<td>Khejri</td>
<td>13.98</td>
<td>1.88</td>
<td>17.80</td>
<td>43.44</td>
<td>61.24</td>
<td>2.18</td>
<td>4.49</td>
<td>40.99</td>
</tr>
<tr>
<td>Acacia senegal</td>
<td>Kheri</td>
<td>16.79</td>
<td>2.13</td>
<td>11.84</td>
<td>46.16</td>
<td>48.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Azadirachta indica</td>
<td>Neem</td>
<td>15.81</td>
<td>3.51</td>
<td>11.79</td>
<td>57.62</td>
<td>69.41</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zizyphus nummularia</td>
<td>Pala</td>
<td>14.06</td>
<td>2.96</td>
<td>17.04</td>
<td>55.85</td>
<td>72.89</td>
<td>2.05</td>
<td>5.56</td>
<td>49.70</td>
</tr>
<tr>
<td>Ficus religiosa</td>
<td>Pipal</td>
<td>9.66</td>
<td>2.66</td>
<td>26.96</td>
<td>45.82</td>
<td>72.78</td>
<td>-</td>
<td>5.47</td>
<td>39.22</td>
</tr>
<tr>
<td>Bombax malabaricum</td>
<td>Semal</td>
<td>12.80</td>
<td>7.72</td>
<td>17.76</td>
<td>52.80</td>
<td>70.56</td>
<td>4.25</td>
<td>8.00</td>
<td>53.07</td>
</tr>
<tr>
<td>Moringa oleifera</td>
<td>Sainja</td>
<td>15.62</td>
<td>4.35</td>
<td>17.89</td>
<td>48.71</td>
<td>66.60</td>
<td>1.77</td>
<td>11.09</td>
<td>61.49</td>
</tr>
<tr>
<td>Leucaena</td>
<td>Soobabool</td>
<td>21.25</td>
<td>6.54</td>
<td>14.25</td>
<td>49.48</td>
<td>63.73</td>
<td>4.00</td>
<td>16.73</td>
<td>70.22</td>
</tr>
</tbody>
</table>

leucocephala
NUTRITION AND FEED RESOURCES FOR SMALL RUMINANTS: PATNAYAK

FEED RESOURCES

The feed resources available for small ruminants, specially in developing countries may be classified into (1) natural vegetation available on non-arable land and fallow land, (2) to a very limited extent developed pastures including silvopastures, (3) cultivated fodders, (4) tree fodders, (5) crop residues from cereal and legume crops, and (6) by-product feeds available from processing industries and other sources. The vegetation available on non-arable land and wastelands, and crop residues in harvested fields are the most important feed resources available for small ruminants. Feeding of grains and by-product feeds in the stalls is a rare practice except in exceptional cases of pregnancy and lactation.

Natural vegetation on non-arable land

About 80 to 90% of the common grazing land and rangeland is in poor to very poor condition due to very high biotic pressure. In desert areas sometimes the climax vegetation is not utilized because of migration of animals, due to lack of stock water facilities. The dry-matter yield from natural rangeland varies from 0.5 to 6.0 q/ha during different seasons of the year. After 1 year of protection dry-matter production/ha increases to about 12 q/year and after rainy season the production increases from 15 to 24 q during second year. The study conducted at the CSWRI, Avikanagar, indicated that in rangeland and natural pastures the availability of adequate energy throughout the year and protein for more than half of the year is a serious problem (Bhatia et al., 1973). These lands hardly carry 1 sheep/goat when unprotected and 2/ha after protection. The strategy should, therefore, be to improve these rangelands by protecting them from biotic factors at least for 1 year. Further improvement of the rangeland could be done by preserving the good natural grasses and removing the non-edible grasses and weeds. Natural legumes such as *Phycomasia minima*, *Indigofera* spp. and *Tribulus terrestris* are very useful species and should be reserved on natural pastures. In India the major grass cover in the arid and semi-arid areas in the north-western region of the country is of *Dicanthium-Cenchrus-Lasiurus* type.

Studies conducted at the CSWRI, Avikanagar and Bikaner (Patnayak, 1988) showed that sheep and goats on natural rangeland generally lost their weight during January to June and regained weight during monsoon. The stocking capacity was 1 to 3 sheep/ha according to the vegetation cover, rainfall and season. Nutrient intake and digestibility of the nutrients in different seasons by sheep and goats grazing on natural rangeland have been determined (Mali et al., 1983; Swain, 1984). The crude protein percentage of the ingested forage was highest (9.5%) and crude fibre was low (26%) during July-September. The birth weights of lambs and kids were 2.5 to 3 kg and the weaning weights at 90 days of age 8 to 10 kg only.

Reseeded pastures and silvopastures

Wastelands and the rangelands need to be developed under reseeded pastures and perennial grasses and as far as possible with legumes. The common perennial grasses like *Cenchrus ciliaris* (Anjan), *C. setigerus* (Dhaman), *Lasiurus sindicus* (Sewan), *Dicanthium annulatum* (Karad), *Cynodon dactylon* (Doob) and *Panicum antidotale* (Blue panic) were suitable depending upon rainfall and soil conditions. Perennial legumes such as *Dolichos lablab*, *Clitoria ternata*,...
*Phaseolus microptelium* (Siratro) and *Stylosanthes* species could be incorporated in the reseeded pastures. Researches were conducted at the CSWRI, IGFRI, CAZRI, CIRG etc. with major emphasis on development of large-scale pastures including silvipastures, their evaluation, maintenance and utilization for sheep and goats in semi-arid and arid areas. Technologies were developed for establishing perennial grass and legume pastures and increasing fodder resources through silvipastoral practices. The common grasses and legumes suitable for arid and semi-arid regions are given in Table 2, along with their nutritive value.

In the development of silvipastoral systems fodder trees such as *Ailanthus excelsa* (Ardu), *Azadirachta indica* (Neem), *Albizia lebbek* (Siris), *Acacia nilotica* (Babool), *Prosopis cineraria* (Khejri), *Bauhinia racemosa* (Kachnar) and *Dichrostachys ciliaris* were tried in 2-tier and 3-tier systems. The dry-matter yield from the grass pastures varied from 2 to 4 tonnes/ha depending upon the rainfall and soil types. In silvipastoral systems with about 100 trees/ha 0.5 to 1.0 tonne of additional dry matter becomes available depending upon the age and type of the tree. In good silvipastoral plots the stocking capacity of 8 to 10 sheep or goats/ha were recommended.

Satisfactory performance of sheep was obtained on developed pastures of the *Cenchrus* and *Lasiurus sindicus* pastures and on silvipastures (Acharya et al., 1985; Thakur and Patnayak, 1985; Singh et al., 1988, 1987; Shinde et al., 1991). Recent experiments on performance of sheep and goats on reseeded *Cenchrus* pasture showed body weight of 11 to 12 kg at 60 days of age of lambs and kids. Performance of ewes was quite satisfactory at a stocking rate of 4 animals/ha (Shinde et al., 1991). Lambs showed higher body-weight gain attaining about 27 kg at about 8 months of age when grazed on *Cenchrus-Dolichos* mixed pasture (Patnayak, 1980).

The stocking rates recommended on the basis of performance of animals on different types of pastures are 3 animals/ha on natural pasture, 5 animals/ha on developed *Cenchrus* pasture and 7 animals/ha on silvipastoral systems. In high rainfall areas with good growth of pasture grasses and tree foliage even 10 animals/ha were recommended by IGFRI. This is a high stocking rate compared to the stocking rate in the semi-arid and arid areas having sandy soil.

**Utilization of cultivated fodders**

Use of cultivated fodders for small ruminants is very much limited. Cultivated grasses under irrigated conditions such as *Panicum maximum* and *Pennisetum purpureum* (Napier) grass are sometimes fed to sheep and goats particularly in organized farms. Annual fodders such as *Pennisetum typhoides* (pearlmillet) and *Sorghum vulgare* (sorghum) are also used. These fodders are generally fed as green in chaffed form in organized farms. They can however, be utilized extensively in meat production programmes of mutton lambs.

Perennial legumes such as luceme and berseem are also used in some places specially for lambs as well as pregnant and lactating ewes. This practice is also limited to the organized farms. In recent years village farmers have started feeding luceme to young lambs and growing lambs meant for meat purposes.

Annual legume fodders such as cowpea (*Vigna unguiculata*), cluster bean (*Cyamopsis...
tetragonoloba) and moth (Phaseolus aconitifolius) are also fed in organized farms as green or hay. Such fodders are also grown as inter-crops in the cereal crop cultivation such as pearl millet and maize.

**Shrubs and tree fodders**

The potential value of shrubs and tree fodders in feeding systems for small ruminants is realized only in recent years. Utilization of tree fodders for small ruminants has been reviewed by several authors (Singh, 1981; Bhatia, 1983; Patnayak, 1976, 1983; Devendra, 1990; Raghavan, 1990). The trees in addition to providing fodder for animals offer a good solution to the problems of desertification, environmental degradation and climatic changes. In situations where feed remain the major constraint for livestock development, specially of small ruminants, it is essential to promote fodder trees and fodder shrubs as a means of feeding livestock and also to obtain a sustainable agriculture. Although a large number of tree species have been identified as fodder trees and shrubs, only a very few species were studied and utilized in feeding practices. There is a need to identify and recommend promising species of fodder trees both in terms of forage productivity, animal acceptability and nutritional value.

Studies on proper planting methods suitable to specific agro-ecological environment and animal production systems as well as methods of harvesting, conservation and processing of the tree fodders are very important. Although the tree fodders are considered as emergency fodders for livestock in general, they serve as potential feed resources for small ruminants and provide about 50% of the total dry-matter requirement. The common tree fodders are utilized for small ruminants either by lopping or by conserving as dry fodders. Dry matter in most tree fodders varies from 20 to 40% and the crude protein from 12 to 20%. Although tree leaves contain comparatively low percentage of crude fibre than grasses and legumes, the fibre is very complex and highly lignified at the mature stage. Very high calcium and low phosphorus is a common feature in almost all the tree fodders providing very wide calcium and phosphorus ratio in the diet, when tree leaves are fed as sole feed. Dry-matter intake from most of the trees leaves varies from 2.5 to 3.5 kg/100 kg live weight. Although the protein is high (12 to 20%), the digestibility of crude protein is very low (20 to 30%) in most cases. The digestibility of protein is quite high in some tree fodders such as Ailanthus excelsa (16.7%) and Leucaena leucocephala (16.2%). In spite of higher intake of nitrogen and calcium, the retention of nutrients in general is poor and phosphorus balance is negative or marginally positive in most cases.

Although the tree fodders are consumed by all species of domestic livestock, the goats have special preference compared to others. The digestibility of nutrients from tree fodder is generally found higher in goats than in sheep (Singh and Gupta, 1977; Bohra, 1980; Singh, 1981; Singh and Bhatia, 1982; Mali et al., 1984). The poor digestibility of crude protein and crude fibre is attributed to high lignin which increases with the increase in the maturity of the tree leaves. Low digestibility of protein is also attributed to presence of tannins and the nitrogen bound to lignin. Several other anti-nutritional factors such as mimosine, cyanogens, lactins, saponins and oxalates are also found in tree fodders. The deleterious effects of various anti-nutritional factors and their possible amelioration were reviewed by Kumar (1990). Anti-nutritional factors of some tree fodders and their possible effects on sheep and goat are given in Table 4.
Table 4. Effect of tannins from different tree fodders on sheep and goats.

<table>
<thead>
<tr>
<th>Tree/shrub</th>
<th>Predominant tannin</th>
<th>Animal</th>
<th>Nutritional effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acacia aneura</em></td>
<td>CT</td>
<td>Sheep</td>
<td>N Dig, Wool yield, growth S abs.</td>
</tr>
<tr>
<td><em>A. angustissima</em></td>
<td>HT</td>
<td>Goat</td>
<td>in-sacco N dig</td>
</tr>
<tr>
<td><em>A. cyanophylla</em></td>
<td>CT</td>
<td>Sheep</td>
<td>DMI-ve, N dig, weight loss</td>
</tr>
<tr>
<td><em>A. nilotica</em> (pods)</td>
<td>CT</td>
<td>Sheep</td>
<td>Growth rate, N and NDF dig.</td>
</tr>
<tr>
<td><em>A. sieberiana</em></td>
<td>HT</td>
<td>Sheep</td>
<td>Growth rate, N and NDF dig.</td>
</tr>
<tr>
<td><em>Albizia chinensis</em></td>
<td>CT</td>
<td>Goat</td>
<td>Reduced in sacco N dig</td>
</tr>
<tr>
<td><em>Calliandra calothyrsus</em></td>
<td>CT</td>
<td>Goat</td>
<td>Reduced in sacco N dig</td>
</tr>
<tr>
<td><em>Eugenia jambolana</em></td>
<td>HT</td>
<td>Goat</td>
<td>DMI, Weight loss</td>
</tr>
<tr>
<td><em>Larrea tridentata</em></td>
<td>CT</td>
<td>Goat</td>
<td>DMI, N dig retn.</td>
</tr>
<tr>
<td><em>Prosopis cineraria</em></td>
<td>CT</td>
<td>Sheep</td>
<td>DMI, N dig wool yield, Fe abs., weight loss</td>
</tr>
<tr>
<td><em>P. grandulosa</em></td>
<td>CT</td>
<td>Goat</td>
<td>DMI, N dig retn.</td>
</tr>
<tr>
<td><em>Quercus gambelii</em></td>
<td>CT</td>
<td>Goat</td>
<td>Dig. of cellular constituent, Feecal N</td>
</tr>
<tr>
<td><em>O. grisea</em></td>
<td>CT</td>
<td>Goat</td>
<td>DMI, N dig, Retn.</td>
</tr>
<tr>
<td><em>Terminalia oblongata</em></td>
<td>HT</td>
<td>Sheep</td>
<td>DMI toxicity</td>
</tr>
<tr>
<td><em>Zizyphus nummularia</em></td>
<td>CT</td>
<td>Sheep</td>
<td>DMI, N, DM dig, wool yield weight loss</td>
</tr>
</tbody>
</table>

CT. Condensed tannin; HT, hydrolysable tannins; a, oxalate; b, cyanogens; c, saponins.

The method of collection, conservation and processing are the important aspects of utilization of tree fodders in the rations for small ruminants. The tree fodders are generally fed as fresh loppings or in the form of leaf-meals mixed with other ingredients in the complete feeds. Feeding as fresh loppings and as dry leaves are the traditional methods of feeding to animals in rural areas. Performance studies on loppings from *Prosopis cineraria* showed better performance on goats compared to sheep (Singh and Bhatia, 1982). Feeding of dried leaves has also shown better performance on goats compared to sheep. The leaf-meals of various tree fodders such as *A. excelsa*, *Z. nummularia* and *P. cineraria* were used in complete feeds for mutton lambs in different proportions (Bhatia and Patnayak, 1989; Karim et al., 1990).

Utilization of crop residues

Crop residues and non-conventional feed resources may account for about 50% of the total feed resources for small ruminants specially in developing countries. Greater part of the crop residues are consumed through stubble grazing in harvested fields. They are also available from the cereal and legume crops after taking the grains. Crop residues from legume crops such as cowpea, clusterbean, gram, horse-gram, green gram and groundnut are specially useful for small ruminants. These materials can be fed as such or in ground form. Ground crop residues are also used as component of the compound feeds. Straws from coarse grain cereal crops such as maize, pearl millet and sorghum have to be chaffed and ground to make them acceptable by sheep and goats. Wheat straw and paddy straw are also available in chaffed form after threshing process. Such materials may have to be ground again into smaller size to make them acceptable by the animals. Crop residues in ground form mixed with tree fodders specially Pala and Khejri in ground form were used with useful results. Equal proportions of ground wheat
Table 5. Chemical composition and nutritive value of some by-product feeds for small ruminants

<table>
<thead>
<tr>
<th>Feed</th>
<th>CP</th>
<th>EE</th>
<th>CF</th>
<th>NFE</th>
<th>Ash</th>
<th>Ca</th>
<th>P</th>
<th>DCP</th>
<th>TDN</th>
<th>Toxic factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple waste (Malus sylvestris)</td>
<td>12.0</td>
<td>2.8</td>
<td>3.5</td>
<td>78.5</td>
<td>3.2</td>
<td>-</td>
<td>-</td>
<td>2.0</td>
<td>70.0</td>
<td>Nil</td>
</tr>
<tr>
<td>Ambodi cake (Hibiscus cannabinus)</td>
<td>23.4</td>
<td>6.3</td>
<td>19.7</td>
<td>40.2</td>
<td>10.4</td>
<td>-</td>
<td>-</td>
<td>18.7</td>
<td>63.8</td>
<td>Nil</td>
</tr>
<tr>
<td>Babul seeds (Acacia nilotica)</td>
<td>17.6</td>
<td>6.0</td>
<td>12.3</td>
<td>59.3</td>
<td>4.4</td>
<td>0.9</td>
<td>0.3</td>
<td>13.8</td>
<td>55.0</td>
<td>Tannins (5%)</td>
</tr>
<tr>
<td>Cassava starch waste (Manihot esculenta)</td>
<td>4.9</td>
<td>1.0</td>
<td>19.2</td>
<td>69.3</td>
<td>5.6</td>
<td>-</td>
<td>-</td>
<td>1.4</td>
<td>64.0</td>
<td>Nil</td>
</tr>
<tr>
<td>Castor bean-meal</td>
<td>34.8</td>
<td>10.6</td>
<td>33.2</td>
<td>32.2</td>
<td>10.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Ricin (0.2%)</td>
</tr>
<tr>
<td>Karanj-cake (Pongamia glabra; Solvent extracted)</td>
<td>34.1</td>
<td>0.2</td>
<td>4.1</td>
<td>58.2</td>
<td>3.3</td>
<td>-</td>
<td>-</td>
<td>25.5</td>
<td>62.0</td>
<td>Karanjine (10-15 mg/100 g)</td>
</tr>
<tr>
<td>Kusum-cake (Schleichera oleosa)</td>
<td>22.11</td>
<td>0.42</td>
<td>7.5</td>
<td>62.1</td>
<td>7.8</td>
<td>0.5</td>
<td>1.1</td>
<td>14.7</td>
<td>79.6</td>
<td>HCN (2.4 mg/100 g)</td>
</tr>
<tr>
<td>Mango seed kemeel (Mangifera indica)</td>
<td>8.7</td>
<td>11.0</td>
<td>0.1</td>
<td>75.8</td>
<td>3.6</td>
<td>0.3</td>
<td>0.3</td>
<td>6.1</td>
<td>70.0</td>
<td>Tannins (5-6%)</td>
</tr>
<tr>
<td>Mahua seed-cake (Madhuca indica)</td>
<td>20.4</td>
<td>2.7</td>
<td>13.3</td>
<td>57.2</td>
<td>6.5</td>
<td>0.4</td>
<td>0.2</td>
<td>9.3</td>
<td>49.8</td>
<td>Mowrin (19%)</td>
</tr>
<tr>
<td>Panwar seeds (Cassia tora)</td>
<td>18.6</td>
<td>7.9</td>
<td>9.9</td>
<td>54.2</td>
<td>9.4</td>
<td>0.9</td>
<td>0.6</td>
<td>15.9</td>
<td>66.0</td>
<td>Cryosophanic acid</td>
</tr>
<tr>
<td>Rubber seed-cake (Hevea brasiliensis)</td>
<td>35.1</td>
<td>12.5</td>
<td>7.1</td>
<td>34.8</td>
<td>10.5</td>
<td>1.0</td>
<td>0.8</td>
<td>18.6</td>
<td>66.0</td>
<td>HCN (9mg/100g)</td>
</tr>
<tr>
<td>Vilayati babool pods (Prosopis juliflora)</td>
<td>12.5</td>
<td>3.6</td>
<td>25.6</td>
<td>53.3</td>
<td>5.1</td>
<td>0.4</td>
<td>0.2</td>
<td>7.0</td>
<td>75.0</td>
<td>Tannins</td>
</tr>
</tbody>
</table>

straw and dried *Ardu* leaves have served as maintenance feed for sheep. Wheat straw has also been used with molasses and urea to make them maintenance feed for sheep.

The latest method of enriching straws with urea-ammonia treatment through ensiling has good promise. Wheat straw and pearl millet straw in properly chaffed form were enriched by mixing with urea @ 4 kg/100 kg straw and ensiling with 40 to 45% moisture. The process increased crude protein percentage in the straws up to 8 to 10% with increase in dry matter digestibility (Sehgal *et al.*, 1989). Complete rations were prepared by using the ground crop residues (Reddy, 1990) such as sorghum straw, rice straw, sugarcane bagasse, sunflower straw, cotton straw, cotton seed hulls and groundnut straw.

**By-product and non-conventional feeds**

The by-product feeds are available from the milling processes of grains, pulses and oilseeds. These by-products are various types of brans, oilcakes, oil-meals, molasses etc., and have been used traditionally in feed mixtures for livestock. In case of small ruminants these ingredients are used specially in areas where the flocks are relatively sedentary. Milch goats are generally supplemented with feed mixtures containing oilcakes and brans. Such by-product feeds have been used in the complete feeds of sheep and goats for mutton production (Reddy, 1990). A large number of by-product feeds as well as non-conventional feedstuffs available from forest resources and the processing industries have been identified, evaluated and used in feeding ruminants. Although large ruminants have been fed these by-product feeds for their evaluation in many cases, sheep has been used as an experimental animal to determine the nutritive value of such by-product feeds. The detailed description and nutritive value of the by-products and non-conventional feed resources are given by Punj (1988) and Gupta (1988). These feedstuffs need to be properly processed and fed to the small ruminants specially for meat production. With the continued depletion of grazing land and grazing resources, the use of these non-conventional feeds will be very important in feeding small ruminants.

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IMPLEMENTATION OF ANIMAL HEALTH CARE IN DEVELOPMENT: INTERACTIONS AMONG DONOR AGENCIES, PRIVATE VOLUNTARY ORGANIZATIONS AND UNIVERSITIES

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In most of the so-called developing nations, populations remain predominantly rural and the vast majority of citizens are engaged directly or indirectly in agricultural activities. Animal agriculture is central to many agrarian societies and in many cases, it has the poorest members of these social groups, i.e. those without land, that are most dependent on livestock for their well being. Paradoxically, animal health care services are often least available where people are most reliant on animals for their livelihood. There is a growing recognition of this situation by private voluntary organizations (PVOs), who are increasingly integrating animal health care components into their general agricultural development programmes.

For organizations involved in livestock development work, namely donor agencies, PVOs and universities, the question then is not if animal health care services are needed or justified, but rather, what is the most appropriate way to deliver them to those who need them most? Furthermore, how can these organizations work together to translate their interest and concern into concrete accomplishment? Finally, how do we define appropriateness in the context of animal health care?

To explore these questions, it is perhaps useful to identify four main components integral to implementation of animal health programmes in developing countries. These are training, research, technology transfer, and the provision of health care in the field.

APPROPRIATE TRAINING

Nowhere does the concept of appropriateness becomes more telling than in the overseas training of post-graduate veterinary scientists from developing countries. Though statistical data are hard to find, anecdotal experience may serve to illustrate the problem. The author personally knows three veterinarians, two South Americans and one African, who received Ph.D. in veterinary immunology at veterinary schools in the USA. These individuals all worked on the research projects of their faculty advisors. While they proved themselves able scientists, capable of mastering sophisticated research techniques, their projects had little application in the context
of animal health in their home countries. Upon returning home, none of them were able to
develop sustainable research projects. The obstacles they faced were considerable and
included such things as overwhelming teaching responsibilities, lack of research funding,
equipment shortages, non-availability of spare parts, and unreliable power supplies. One of
these veterinarians is now a Dean and the other two are Department Heads at their respective
veterinary schools. There is no doubt that their American Ph.D. helped them advance
professionally, but they were thwarted in their attempts to successfully utilize their research
training in direct contribution to the animal health care needs of their countries.

Fortunately this problem is well recognized and is being addressed. An innovative programme
at the University of Minnesota College of Veterinary Medicine in conjunction with Hassan II
University in Rabat, Morocco, has been underway for the last 10 years. Moroccan veterinarians
are accepted into the Ph.D. programme at Minnesota and come to St Paul to do their coursework.
They are then required to do their field or laboratory investigations back in Morocco, ensuring
that their research is germane to local needs and resources. Their faculty advisors visit
periodically for advise and counsel, and the students return to Minnesota to defend the thesis.
This programme has produced a cadre of Moroccan veterinary scientists aware of the needs
of the livestock industry in Morocco and capable of implementing research that is achievable
and relevant to the local context.

Training in the home country does not of course necessarily ensure a sensitivity to development
issues. Too often, researchers at universities are called upon to solve the problems of the richest
segments of their societies, and not the poorest. This is an area where PVO/University
collaboration can bear fruit. PVOs with their long standing grassroots present in developing
countries, have keen insight into the needs of peasant communities. When PVOs forge linkages
with universities both at home and abroad, the opportunities arise to channelize research training
into projects that are both scientifically sound and appropriate from the development standpoint.
Research results are useful to the PVOs in furtherance of their projects, local people benefit
from the outcome, scientists become sensitized to development issues and communication
lines are opened between the nation's intellectual elite and the general population. Seconding
graduate students to PVOs to carry out their field studies is a possible means of achieving these
beneficial ends.

APPROPRIATE RESEARCH

As indicated above, field-based research in support of ongoing PVO programmes has distinct
value to all parties involved. This research does not have to be linked to long-term training of
veterinary scientists, nor does it have to be particularly ambitious or costly. Short-term, low-cost,
field-based, applied research activities can help to fine tune animal health care programmes,
and result in a more appropriate use of funds and resources. This can be illustrated by an
example involving a collaboration between Heifer Project International (HPI) and the Tufts
University School of Veterinary Medicine (TUSVM).

HPI has an active programme in Honduras involving extension work in dairy cattle co-operatives.
A TUSVM student, Nan Swane, has worked in Honduras with dairy co-operatives as a Peace
Corps volunteer before coming to veterinary school. Extension workers in Honduras had been
telling co-operative farmers to work their young cattle regularly, and to carry out the CMT test on milking cows to detect subclinical mastitis. On the surface, these were eminently reasonable suggestions, typical of recommendations made to dairy farmers in North America. With financial support from HPI and carrying a microscope and CMT paddle, Ms Swane went to Honduras for 8 weeks in the summer of 1990 and carried out a field research project to test the appropriateness of these recommendations. Working with 12 co-operatives in Tocoa, Honduras, she carried out CMT tests on all milking cows and compared production records with CMT test scores. She did faecal egg counts on 10% of growing heifers in each co-operative and compared the counts to the average age at first calving for heifers at each co-operative. She also took blood samples from newborn calves and compared serum immunoglobulin levels in these calves to farm records of calf mortality to determine if failure to suckle colostrum was a factor in calf mortality.

Interestingly, this field research indicated that there was no correlation between a high CMT score and low production, that high faecal egg counts had no effect on: maturation rate as measured by age of first calving, and that serum immunoglobulin levels had no demonstrable relationship to calf mortality figures (Swane et al., 1991). The conclusion was that under Honduran conditions of extensive management, marginal nutrition, slow growth rates, and low milk production, the effects of gastrointestinal parasitism, subclinical mastitis and failure to nurse colostrum on overall productivity were marginal.

The benefits of this research were considerable. It allowed a reorientation of extension efforts away from subclinical disease problems to an emphasis on nutrition, and it meant that farmers could shift some of their limited financial resources away from the purchase of anthelmintics and intramammary infusions to the purchase of feed supplements as a more direct means of improving productivity and profitability. The total cost of this research activity was less than US $3,000.

Active, open communication between veterinary schools and PVOs can undoubtedly lead to the definition of similar field research activities with a high benefit to cost ratio. At TUSVM, we encourage the use of students in such research because it provides them with tangible opportunities to garner experience in development work, not as passive observers, but as active participants with a stake in the outcome. We are committed to the training of American veterinarians sensitive to development issues in animal health.

**APPROPRIATE TECHNOLOGY TRANSFER**

Though not pervasive, there is a tendency in development circles to put a value judgement on different forms of technology; specifically, that high tech is bad and low tech is good. In fact, it is the appropriate application of technology rather than the nature of the technology itself that requires appraisal. Again, several examples from experience at TUSVM may help to illustrate these points. In the 1980s TUSVM, under contract with USAID, worked at Niger on basic animal health care delivery systems for Nigerian pastoralists. It became clear from field experience that rinderpest was a significant problem in local livestock and that under local conditions of extreme heat, unreliable electrical supplies, limited refrigeration and poor transportation in-
STRUCTION, efforts to maintain the cold chain necessary for proper preservation of heat sensitive, live rinderpest vaccines was highly problematic.

Based on these field observations, TUSVM entered into a research collaboration with the USDA to develop a heat-stable rinderpest vaccine that would circumvent the need for maintaining a cold chain. Dr. Jeff Mariner, a TUSVM graduate who worked on the Niger project as a student, was seconded to the USDA Foreign Animal Disease Diagnostic Laboratory at Plum Island after graduation to work with the USDA scientists on the development of the heat-stable vaccine. Through the manipulation of the lyophilization procedure, a reliably heat-stable and immunogenic vaccine was produced (Mariner et al., 1990a, b). This vaccine has since been adopted by the Pan-African Rinderpest Campaign (PARC), and Dr. Mariner is now seconded to PARC in Nairobi where he is acting as a technical advisor to vaccine production facilities in East and West Africa gearing up for large-scale production of the heat-stable vaccine.

Elimination of rinderpest from the African continent is now a conceivable notion. But even with advances in technology, political realities hamper efforts at eradication. Not surprisingly it is the politically turbulent Horn of Africa where persistent pockets of rinderpest remain in livestock populations. Though each government in the region supports a national PARC office, the reality is that government-sponsored vaccination teams cannot operate effectively in areas of political unrest.

This creates an opportunity for donor agencies, universities and PVOs to collaborate. For example, in the southern Sudan, TUSVM is negotiating an arrangement for UNICEF sponsorship, with financing from the USAID office of Foreign Disaster Assistance, for the use of the heat-stable rinderpest vaccine by vaccination teams organized, trained and fielded through PVOs such as Oxfam with an established presence in the region. This sort of ad hoc arrangement may be crucial in eliminating the remaining pockets of rinderpest in Africa. A highly technical solution to a practical problem defined from field experience has made this possible.

Simpler technologies can also be brought to bear on problems identified in the field. Another example derives from the TUSVM experience in Niger. In field surveys to determine the prevalence and importance of various infectious diseases, serological tests can be of considerable help in accurately diagnosing diseases with similar clinical presentations. Once again, however, electricity and refrigeration are necessary for proper centrifugation and storage of blood samples obtained in the field. Dr. Chip Stem, who worked on the Niger project, has been experimenting with the use of filter-paper blots of whole blood rather than tubes of serum as a way of circumventing the need for centrifugation and refrigeration of blood samples under difficult field conditions. A drop of blood is placed directly on a small piece of filter-paper and allowed to dry. This preparation does not require any special handling in the field. Upon returning to the laboratory, antibodies are eluted by soaking the filter-papers in salt solutions and sensitive immunoassays such as ELISA can be used to quantify antibody. This technique has since been used in a serologic survey for brucellosis in livestock in Morocco with some success.

Another problem observed in Niger in the training of basic animal health care workers was the use of injectable drugs. Given local conditions, it was difficult to maintain syringes and needles in proper sterile condition with the result that abscesses and infections sometimes followed
parenteral administration of drugs. The problem was further compounded by the fact that some parenteral drugs require refrigeration. While it would seem reasonable to switch to oral preparations, many useful antibiotics are degraded in the rumen of cattle, sheep and goats, the important species of livestock. In response to this problem, we are currently carrying out pharmacokinetic studies in which oral antibiotic preparations are given to ruminants as rectal suppositories. Preliminary results are encouraging, with detectable blood levels of antibiotic occurring in sheep after rectal administration of tetracycline and sulpha drugs.

Clearly, innovation takes many forms. The common thread however, is that experience in the field helps to define otherwise unperceived problems and prompts researchers to develop creative solutions. Forums such as this one that allow the research community to hear about the day-to-day challenges encountered by PVOs in the field can only serve to stimulate more collaboration and creative problem solving.

APPROPRIATE HEALTH CARE DELIVERY SYSTEMS

Providing direct, timely and appropriate veterinary services to livestock owners is a major challenge in developing countries. Selection of a proper scheme for animal health care delivery depends on a number of factors including, but not limited to, the historical approach to veterinary services in a given country, the availability of trained veterinary professionals, the extent of financial and material resources available to veterinary professionals, the sophistication of communication and transportation infrastructure, the availability of drugs and vaccines, the distribution and management patterns of livestock holders (sedentary vs nomadic), and the willingness of veterinary professionals to delegate veterinary activity to paraprofessionals. The general state of political stability is also of course central to the delivery of sustained animal health care.

There is now a distinct orientation among donor agencies, including World Bank, EEC and USAID, among others, to shift away from support of government and veterinary services to privatization of veterinary practice for veterinarians and the increased use of trained paraprofessionals drawn from local, livestock-owning communities. Fee for service has been identified as a means of promoting sustainability of health care delivery. It does not however ensure equitable distribution of veterinary service. In fact it may discourage it. Veterinarians leaving government service to make it in private practice will undoubtedly migrate to locales where farmers are prosperous and well established and can pay adequately and reliably for services. This underscores the need for the training and outfitting of paraprofessionals from less prosperous communities to ensure that some basic level of veterinary service is consistently available to those who stand to lose the most by death, illness or decreased productivity of their livestock.

The situation in Afghanistan, where the author is currently working, illustrates the need for paraprofessional veterinary service and exemplifies the interaction of a donor agency, PVO, and university to address this acute need. Afghanistan is a predominantly agrarian society with a large segment of the population, Koochi pastoralists, wholly dependent on livestock activities. Sedentary farmers also depend heavily on animals for draught power, food, and cash income. Normal rural life has been thoroughly disrupted by a decade of war and occupation. Animal
numbers have depleted. Government veterinary services that existed before the civil conflict are totally inoperative in rural areas. Communication and transport are disrupted. With depleted animal numbers and limited resources for replenishment, health maintenance of existing stock takes on added importance in efforts to reconstitute national herds.

Numerous PVOs in co-operation with international relief agencies are providing vaccination and other preventive veterinary services in Afghanistan through the training and fielding of paraveterinarians and vaccinators. The typical training course is 5-6 months for paraveterinarians and 1 month for vaccinators. Ruminant stocks are vaccinated principally for anthrax, enterotoxemia, hemorrhagic septicemia and blackleg. While this is clearly of benefit, vaccination teams are constantly on the move and cannot provide day-to-day treatment services for local livestock owners, nor can they remain with specific groups of migrating Koochi herders. Delivery of appropriate animal health care to pastoralists presents many specialized problems which are just beginning to receive attention (Sollod and Stem, 1991).

Mercy Corps International (MCI), a Portland Oregon based PVO, has been working in several provinces of south-western Afghanistan for 6 years in the area of human health, and more recently, on various agricultural projects including irrigation system rehabilitation and orchard improvement, among others. They also field several animal vaccination teams. Feedback from extension staff and paraveterinarians identified a community-defined need for routine veterinary services. MCI entered into a collaborative partnership with TUSVM to further define this need. In the spring of 1990, TUSVM faculty carried out an epidemiologic survey in several south-western provinces to determine the relative prevalence and importance of various diseases of cattle, sheep, goats and camels. In the summer of 1990 a second, ethnoveterinary survey was done to determine producer perceptions of diseases, the use and efficacy of traditional animal health interventions, openness to and awareness of veterinary drugs and services, and clarification of animal caretaker responsibilities for animal health within the family or village unit.

MCI and TUSVM then drafted a proposal for providing basic animal health care services to south-western Afghanistan through a network of Basic Veterinary Workers (BVWs) which has since been funded by USAID through O/USAID/Rep Afghanistan. The programme is similar to others already underway in Africa and Asia (Hedrill, 1089; Grandin et al., 1991).

Trained paraveterinarians already working with MCI vaccination team will be brought to MCI headquarters in Quetta, Pakistan, for a 2-3 weeks training course. The emphasis of the course is not on technical veterinary knowledge, which the paraveterinarians have already received, but on becoming teacher/trainers capable of transferring their technical knowledge to Basic Veterinary Workers, who are likely to be illiterate. MCI field co-ordinators, who are Afghans, will contact local community leaders, explain the programme, and solicit candidates from the livestock-owning populace to be trained as BVWs to serve their communities.

Paraveterinarians will then train BVWs in their own communities using practical demonstration techniques applied to the animals of the BVW candidate and his neighbours. This will be supported by the use of pictograms and flip charts. A kit of basic veterinary drugs and equipment will be left with each BVW. The BVW is expected to charge for his services and the proceeds of his work will be used to purchase drugs to replace those that are used. Initially, MCI will
manage the drug resupply programme. It is intended however, that as more BVWs are trained and the demand for drugs increases, private traders will take over the task of resupply.

The performance of BVWs will be monitored by periodic visits from Afghan veterinarians and paraveterinarians on the MCI staff. Successful BVWs will receive additional training so that their repertoire of goods and services can be expanded to meet the evolving needs of the community. The author is currently seconded to MCI, Quetta, from TUSVM to co-ordinate the paraveterinarian and BVW training courses and the monitoring efforts. The first paraveterinary teacher/trainer course is to be held in February of 1992.

CONCLUSIONS

Clearly, this presentation is not intended as a comprehensive analysis of development issues in animal health care delivery. Rather it serves to provide an overview of the subject largely through the presentation of anecdotal examples derived from field experience. It is hoped that the paper will serve to stimulate discussion of the key concepts of training, research, technology transfer and on-site provision of animal health care during the seminar session of this valuable workshop.

A principal theme of this report is that an obvious synergism arises from close collaboration between donor agencies, PVO and the university/research community. Effectiveness and efficiency of field activities are clearly enhanced by such interactions. Donor agency support, in addition to providing financial resources, adds legitimacy and weight to the field activity and facilitates co-operation by local government authorities. PVO participation provides keen insight into local conditions and, through the element of trust nurtured in local communities by a sustained PVO presence, encourages acceptance of new, unfamiliar programmes and technologies. The university/research community provides technical and training expertise typically beyond the institutional capacity of the PVO. The contributions of each group are refined and enhanced by close collaboration and open communication among them. This USAID sponsored workshop is a clear indication that the value of collaborations is being increasingly recognized and encouraged. This is a heartening development.

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REPRODUCTIVE TECHNOLOGIES ON GOATS

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Different breeds of goats are believed to have developed through genetic isolation and age-old experiences and perhaps fancies of breeders in terms of colour, conformation, fertility and possibly taste of meat. The environment of the home-tract has presumably played an important role in developing certain reproductive traits, now found in recognized breeds. While the availability of abundant green phytomass in certain periods of the year and seasonal rhythm modulate the reproductive phenomena in goats (Prasad and Bhattacharyya, 1979), the breeding behaviour is inherent in animals. Temperate breeds have the tendency to breed in one season (spring); tropical breeds generally exhibit oestrus round the year. Pashmina goats, located at 12,000 to 14,000 ft above the sea level on the high Himalaya, and Don breed in the USSR have developed the characteristics of kidding once in a year during spring (March-April-May) befitting to the need of that geoclimate.

Goats as a species are known for their higher fertility over other ruminants. In recent years a number of reproductive tools have been experimentally applied for widespread use of the superior bucks and augmentation of kidding rates in does. It is also possible to improve the life-time reproductive performance of does by promotion of sexual maturity, reduction in inter-kidding period and control of reproductive disorders leading to perinatal loss.

SEmen TECHNOLOGY

Identification of superior bucks and the maximum utilization of their semen for breeding of does have been the well-known method for promoting the goat production all over the world. Artificial insemination (AI) with freshly diluted buck semen, though as successful as bull semen, has inherent problem of rapid loss of sperm motility and consequently fertilizing ability during storage at refrigerated temperature (4°C-6°C). The proposition of large-scale propagation of semen of proven bucks, either through natural service or liquid semen, in a population of goats spreads over a wide area is about impossible. Moreover, the period, essential for buck evaluation for progeny performance is 2-3 years when the bucks would have spent major period of their sexual virility. Maintenance of superior bucks in a chain of AI centres for donating fresh semen are expensive and the proven bucks are seldom available for covering the nannies in the next generation. Deep freezing
of buck semen and application of frozen semen technology are naturally the only alternative left for scientific breeding of goats for improved production.

**Deep freezing of buck semen**

Recovery of motile goat spermatozoa after freezing to -79°C was reported by Smith and Polge (1950). The deep freezing (at -196°C) of buck semen in tris-yolk (Hahn, 1972; Founger, 1976; Aamdal, 1982; Drobins et al., 1982), skim milk (Anderson, 1969; Corteel, 1974, 1977) and citrate-yolk (Viachos and Kargiannid's, 1968) with sugar/glycerol (4-8%) as cryoprotective agent has been reported. Loss of sperm motility in yolk-containing diluents due to the presence of egg-yolk coagulating enzyme in buck semen has been reported by Roy (1957). Removal of seminal plasma from buck semen by washing with buffer solution prior to processing for deep freezing in yolk-containing diluents was recommended for better freezability and fertility (Corteel and Barit, 1975; Founger, 1976; Memmon et al., 1982).

The work on deep freezing of semen in Barbari (Sahni and Roy, 1972), Jamunapari (Sahni and Roy, 1972) and other breeds (Deka and Rao, 1985; Nimkar, 1977; Shirbhate and Honmode, 1982) have been carried out in different laboratories in this country. The claim on successful freezing based on post-thaw motility have been often questioned for want of fertility trials. At the CIRG, elaborate experiments have been conducted on different aspects of deep freezing of buck semen along with fertility trials in Barbari and Jamunapari breeds (Tiwari, 1984, 1985; Tiwari et al., 1985, 1986; Tiwari and Bhattacharyya, 1987 a, b).

**BROAD GUIDELINE ON STEPS FOR DEEP FREEZING**

**Washing of spermatozoa**

Buck semen generally contains egg-yolk coagulating enzyme (phospholipase A type) which prevents successful storage of semen in yolk-containing diluent at 5°C. This enzyme is responsible for hydrolysis of egg-yolk lecithin to lysolecithin and fatty acid. Higher concentrations of lysolecithin are toxic to goat spermatozoa (Roy, 1957; Iritini and Nishikawa, 1963; Corteel et al., 1980). Therefore, the removal of seminal plasma and collection of washed spermatozoa before further processing are necessary (Corteel and Barit, 1975; Memnon et al., 1982). Semen samples are gently mixed with tris buffer (1:9 dilution) and sperms are collected after centrifugation for 15 min at 3,000 rpm.

**Diluents and dilution rate**

Successful freezing (at -196°C) of buck spermatozoa in citrate-yolk, tris and skim milk was reported with glycerol (4-8%) as cryoprotective agent (Viachos and Kraginannidis, 1968; Hahn, 1972; Corteel, 1974, 1977; Founger, 1976; Drobins et al., 1982). At the CIRG we prefer tris diluent having the following composition:
FLOW DIAGRAM FOR FREEZING OF BUCK SEMEN AND

PRE FREEZING

Selection and training of bucks

Semen collection in A.V.

Semen evaluation

FREEZING

Washing of spermatozoa

Dilution and glycerolization

FREEZING

Filling and sealing of straws

FREEZING

Equilibration

FREEZING

THAWING

Storage and transportation

Evaluation of freezing

Freezing

THAWING

Thawing and insemination

INSEMINATION

Pregnancy diagnosis
<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tris</td>
<td>3.604 g</td>
</tr>
<tr>
<td>Citric acid</td>
<td>2.024 g</td>
</tr>
<tr>
<td>Fructose</td>
<td>1.000 g</td>
</tr>
<tr>
<td>Egg-yolk</td>
<td>10 ml</td>
</tr>
<tr>
<td>Glycerol</td>
<td>4 ml</td>
</tr>
<tr>
<td>Penicillin</td>
<td>100 IU</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>100 μg</td>
</tr>
<tr>
<td>Triple-distilled water to 100 ml.</td>
<td></td>
</tr>
</tbody>
</table>

Dilution of washed spermatozoa in tris diluent (contains 4% glycerol) to $80 \times 10^6$ live and normal spermatozoa in 0.1 ml semen and cooling from $30^\circ C$ to $10^\circ -15^\circ C$ within 60 min and to $50^\circ C$ within 60 min are recommended.

**Filling and sealing of straw**

Sterilized, printed mini straw (0.25 ml, IMV France) are filled with glycerolized semen with the help of weak regulated vacuum pump attached to factory plugged end of the straw. This end of the straw seals automatically when diluted semen comes in contact with it. The opposite end of the straw is normally sealed with polyvinyl alcohol powder (PVA) after an air space is created with the help of plastic comb. The simplest method of sealing the straw is to dip the open end into PVA powder and place it into a water-bath maintained at $10^\circ -15^\circ C$ which takes care of laboratory seal. It is important to leave a small air space in the straw to avoid crack on the straws during freezing.

**Equilibration**

Significance of maintaining diluted buck semen at $5^\circ C$ for 4 hr (equilibration) prior to freezing was detailed by Fraser (1962), Hahn (1972), Corteel (1974), Aamdel (1982), Memon *et al.* (1982) and Drobnis *et al.* (1982). Equilibration is essential for spermatozoa-extender interaction which minimize sperm damage during freezing and helps in better harvest of post-thaw sperm motility and resultant higher fertility. Although reports on equilibration time are controversial, 2-5 hr have been considered suitable for freezing of buck semen. In our laboratory we preferred 4 hr of equilibration.

**Freezing**

Equilibrated straws are cleaned and dried completely with pre-cooled soft tissue-paper in cold handling cabinet; they are spread horizontally on a freezing rack and lowered into liquid nitrogen (Ln2) vapour for freezing (1-2 cm above Ln2 level) for 10 min before plunging into Ln2 (-196$^\circ C$).

**Evaluation of freezing efficiency**

There is a good deal of variation in efficiency of semen freezing depending on the diluents...
and breeds. We find that post-thaw sperm motility is superior in tris diluent. Freezability of Jamunapari semen (48.47 ± 2.37%) is slightly better as compared to that of Barbari (44.84 ± 2.18%). Individual variation in freezability has been noticed in both the breeds.

**EMBRYO TECHNOLOGY**

The practical application of multiple ovulation and embryo transfer (MOET) has taken place in many different countries and environments. Some of these applications have been directed towards:

* Maximizing the life-time production of offspring from genetically superior does
* Utilizing genetically inferior does as biological incubators for embryos of desired genetic make-up
* Conserving threatened species (e.g. Jamunapari and Surti breeds of India)
* Reducing twins and multiples in each pregnancy (especially in fibre-producing breeds)
* Producing twins and multiples in each pregnancy (especially in fibre-producing breeds)
* Providing the opportunity for progeny testing of does which has so far been limited to bucks
* Minimizing the time required for progeny testing of bucks
* Intensifying selection pressure in a population
* Introducing new breeds into closed colonies or countries
* Reducing the cost and risk involvement in transportation of animals
* Avoiding depletion of numbers of superior genetic strains from the exporting countries
* Promoting adaptation of progeny to a stressful neoenvironment
* Producing identical twins, multiples and chimeras

The success of an embryo transfer programme in the goat depends on many individual components of the procedure. Namely, the selection and proper management of the donor animals (including bucks), the choice of optimum drug regimen for synchronization and superovulation of the donors, the management and synchronization of the recipients, and the technical skill in collection and transfer of the embryos (Agrawal et al., 1979; Na et al., 1987; Ocampo et al., 1988; Prizada et al., 1988; Sharifuddin et al., 1988; Mahmood et al., 1989; Lohan et al., 1989; Mutiga, 1991).
**Augmentation of ovulation and monitoring of oestrus**

The normal ovulation rate of large breeds of goats have not been studied adequately. In dwarf goats, the ovulation rate can be as high as 4.0 (Rao and Bhattacharyya, 1980). The ovulation sequence of some of the polytocous breeds was studied (Bhattacharyya and Prasad, 1974; Rao and Bhattacharyya, 1980).

With the advent of drugs, PMSG, GnRH and FSH, induction of superovulation or multi-ovulation has been possible in large flocks of goats. In practice, minor problem of seasonal depression in breeding of goats could be corrected by the synchronization of oestrus along with judicious induction of multi-ovulation (Table 1).

**Table 1.** Multiovulation and synchronization agents for goats

<table>
<thead>
<tr>
<th>Breeds</th>
<th>Hormones/chemicals/others</th>
<th>Source</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angora</strong></td>
<td>PMSG (Folligon)</td>
<td>Intervet, Bums, Omaha USA</td>
<td>1,000 IU</td>
</tr>
<tr>
<td></td>
<td>FSH-P (decreasing dose division in two at 12 hr interval)</td>
<td></td>
<td>15 mg and 18 mg</td>
</tr>
<tr>
<td><strong>Barbari</strong></td>
<td>PMSG; PMSG &amp; hCG</td>
<td>Sigma Chemicals, USA</td>
<td>400-1,000 IU</td>
</tr>
<tr>
<td><strong>Black Bengal</strong></td>
<td>a) PMSG</td>
<td>Sigma Chemicals, USA</td>
<td>400-1,000 IU</td>
</tr>
<tr>
<td></td>
<td>b) Audio-visual olfactory and coital stimuli</td>
<td></td>
<td>Stimulate 36 hr post-oestrus</td>
</tr>
<tr>
<td></td>
<td>c) Oxytocin</td>
<td></td>
<td>- 40 IU</td>
</tr>
<tr>
<td><strong>Angora</strong></td>
<td>a) Progestagen in vaginal sponges</td>
<td>Upjohn, UK Kalamazo, USA</td>
<td>60 mg</td>
</tr>
<tr>
<td></td>
<td>b) PGF2 α analogue</td>
<td></td>
<td>8 mg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11 days apart</td>
</tr>
<tr>
<td><strong>Barbari</strong></td>
<td>MGA</td>
<td>Upjohn, UK</td>
<td>0.15 mg/goat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 day for 15 or 16 days</td>
</tr>
<tr>
<td><strong>Black Bengal</strong></td>
<td>MGA</td>
<td>Upjohn, UK</td>
<td>15 or 16 days</td>
</tr>
<tr>
<td><strong>Black Bengal</strong></td>
<td>PGF2 α</td>
<td>Upjohn, UK</td>
<td>11 days apart</td>
</tr>
<tr>
<td><strong>Jakhrana</strong></td>
<td>Progestagen (in vaginal sponges)</td>
<td>Upjohn, UK</td>
<td>60 mg (Medroxy progesterone acetate)</td>
</tr>
<tr>
<td><strong>Non descrip (local)</strong></td>
<td>r'GF2 α analogue</td>
<td>Upjohn, UK</td>
<td>100-125 μg in two doses 1 days apart</td>
</tr>
</tbody>
</table>
A typical sequence of events for multi-ovulation and embryo collection is as follows:

<table>
<thead>
<tr>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>-14</td>
<td>PGF2 alpha or analogue</td>
</tr>
<tr>
<td>-4</td>
<td>FSH &lt; or PMSG</td>
</tr>
<tr>
<td>-3</td>
<td>FSH &lt; + PGF2 alpha or analogue</td>
</tr>
<tr>
<td>-2</td>
<td>FSH &lt;</td>
</tr>
<tr>
<td>-1</td>
<td>FSH &lt;</td>
</tr>
<tr>
<td>0</td>
<td>hCG or GnRH</td>
</tr>
<tr>
<td>+1</td>
<td>AI/mating</td>
</tr>
<tr>
<td>+2</td>
<td>Tubal collection (surgical)</td>
</tr>
<tr>
<td>+3</td>
<td>Tubal collection (surgical)</td>
</tr>
<tr>
<td>+4</td>
<td>Uterine collection (surgical)</td>
</tr>
<tr>
<td>+5</td>
<td>Uterine collection (surgical/non-surgical)</td>
</tr>
<tr>
<td>+6</td>
<td>Uterine collection (surgical/non-surgical)</td>
</tr>
<tr>
<td>+7</td>
<td>Uterine collection (surgical/non-surgical)</td>
</tr>
<tr>
<td>+8</td>
<td>Uterine collection (surgical/non-surgical)</td>
</tr>
</tbody>
</table>

Collection and transfer of embryos

Embryos have been mostly recovered from the oviduct or the uterus at laparotomy (Agrawal et al., 1982). The temporal effect on cell-stage of the cleaving embryos and their location in the tubo-uterine tract has been reported (Agrawal and Bhattacharyya, 1984). It is technically much easier to collect embryos from the uterus than from the oviduct and recoveries are therefore usually performed after day 4 following oestrus.

Lately semi-surgical and transcervical techniques have been described for the collection of embryos from goats. The use of laparoscopy (McKelvy et al., 1986; Legende et al., 1988) or the transcervical embryo collection either by simple mechanical dilatation of the cervix (BonDurant et al., 1984; Nagashima et al., 1987; Hays, 1988) or by using prostaglandin E2 and oestradiol for softening and ripening the cervix (van Neikerk et al., 1990) have greater promise.

Embryos are generally transferred to the uterus of synchronized recipients either at laparotomy or using a laparoscopic technique (McKelvy et al., 1985; Walker et al., 1985). There is apparently no difference in the pregnancy rates which result from the transfer of embryos at different cell-stages (Armstrong and Evans, 1983).

Embryo cryopreservation

Several methods of short and long-term preservation have been tried for goat embryos (Agrawal et al., 1983a, b). The preservation at ultralow temperature is preferred as cryopreserved embryos are time neutral (Lyon et al., 1977). Effective methods of cryopreservation are essential for international trade in embryos, for maximizing the use
of available recipients in MOET programme and for the retrieval of endangered breeds.

The first successful cryopreservation of goat embryos was reported by Bilton and Moore (1976), but since then only a few investigations (Rao et al., 1983) have been conducted in which a substantial number of caprine embryos were studied. Most caprine embryos were frozen by the conventional procedure of exposing the embryo to a cryoprotectant and then cooling at a specified rate prior to storage in liquid nitrogen; the embryos were then rapidly warmed to room temperature and the cryoprotectant removed prior to transfer to recipient animals.

Empirical results indicate that both glycerol and ethylene glycol can be successfully used as cryoprotectant for caprine embryos. However, in common with the much more extensive literature on the freezing of bovine embryos, the pregnancy rates reported for goats vary greatly between operators and methodologies; thus whilst Baril et al. (1989) achieved an embryo survival rate of 52% for caprine embryos frozen using step-wise addition of glycerol, Rong et al. (1989) reported an embryo survival rate of only 35% for goat embryos frozen by a procedure involving a single step addition of glycerol. Glycerol when added at 37°C appeared to offer better cryoprotection than DMSO at 6°C (Rao et al., 1983).

**Embryo micromanipulation**

In early work in which goat morulae were split (the usual stage chosen for bisection in cattle), poor embryo survival rates were reported (0 out of 22 for morulae, 3 out of 21 for blastocysts; Tsunoda et al., 1985). However, in the same study, 10 offsprings were produced from 18 hatched blastocysts. Poor embryo survival rates were also reported by Rorie et al. (1987). In blastomere deletion studies of 2-cell embryos, single blastomere transfer resulted in live offspring (Nandy et al., 1989a, b).

Chimeras have been extensively used as models for research in developmental biology. There are composite animals in which different cell populations are derived from more than one fertiliser egg or the union of more than 2 gametes (Anderson, 1987). Chimeras have been produced by the micro-dissection of early embryos followed by aggregation of the blastomeres from a number of embryos of the same or different species, or by injecting a single blastomere from another species into the embryonic blastocoel cavity.

Goat chimeras have most commonly been produced by aggregation with cells derived from ovine embryos (Fehilly et al., 1984; Polzin et al., 1986; Roth et al., 1989; MacLaren et al., 1990).

Embryo cloning in goats consists of dissociating a donor embryo into separate blastomeres and then fusing one of these to an enucleated recipient ovum. The feasibility of producing multiple identicals by nuclear transfer was demonstrated by Illmensee and Hoppe (1981) who produced identical mice by the direct microinjection of nuclei from the inner cell masses of mouse blastocysts into enucleated pronuclear zygotes. Kids have
now born from the fusion of blastomeres to enucleated oocytes in goats (Yong et al., 1991).

**In-vitro fertilization**

The first 2 reports of successful *in-vitro* fertilization of goat oocytes were those by Rao (1984) who used *in-vitro* capacitated spermatozoa (in rabbit oviduct) and by Hanado and Pao (1984) who achieved fertilization using ionophore-treated spermatozoa. The xenogenous fertilization of goat ova in the rabbit oviduct and the birth of kids from transfer of such embryos was reported by Rao et al. (1984). Much of the subsequent work on *in-vitro* fertilization in this species has been conducted in Japan and in the Far-East (Hamano et al., 1985; Song and Iritani, 1985, 1988; Huang et al., 1989; Zhiming et al., 1990; Jufen et al., 1991).

Following fertilization caprine embryos can be matured *in-vivo* in ligated oviducts (Cheng et al., 1990) or in domestic chicken eggs (Biakewood et al., 1990). They can also be matured *in-vitro* by using synthetic oviduct fluid medium (McLaughlin et al., 1989), or by using oviductal and uterine cell monolayer culture systems (Prichard et al., 1991).

**CONCLUSIONS**

* Goats are known for their higher fertility among ruminants.
* Improvement in their production potential over generations would depend on the use of superior bucks.
* Frozen semen technology can be used as effective tool for rapid genetic improvement.
* Embryos of exceptional does can be collected by non-surgical technique.
* MOET programme in caprine species has equal potential like other species.
* Successful cryopreservation of caprine embryos is possible.
* Embryo manipulation techniques are presently under laboratory scrutiny.

**REFERENCES**


ECONOMIC IMPORTANCE OF GOAT AND SHEEP SKINS IN INDUSTRIAL ACTIVITY AND TO THE EXPORT TRADE

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Central Leather Research Institute, Madras 600 020 India

India with 111 million goats and 52 million sheep (1986) claims first and fifth positions in the respective populations of the world. These two species are generally termed as 'small ruminants' on account of their being small in size. Their contribution to the Indian economy through milk, meat, skins, wool, manure, etc. is by no means small as revealed by the following data:

<table>
<thead>
<tr>
<th>Value of products from goats and sheep - an estimate (1991-92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
</tr>
<tr>
<td>Milk</td>
</tr>
<tr>
<td>Raw skins and by-products</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Although their contribution is substantial, these ruminants have not received that much recognition as they should deserve in terms of development programmes, policy formulations and R&D efforts. In recent years only, under Intensive Rural Development Programmes (IRDP) sheep rearing has been encouraged but not goat rearing. Most of the R&D efforts have been oriented towards improving the wool yield only. Goats as a source of meat, milk and skins have not received due attention. On account of growing demand for meat coupled with remunerative prices, new awareness about their importance has been spreading. Skins, hair/wool and intestines do serve as basic raw materials for a series of processing industries. Of these leather is the most important; it accounts for sizeable employment, value addition and even export earnings.

SOCIAL RECOGNITION

At the farm level these ruminants provide continuous source of livelihood to several thousands of landless poor and marginal farmers, mostly representing socially and economically backward communities. In the production of meat and by-products, thousands of men/women and children find full or partial employment. As a result of social stigma attached to meat production and handling of by-products like skins, only socially
and economically backward communities are found engaged in this profession. The location of meat outlets, in general, are found relegated to slums, road margins or to isolated places, that deal with various food articles. Similar treatment is accorded to handling of skins and intestines too.

REALIZATION FROM SLAUGHTERED SHEEP/GOAT

Of the total realization from a slaughtered animal, meat accounts for 75.5% and skins 15.1%, together accounting for 90.6%; other by-products together represent the balance of 9.4% (Table 1).

Table 1. Realization from sheep/goat

<table>
<thead>
<tr>
<th></th>
<th>Value (Rs)</th>
<th>%Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>400</td>
<td>75.5</td>
</tr>
<tr>
<td>Skin</td>
<td>80</td>
<td>15.1</td>
</tr>
<tr>
<td>By-products</td>
<td>50</td>
<td>9.4</td>
</tr>
<tr>
<td>Total</td>
<td>530</td>
<td>100.0</td>
</tr>
</tbody>
</table>

SKINS—A CO-PRODUCT OF MEAT INDUSTRY

Skins constitute the basic raw materials for further processing into various stages — unfinished leather, finished leather and consumer items like leather garments and fancy items. The processing and export of these leather-based items facilitate various other material inputs and wage units to enter the export trade. It is also a highly labour-intensive industry. As a result of overall importance, the leather industry is recognized as a thrust area deserving all out government support.

Table 2. Value addition accruing during processing

<table>
<thead>
<tr>
<th></th>
<th>Value (Rs)</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw skin</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Tanned but unfinished leather</td>
<td>112</td>
<td>140</td>
</tr>
<tr>
<td>Finished leather</td>
<td>160-180</td>
<td>200-225</td>
</tr>
<tr>
<td>Products</td>
<td>320-400</td>
<td>400-500</td>
</tr>
</tbody>
</table>

If a goat/sheep skin is processed into leather and then converted into ultimate consumer products, its value would enhance 4 to 5 times and reach a level as high as that of meat (Tables 1, 2). Thus, skins in view of their industrial potentialities deserve to be treated as a co-product but not as a by-product of meat industry.

PRODUCTION OF SKINS

According to a nationwide survey on hides and skins (CLRI, 1987) about 68 million goats and 28 million sheep were annually slaughtered, of which 50% were obtained from urban
slaughterhouses and the balance from numerous villages scattered all over the country. In addition 7.4 million goat skins and 3.4 million sheep skins were recovered from fallen animals. Due to non-recovery of fallen goats and sheep, about 9 million pieces valued at Rs 540 million were lost to the tanning industry.

Table 3. India’s share of population and skin in the world (1987)

<table>
<thead>
<tr>
<th>Species</th>
<th>Population</th>
<th>% Share</th>
<th>Skins</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>World</td>
<td>India</td>
<td>World</td>
<td>India</td>
</tr>
<tr>
<td>Goat</td>
<td>502</td>
<td>111</td>
<td>202</td>
<td>75</td>
</tr>
<tr>
<td>Sheep</td>
<td>1,158</td>
<td>52</td>
<td>473</td>
<td>31</td>
</tr>
</tbody>
</table>

India’s share of goat population was 22% and of skins 37%. Similarly, sheep claimed 4.5% whereas their skins represented 6.6% of the world production. Higher percentage shares of skins compared with the respective proportions of populations had been on account of the high off-take rates of 67.9% for goats as against the world off-take rate of 38.9% and 60.4% for sheep compared to 36.7% of world off-take rate. On account of social prejudices against consumpation of pork and beef, goat and sheep meat continue to serve as important sources of meat in India. With the growth of the human population and growing standard of living, the steady growth in the demand for meat/mutton coupled with high prices persist strongly. In recent years, to cope up with the demand for meat, even the pregnant and under-aged animals are being slaughtered ignoring the long-term adverse effects on the basic stock. This trend resulted in the proportion of small-sized skins in the total supply. The available population data for 1987 showed a declining trend compared to 1982 (Table 4).

Table 4. Trends in India’s goats and sheep population

<table>
<thead>
<tr>
<th>Species</th>
<th>1961</th>
<th>1982</th>
<th>1987*</th>
<th>Annual growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1961-82</td>
</tr>
<tr>
<td>Goat</td>
<td>60.9</td>
<td>95.3</td>
<td>92.0</td>
<td>(+) 2.7</td>
</tr>
<tr>
<td>Sheep</td>
<td>40.2</td>
<td>48.1</td>
<td>43.0</td>
<td>(+) 0.9</td>
</tr>
</tbody>
</table>

*Estimate based on the partial information.

Between 1961 and 1982 goats recorded 2.7% growth per year, whereas between 1982 and 1987 negative growth of 0.6% was observed. Similarly, sheep registered 0.9% between 1961 and 1982 whereas in the subsequent five years, negative growth of 1% was recorded. Both from the interest of meat industry and leather industry, this declining trend has to be corrected through introduction of policy measures and development programmes. An imaginative and pragmatic National Policy to arrest the indiscriminate slaughter of productive stock as well as underaged animal is needed. The small ruminant farming should prove more beneficial to the farming community than it is a present. One
way would be promotion of Farmers' Co-operatives for production of hygienic meat through viable rural slaughterhouses to produce and market meat in hygienic packets similar on the lines of dairy industry so that farmers can claim a share in the meat production also instead of being content with the sale of meat animals at distress prices as it is in vogue at present. If this alternative system becomes popular, the leather industry will be benefitted in more than one way. The skins emanating from such meat production centres can be processed soon after recovery in the rural environments without using preservatives nor losing time causing deterioration in the quality of the skin. With better remuneration to the farmers, stock building would get encouraged which in turn would provide more supplies of skins. Various man-made defects like flay cuts arising out of hasty slaughter as taking place in the urban slaughterhouses can be avoided. If the production of meat in rural centres and marketing of meat in urban centres gains momentum, the existing urban slaughter activities are expected to decline as it happened in the case of milk production and distribution system.

MARKET STRUCTURE

In the market network that connects the primary producers of skins, a number of middlemen are involved in the collection, trading, preservation and transportation. Their role is important in the existing circumstances of decentralized and often isolated and occasional production of skins and their mobilization from the rural areas. At each point in the market chain, skins gain additional mark-up price on account of market costs, commission, wastages etc. Longer the chain, higher the ultimate price compared to basic primary price. In respect of skins produced in urban centres, the number of middle men is less and hence the price differential between the primary procurement and ultimate sale to the tanner is normally not high.

With the increased processing activity, the market structure has undergone remarkable changes in the recent years. Some of the tanners have opened their own procurement centres in the terminal markets; some of the traditional hides/skins dealers have entered into tanning activity to sell crust leathers instead of raw materials.

IMPORTANT TERMINAL MARKETS FOR GOAT/SHEEP SKINS

Traditionally, the skins being recovered from numerous villages, towns and cities get mobilized and transported to important terminal markets from where the tanners obtain their supplies. In spite of the fact that the tanners in recent years are obtaining even at the district level markets to some extent the importance of terminal markets continue to exist. For skins, these markets are Calcutta, Delhi, Bombay, Hyderabad, Madras etc.

INDUSTRIAL ACTIVITY

The tanning and finishing activity received a tremendous boost with the introduction of a package of measures in 1974 and these measures comprise ban on the export of raw skins, restrictions on the export of semi-tanned leathers and simultaneously introduction
ECONOMIC IMPORTANCE OF GOAT AND SHEEP SKIN: RAO

of export incentives on high value-added finished leathers and products. A large number of traditional tanneries were expanded and modernized; new mechanized tanneries were set up in different parts of the country. Between 1974 and 1988, 600 units in small-scale sector and 30 units in the large-scale sector came into existence for processing hides and skins. In addition to absorbing domestic supplies, the industry started importing skins from various countries to facilitate higher capacity utilization of tanneries. In 1990-91, Rs 1,910 million worth of raw material/leathers were imported. It is expected that the imports in the years to come would be much larger. Footwear, leather garments and high value-added product industries sprung up to take advantage of the export incentives and growing export opportunities. All these developments are reflected in the export structure (Table 5).

Table 5. India's exports (in million Rs) of leathet and leahe products and their structure

<table>
<thead>
<tr>
<th>Items</th>
<th>1973-74</th>
<th>%</th>
<th>1980-81</th>
<th>%</th>
<th>1990-91</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-tanned leathers</td>
<td>1,476</td>
<td>81.6</td>
<td>503</td>
<td>12.6</td>
<td>40</td>
<td>0.1</td>
</tr>
<tr>
<td>Finished leathers</td>
<td>168</td>
<td>9.3</td>
<td>2,268</td>
<td>56.7</td>
<td>7,656</td>
<td>30.0</td>
</tr>
<tr>
<td>Footwear components</td>
<td>8</td>
<td>0.1</td>
<td>451</td>
<td>11.3</td>
<td>5,860</td>
<td>23.0</td>
</tr>
<tr>
<td>Footwear</td>
<td>104</td>
<td>4.8</td>
<td>338</td>
<td>8.4</td>
<td>2,104</td>
<td>8.2</td>
</tr>
<tr>
<td>Leather garments</td>
<td>3</td>
<td>0.2</td>
<td>52</td>
<td>1.3</td>
<td>5,792</td>
<td>22.7</td>
</tr>
<tr>
<td>Leather goods</td>
<td>49</td>
<td>2.7</td>
<td>386</td>
<td>9.7</td>
<td>4,086</td>
<td>16.0</td>
</tr>
<tr>
<td>Total</td>
<td>1,808</td>
<td>100.0</td>
<td>3,998</td>
<td>100.0</td>
<td>25,538</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: 1. Monthly Statistic of Foreign Trade of India
2. Council for Leather Exports

The above trend reveals the following: The share of unfinished leathers declined from 81.6% to almost nil between 1973-74 and 1990-91. The share of finished leathers which was 9.3% in 1974 steadily grew and subsequently slid down in favour of products. In 1990-91 its share was hardly 30%. All the leather products, as a group, which contributed to an insignificant share in 1973-74, rose to a level of 70% in 1990-91.

Nearly 60% of the export earnings in the form of finished leathers and leather products together valued at Rs 15,000 million had been derived from goat and sheep skins (1990-91). Germany absorbed 25% of India’s export, followed by the USA (12%), Italy (12%), UK (12%) and Russia (12%). These five countries together absorbed 73% of India’s exports.

FACTORs CONTRIBUTING FOR THE GROWTH OF INDUSTRIAL ACTIVITY

Rich raw material supply, low-cost wages, promotional policies of the government at the domestic level and growing export opportunities at the international level, have been the major factors for the phenomenal growth of leather industry and export trade.

RAW MATERIAL BASE

India claims substantial share in the production of small ruminant skins. Their intrinsic
quality is well suited for producing high value-added leather products for meeting international markets. The low level domestic demand for leather products is another factor that enhanced the exportable surplus.

**WAGE ADVANTAGE**

Comparative wage levels (US $/day) prevailing in different countries are given below: USA/Germany, 40-45%; South Korea/Taiwan, 10-15%; and India 2-3%.

Leather industry continues to be labour intensive and as such it flourishes where low cost labour is available. The average wage per worker works out to 2 US $/day in India compared to 15 to 20 US $ in South Korea and Taiwan and 50 US $ in USA and Germany. Moreover, the leather product industries are well suited for employing female workers. In India, around 80% of the workforce in the footwear, leather garment and leather products industry are women workers.

**EXTERNAL FACTORS**

Until three/four decades ago, the developed countries of the world specialized in processing of skins and conversion into products both for their domestic consumption and export. The raw materials from less developed countries used to be imported for re-export in the form of products. With the growing effluent problems coupled with the shrinkage of workforce to work in wet operations and high wage levels this trend got reversed. The industrial activity sharply moved to developing regions along with the basic raw materials from developed countries. In return, leather products have become regular merchandise of imports into these countries. India is one of the countries that has been benefitted by this trend.

**NEAR FUTURE**

Ambitious export target of Rs 100 billion to be achieved by the end of the century by the leather industry has been set. Assuming 60% of this target has to be achieved from skins sector, then raw material base has to be strengthened in terms of quantity, quality and handling systems. The measures that contribute to strengthening the raw material base are as follows:

1. Develop meat production and marketing in the decentralized sector by setting up viable rural slaughterhouses in the animal production centres and transport the meat to urban consuming centres similar on the lines of milk, fish and prawns, to eliminate the avoidable wastages, reduce transport cost, benefit the farmer and process the skins in the vicinity without loss of time and using salt. In course of time, with the spread effect of this system, it is possible to replace the unhygienic urban meat production system which neither benefitted the farmer nor the consumer.

2. Promote goat farming under Small Farmers’ Development Programmes similar on the lines of sheep development.
3. The existing prejudices against goat as an enemy to the forest and farming need to be replaced by objective assessment of its economic role and positive promotional programmes; their farming should be encouraged under controlled grazing/browsing systems.

4. Evolve viable and bankable schemes for setting up of stall-fed/semi-intensive farms in different scales and promote as commercial ventures with bank finance/incentives.

5. A nation-wide socio-economic study seems to be necessary to assess the production of meat and other by-products and to estimate the benefits accruing to the country.

6. To prevent premature slaughter of productive stocks and under-aged animals, there is a need to formulate a pragmatic and effective slaughter policy at national level.

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Council for Leather Exports, Madras Export data.


Balochistan is the largest province of Pakistan, with 34.5 million ha (45% of the total area), 4.3 million people in 1981 and an estimated population of 7.1 million in 1990 (Van Giles and Baig, 1991). It is located in the western part of Pakistan, sharing borders with Iran in the west and Afghanistan in north. The livestock sub-sector of Balochistan contributes 25% of the Gross Agricultural Product (FAO, 1983). Most of the economic output value of agriculture is contributed by fruit and vegetables produced under irrigated conditions. While the value of crop production has increased mainly by the intensification of input use (i.e., irrigation, fertilizer and pesticides), the value of livestock production has increased mainly because of the larger numbers of animals and more extensive grazing, mostly small ruminants and camels. Balochistan has 11.3 million sheep and 7.4 million goats, 0.8 million cattle and 0.24 million camels. Using figures provided by Mahmood and Rodriguez (1991), the estimated provincial annual offtake of small ruminants is 56,000 tonnes of meat with a market value of Rs 2,840 million ($130 million, using $1 = Rs 21.8). Adding the value of edible and non-edible by-products, this figure increases to Rs 3,336 million or $153 million.

The rate of increase in Balochistan's small ruminant population from 1972 to 1986 was 6.5% and the rate of increase in the human population from 1972 to 1981 was 7%. This exacerbated the already existing high pressure on the rangeland resources. The percentage of income from sheep and goats as a percentage of agricultural income ranges from 40 to 50% for transhumants in the northern areas of highland Balochistan to 100% in the case of nomadic pastoralists. Most of the people in the province are illiterate and womenfolk especially are socially disadvantaged. The current status of the rangeland resources and the structural and social problems of resource distribution pose serious question about the short-term sustainability of this sub-sector.

**Population**

Out of 4.3 million people living in Balochistan in 1981, 16% were located in urban areas while the rest were in rural areas (GOB, 1989). During 1972-1981 the population grew at 7% per year, and this was more or less equally divided between net immigration of Afghan refugees and autonomous growth. This average growth rate is well above the alarmingly high national average (3.1%). It is estimated that the population in 1990 was 7.1 million and that by the end of the century it will be 10.7 million. Balochistan's share of the national population is 5.1%, and
it is expected to increase to 8.5% by the year 2010 (Van Giles and Baig, 1991).

Family planning is not known or is incomprehensible for most of the population, and children are perceived as wealth and a future source of labour. About 50% of the population is below 15 years. The sex ratio of males to females is 1.12. This is possibly due to the lower life expectancy of women resulting in part from an extremely high maternal mortality rate, a characteristic that Pakistan shares with other countries in the subcontinent. However, this ratio could be due perhaps to erroneous census results. Women do not appear easily outside the house, census enumerators are not permitted into the women's quarters, and men do not even like to talk about their women (Van Giles and Baig, 1991).

The literacy rate in rural areas is 9.8% for males and 1.8% for females, while in the urban areas it is 42.4% for males and 18.5% for females. In rural areas 77% of the population works in agriculture, animal husbandry or forestry; in the urban areas this proportion is 13% (1981 Census Report of Balochistan Province, as reported by Massod et al., 1988).

SOCIAL ORGANIZATION

The majority of the rural population in Balochistan is either Baloch or Pashtun, with a social organization based on traditional tribal lines. These two groups have some differences, but their main social organizations are fairly similar. Each tribe (Qaum/Kaam) is divided into clans (Takar/Shakh) which are in turn divided into sections (Pasha/Shaiwa) and sub-sections (Tal"abar/Khel). Starting from a family at the bottom of the system there is a hierarchical leadership pattern, at the top of which is the tribal chief or Sardar. The decision-making process is decentralized and most of the petty disputes regarding personal matters, property rights and resource use are settled between their respective leaders. At all levels there are councils of elders called Jirga. These decide matters and enforce tribal customary laws (Buzdar et al., 1989).

The cooperation of all members of the community is needed to attain a sustainable resource utilization and to avoid misuse. Where the tribe or section closes its rangelands for part of the year, it is necessary to discontinue all grazing activities. These types of co-operative activities for the good of the entire group must be enforced, even if that requires the use of force or sanctions. Other types of co-operation entail voluntary monetary contributions or loans of animals when a member of the community has lost livestock due to natural hazards (Buzdar et al., 1989).

Rangeland resources and land tenure

Only 10 million ha of Balochistan (30%) can be considered as usable rangeland. The often quoted figure of 90-93% is a gross overestimate and obtained by subtracting the cultivated land (4-5%) and forests (a few %) from the total land surface (Van Giles and Baig, 1991). However, many mountain slopes are practically barren and useless for livestock foraging. Good rangelands in Balochistan (15% of the provincial area) produce 200-300 kg DM/ha a year and the other 15% produces less than 10 kg DM/ha a year. About 2 ha of good rangeland is required per sheep for sedentary (year round) grazing and 1 ha for summer (nomadic/transhumant) grazing. For the remaining rangeland the grazing capacity would be two to three times lower (Van Giles and Baig, 1991).
Balochistan rangelands are generally degraded by both reduction of their standing biomass and degeneration into unpalatable vegetation. Similarly degraded rangelands are common in adjacent south-west Asia and the Mediterranean, and are the result of over-exploitation for forage and fuelwood. The range degradation on the mountain slopes is largely irreversible on a time scale of decades, but range rehabilitation on the gravelly fans and terraces (22% of the area) is quicker, taking five to ten years when full protection against any usage is imposed. Full protection will not suffice everywhere, and planting of forage shrubs and trees is locally required (Van Giles and Baig, 1991).

Some inferences about the rate of rangeland degradation (Cossins, 1988) have been made based upon the increasing goat population. However, there is a need to quantify these degradation, deterioration or desertification processes in a time scale of 5 to 30 years by taking field measurements. Camels are often ignored as another source of grazing pressure. Assuming that the average camel in Balochistan weighs 300 kg and the average small ruminant weighs 30 kg, the camel population is equivalent to another 2.35 million sheep and goats. The frequently cited report by FAO (1983), used as the baseline study of Balochistan’s vegetation, was based on scattered samplings during the summer of 1982. Even though there is evidence of the widespread extent of unpalatable range species, which are found in lower densities in relictus (climax) vegetation, it is not possible to know how long it took for the vegetation to change or what were the causes.

There are two types of rangelands in Balochistan: common and open rangelands. Common rangelands are traditionally owned by tribes, with customary institutional arrangements for their sustainability and effective management. Because of the exposure of the tribal societies to exogenous economic and social forces, the traditional institutions have been under increasing pressure and in some instances they have been replaced by an increasing degree of anarchy. As a result range resource depletion has been accelerating rapidly. When the tribes close their own common rangelands they move their animals to open rangelands; lack of grazing rights, and overgrazing in these open rangelands has worsened their depletion and decreased their productivity. Open rangelands have been increasing in area as the more exclusive common rangelands have lost the ability to sustain animal feed demand and are abandoned by their owners (Buzdar et al., 1989).

Two factors have caused rangeland degradation: excessive population growth and exogenous social and economic forces. An example is provided by Cossins (1988):

"In 1980, war in Afghanistan caused massive migrations to Pakistan. At least 3 million refugees fled into Pakistan with their livestock — 600,000 people with 4.8 million sheep and goats to Balochistan alone. Because they have been largely concentrated in a number of camps along the border areas, their presence has resulted in extremes of degradation in the neighbourhoods of their camps in northern Balochistan. The effect of a sudden increase equivalent to 14% of the total livestock and human population in Balochistan on the already saturated and fragile environment has been drastic."

No specific example is provided by Buzdar et al. (1989) to characterize these exogenous forces or how the social deterioration process has occurred.
The presence of irrigation water in certain areas of Balochistan has encouraged an increase in the livestock population because of the presence of stubble and fodder. At the same time, when the stubble and fodder are not available for grazing or foraging, the animals are turned out on the common or open rangelands without appropriate management. Depletion of the vegetation cover has reduced the ability of the watersheds to retain rainfall, and this in turn leads to less recharging of ground water. Extraction has increased greatly, for irrigation and for the growing towns and villages. For example, the Water Power Development Authority estimated that the annual decline in the water table in the Quetta valley was 0.15 m during 1900-1960, 0.24 m during 1960-1980, and 3.05 m during 1989-1990 (Van Gile and Baig, 1991).

GRAZING SYSTEMS

The three major grazing systems in Balochistan are nomadic, transhumant and sedentary; these depend on the type of animal raider and the rangeland ownership.

True nomads

The true nomads follow the seasonal patterns of forage production, spending the summers in the cold highlands in Central Asia and winter in the warmer lowlands of Pakistan and India. They move across the open rangelands where they spend a few days, or sometimes weeks if range vegetation is abundant. They can pass through the tribal common rangelands but cannot prolong their sojourn. In the lowlands of the Indus valley they have contacts with local farmers, from whom they buy stubble grazing rights, straw and other feed for their animals and sell their own labour and animals and their by-products in exchange. Their arrival in the lowlands must coincide with the winter growing and harvesting season, so they can sell their labour and buy cheap feed for their animals. Likewise, their return to the highlands in the spring and summer must coincide with the growth of palatable forage resources and with seasonal labour requirements (Buzdar et al., 1989).

In Balochistan 30% of the small ruminants follow this type of grazing system (FAO, 1983). Nomadic families own 80-100 heads of sheep and goats, with about 20 animals per male member. Three or four families keep their livestock together making up flocks of about 300 animals. A nomadic flock of 100 animals, of which 85 are sheep and 15 are goats, usually has 45 breeding ewes and 8 does (FAO, 1983; Table 7, Annexure 3). The annual gross income, in 1991 Rs\(^1\), would be approximately Rs 18,473, of which sales of livestock comprise 80%, sales of wool and skins comprise 8%, and the remaining 12% is the value of family consumption (meat, milk, wool and hair). Annual production costs are about Rs 910. These figures are very low considering that this is the family income of 3 or 4 adults. The estimated daily income of one adult is Rs 12 per day, which is one quarter of the urban daily wage of Rs 50. Data on health and education are not available for these nomads, but it is easy to deduce that basic services are not available or are well below the provincial average. Given this extreme poverty, it seems unrealistic to design livestock development schemes before greatly improving the welfare of this sector of the population.

\(^1\) One rupee of 1992 used in the FAO (1983) model is 1.82 times one rupee of 1991.
Transhumants

Buzdar et al. (1989) distinguished between transhumants with land ownership (semi-sedentary transhumants) and those without it (semi-nomadic transhumants). The semi-sedentary transhumants raise rainfed crops, mainly winter wheat. Each winter they move from the central highlands of Balochistan to the warmer areas of the Indus valley. When they are in the lowlands, they behave like the truly nomadic population, selling their labour, animals and by-products to the crop farmers and buying from them grains and feed for their animals.

The semi-nomadic transhumants are almost completely dependent on their small ruminants. They are co-owners in the common tribal rangelands, and in most cases their movements take place only within the limits of their tribal lands. They move from commonly owned rangelands to the open rangelands as forage availability fluctuates, and they usually return to their permanent dwellings in the rangelands during the summer months. In years of drought, some of them take their families and animals to the nearby agricultural valleys, where the family sells its labour, and their animals graze stubble or grasses in and around the fields. They possess camels and donkeys, which are used for transportation of crops and other goods. They earn enough money by these means to buy wheat grain and other supplies (Buzdar et al., 1989). Transhumant flock sizes range from 20 to 80 sheep and goats. Sixty five per cent of the sheep and 50% of the goats are managed as transhumant flocks (FAO, 1983).

Sedentary livestock producers

Most of the people living in the agricultural villages in Balochistan raise a few animals. This supplementary animal raising sometimes accounts for a major portion of the household income and helps increase farm productivity. Women play a major role, not only in the raising of these animals, but also in converting their by-products into useful food and saleable items like carpets. Usually a shepherd is employed to take care of all the animals in a village as a single flock. As the agricultural villages are normally inhabited by members of the same lineage or clan group, they have use rights over the rangelands adjacent to the village (Buzdar et al., 1989).

Since the mid 70s there has been a steady decrease in the number of transhumant herds; many flocks are becoming increasingly sedentary as communities settle around the permanent water from new tubewells, and as former shepherds increasingly find alternative work opportunities (Cossins, 1988).

Socio-economic influences might change the structure of Balochistan society in the coming years and allow more control over rangelands, but this change may not occur fast enough to slow down the degradation of the range vegetation (Nagy et al. 1991). The only examples of sustainable range management with the traditional tribal structure are under conditions of low population pressure (Buzdar et al., 1989), conditions which are now almost non-existent in Balochistan. It seems unnecessary to conduct even more
research to study the existing political, tribal, and village structure before trying to improve rangeland management, as suggested by Nagy et al. (1991); it is time to take action, even though it may be very difficult.

**RESOURCE ENDOWMENT OF THE SEMI-SEDENTARY TRANSHUMANTS AND SEDENTARY LIVESTOCK PRODUCERS**

There are the problems associated with surveying nomads who do not have a permanent home base. More information is available about the semi-sedentary transhumants and the sedentary households.

In Balochistan 90% of the farms range between 1 and 20 ha in size, while in highland Balochistan this figure is 93% (GDP 1981 Census of Agriculture, as reported by Massod et al., 1988). The average number of sheep per household in Balochistan is 60 sheep and 32 goats, while 80% of the sheep and 88% of the goats are in flocks that range between 3 and 170 animals. A few owners (12-20%) possess larger flocks than 400 head (GOP, 1989). In highland Balochistan, the overall average sheep flock size is 29.5 with an average of 16.8 breeding ewes. The average goat herd size is 22.2 with an average of 12.2 breeding does. The sheep to goat ratio for 50% of the mixed flocks is 1.8 (Nagy et al., 1991). For household consumption, or social purposes such as gifts to relatives, bridal price or sacrifices 30% of sheep and 20% of goats are used (Buzdar et al., 1989). Most of the goat hair and about 55% of the wool are used at home, usually to make coarse carpets, and the rest of the fleeces are marketed.

The percentage of income (cash and credit) for sheep and goats as a percentage of agricultural income ranges from 40 to 50% in the northern areas of highland Balochistan to 70 to 60% in the southern areas. In the southern areas income is often supplemented with earnings during winter migration (Nagy et al., 1991). Off-farm income is also becoming more important for farm families and there is a trend of increasing migration to larger centres and even for men to go to work in the Gulf. The importance of off-farm income is strongly related to the weather conditions. In good rainfall years 10-15% of the total income is off-farm, but in bad rainfall years the off-farm income ranges between 35 and 65% (Rees et al., 1987).

Credit could be used by livestock producers for diverse purposes—to offset the effects of poor agricultural years, to improve animal husbandry practices, to improve the rangeland condition (deferred grazing), to initiate fodder banks (fourwing saltbush), to shorten the marketing chain or to fulfill social obligations. However, credit is not readily available for small land-owners, and only 12% of the households had borrowed from the Agricultural Development Bank. Large land-owners took 38% of the loans while farmers with 5-20 ha were granted 62% of the loans (Massod et al., 1988). Sheep and goats alleviate this constraint since they are used as a store of wealth, and can be used as collateral to obtain credit from money lenders. When cash is required, usually in poor agricultural years or for special social occasions, money is borrowed and paid back in kind (sheep or goats) in better agricultural years. Interest, if calculated, on money borrowed against live animals can be excessive, and much greater than the interest
charged by banks. However, farmers indicated that they do not trust banks. Bank regulations dictate foreclosure when a farmer cannot pay back the loan, whereas money lenders can afford to be more lenient. Also, banks do not take small ruminants as collateral (Nagy et al., 1991).

MARKETING OF LIVESTOCK, MEAT AND SKINS

Not many producers can afford to travel long distances ranging from 20 to 50 km to intermediary markets or 40-150 km to terminal markets, to sell their livestock. Most of them do not have money for transportation, and they lack the connections or information that could help them to take advantage of the supply and demand situation when the decision to sell is made. About 69% of the retail value of small ruminants (meat, and edible and non-edible by-products) is received by the producers in highland Balochistan, while the remaining 31% represents the value of the services provided by village dealers, commission agents, beoparis (wholesalers) and butchers involved in the marketing chain from producer to consumer (Mahmood and Rodriguez, 1991).

Livestock and meat grading is absent, but there is government regulation of retail prices. Thus, consumers do not have ways to convey their degree of dissatisfaction to producers through the intermediaries in the marketing chain. This is a major structural problem at the provincial and national level which does not encourage production and market efficiency. The intricate marketing chain could be improved for the benefit of producers and consumers: overall volume of the market could be higher, the quality of the meat could be improved and some marketing costs could be reduced (Mahmood and Rodriguez, 1991).

After mutton (meat from both sheep or goats), the market for skins is the second major source of wealth in the small ruminant component of the livestock sub-sector as there are no tanneries in Balochistan. It is estimated that 2.9 million skins are produced in Balochistan and shipped to tanneries in Punjab and Sindh. A complex network of merchants has evolved to process and distribute the provincial production. Even importation of skins from Afghanistan and Iran has flourished in Quetta city market. The quality of the skins produced in Balochistan can be improved by taking more care to reduce skin scars and by providing better nutrition. Producers should adopt good shearing practices to avoid the risk of damaging the skins. Increasing the protein content of the animals' diet might increase the skin thickness but would require cost-effective nutrition improvement.

A major question is how can the livestock producers take advantage of the potential production and market opportunities? Deficient extension services and low literacy rates explain why there has been little progress with livestock producers. Extension services, when available, have focused on the physical aspects of production (flushing, vaccination, supplementation, breeding, etc.) while neglecting the social and economic aspects. There are no easy ways to improve the welfare of the livestock producers. Institutional research requires better financial support to carry out a comprehensive agenda on livestock development. Perhaps the most important deficiency of government agencies and the international donor community is that there is no strategic social
and economic planning, at national or provincial levels, where the livestock sub-sector is a component.

CONCLUSIONS

The contribution of the small ruminant component in the livestock sub-sector to the provincial economy, 25% of the Provincial Agricultural Products, is not likely to increase in the near future. Forage and fodder resources are deteriorating due to demographic pressure and deficient resource management. There are no market incentives for livestock producers to improve offtake since there is a ceiling price for mutton and their is lack of livestock grading systems.

Nomadic pastoralists, with no grazing rights, are ecologically sensitive to fluctuations in forage resources and cope with the risk of droughts by moving. In contrast, pastoralists who are either transhumant or sedentary have allowed their flocks to grow close to or above the feeding capacity of rainfed cereal crops. These pastoralists, who have grazing rights, are responsible for the abandonment of common rangelands and converting them into less productive open rangelands.

The population growth in the tribes of Balochistan has played an important role in the weakening of the traditional range management, along with the contact with capitalist production systems and land tenure. This weakening of the traditional management schemes needs to be taken into consideration in designing operational alternatives for Balochistan's pastoralists to help them to take advantage of modern techniques of range management or to recreate traditional management schemes.

Our knowledge about the livestock producers is unbalanced and incomplete. More is known about producers who own land than those who do not. It is obvious that social and economic inequity limits the possibilities that alternative resource management techniques could sustain current production levels. Little improvement can be expected until the current illiteracy rates are greatly reduced, the social handicaps on women are decreased, access to credit is made more easy and equitable, and roads and health care are expanded.

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FARMER-DIRECTED RESEARCH IN FARMING SYSTEMS

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That the problems associated with some research activities are not appropriate to the local farmers' situation (i.e. the intended recipients of the output of the research) is well-known. Even so-called "applied research" activities have failed in many cases. One of the major common denominators in all of the less-than-successful research activities in the area of integrated animal husbandry/agriculture, is the lack of farmer or client involvement - right from the beginning. Some of the reasons for this, but not limited to lack of funds, are lack of time, unfamiliarity of the researchers with the region, top-down or paternalistic attitudes among the researchers, limitations imposed by funding agencies, lack of local contacts or agents, and lack of skills needed to crack the social barriers that may exist.

There are some advantages to the "top-down" approach in some cases which include easier communications, reduced time required in tangential activities, relationships with selected host government officials, reduced time required in the field, lack of need for social or rural development personnel, easier documentation for submission of concept to funding agencies, and clearer, more stable long range objectives. These advantages can be and often are disadvantages in the same situation in that they usually tend to reduce the appropriateness of and long-term benefits from the research activities.

Chambers states that there are two cultures of outsiders. These have become polarized into "negative academics", composed of social scientists who are engaged in unhurried analysis and criticism, and the "positive practitioners", or physical ecologists engaged in time-bound activities. He says they need to remain open to a third and most important culture — the rural people in a particular place! Chambers simply states in Rural Development : Putting the Last First, that narrowness among outsiders is a luxury poor people should not be asked to afford.

E.F. Schumacher notes that economics and technology have become so important in modern politics, that they cannot be left to experts alone.

FARMER-DIRECTED RESEARCH

More and more literature is being produced from conferences and workshops on the subject of Client-Oriented Research. Perhaps thinking instead in terms of "Farmer-Directed" puts us into an even more participatory frame of mind, in that we see the intended recipients as real people and not merely as clients for whom we are providing a service or information, and that the...
direction can come largely from the farmers themselves, as opposed to just being "oriented" towards them from someone else's frame of reference. Farmer-directed research will enable us to more adequately come to understand traditional technologies and to learn why farmers make decisions the way they do in a given situation. Farmer involvement needs to occur in the planning stages, and continue right on through evaluations.

The benefits of farmer-directed research are many. The researchers will learn more about the systems they are studying. The planning and strategic stages of the actual research will have acceptance, and will be culturally and practically appropriate to the local situation. More sustainable results will likely be attained in terms of the livelihood of the farm families. A complete cycle of information will be created in that all parties will learn from each other. Local ownership and support will be obtained, and previously unconsidered outcomes may result.

The fact that farm families live in rural villages, which, by definition are very complex, makes farmer-directed research difficult. Richard Critchfield's description of villages clearly emphasizes this point:

"Villages are people's oldest and most durable social institution, emerging with settled agriculture around ten thousand to fifteen thousand years ago. There are, in the economically developing nations, about two million villages left, a third in China, a third in India-Pakistan-Bangladesh, and the rest in the 130 or so countries of Asia, Africa and Latin America .... Villages possess a universal culture (based upon tilling land, property, and family), which varies significantly only in the realm of abstract ideas or religion. These variations explain the relative ease or difficulty in cultural adaptation to the present very rapid spread of western agricultural science. The Confucians are roaring ahead, followed more hesitatingly by the Malay-Javanese and the Hindus. But all three purely Asian cultures are adapting more easily than Muslims, Christians, or Africans."

Farmer-directed research is clearly more difficult, but the rewards are greater. Whether or not you agree with Critchfield's assessment of the rate of adaptation based on religion/culture, villages are indeed complex. The farming systems of limited resource farm families in developing areas of the world are certainly among the most complex found anywhere. Chambers, in Farmer First describes these systems as "complex, diverse and risk-prone". The use of purchased inputs is usually low, the environmental diversity is high, production stability is high-risk, and current production related to sustainable production is low.

ROLE OF ANIMALS

Animals are involved in many farming systems in developing countries. Regarding the roles of livestock in communities, Feuerstein et al. (1987) list the community/family inputs as feed, water, safety/protection, shelter, health care, equipment and processing.

Outputs from the livestock include ceremonial uses, such as the slaughter of a goat or a buffalo for a funeral or marriage. The obvious value of this is the cash market value of the animal to the family. Companionship is difficult to measure scientifically, but water buffaloes are usually considered members of the family in many locations. It is common to observe young boys riding on their backs to the watering hole where they will clean them thoroughly. Hides are used for
suffering and clothing in many areas. Yaks provide hair and leather for the Tibetan herders. Fuel is provided through the manure which is either burned in a dried state, or used in biogas tanks. This can often reduce or eliminate the need for firewood, and the resulting damage to the local ecosystem. Manure also replaces high-cost imported fertilizers in many cases, adding the needed organic material back to the soil. Some African cultures prize cattle for their manure above all else. Security is often a major reason for owning livestock. They diversify the income and food production of a family. In northern Thailand, a yearling water buffalo can be sold in times of rice shortages for enough rice for a family of five for one full year. As rice is their main staple, and consumed several times a day, this is a significant value to these families. Other well-documented and obvious uses and values of animals include food production, income generation (from selling outright or renting for ploughing) and transportation. Use as draught animals can increase a family's productivity 5-fold. In Ethiopia, a family with an ox can plough and prepare their field in the critical planting stage of the year, 5 times faster with an ox than by hand.

**METHODOLOGIES**

Having defined some of the advantages and disadvantages of farmer-directed research, and outlined the complexities of limited-resource farmer activities, the next question is "How can it be done?".

On-Farm Research is one major methodology employed by researchers hoping to help solve more "real-world" problems. The purposes of On-Farm Research, as described by Hildebrand and Poey (1985) include:

- Linkage between ongoing research and extension
- More purposeful research by integrating components into systems
- Orientation of research and selection of priorities
- More understandable research that is accessible to decision makers
- Checks and balances in the real world to improve research management
- Hands-on experience to improve the image of researchers
- Added dimensions to current component research
- A learning experience for researchers, extensionists, and farmers

Ethnographic methods of research were pioneered by de Schlippe (1956) who had training in agronomy and anthropology. Recent work done by McCorkle and Mathias Mundy on ethnoveterinary activities around the world has generated much discussion. Heifer Project International and Tufts University School of Veterinary Medicine have collaborated on several ethnoveterinary studies followed by epidemiological investigations based on those studies. In Honduras, the study yielded information on what epidemiological investigations were most appropriate, which was different from our original assumptions before the study was conducted. The survey revealed people's concerns about calf mortality rates, and low production of cows. The tests performed were zinc-sulphate turbidity tests on calf serum to indicate degree
of colostral ingestion and absorption, faecal ova quantification (McMaster method) on growing/replacement heifers to test nematode load, and the California Mastitis Test (CMT) on milking cows to test for evidence of subclinical mastitis. All these tests were easily performed using a few external inputs, and they were performed by local technicians who had received training. The results indicated insignificant levels of problems in all the 3 cases.

This is significant in that we have had a presence in the area for almost two decades and had built a foundation of knowledge using our own systems of collection and interpretation which led us to our original assumptions. Much of the reason for the difference in outcomes was based on previously misunderstood and unrecorded indigenous knowledge and practices involving care and maintenance of the animals. In fact, McCorkle and Mathias Mundy have shown that in some cultures in the Andes of Peru and Bolivia, the local people believe that diseases in their livestock often come from "malevolent foreigners" visiting their village!

**CORE STRATEGIES FOR PARTICIPATION**


Bryant goes on to say that developing institutional capacity is the most important and most difficult strategy. The concern here is for sustainability. In order for some initial efforts or findings to be utilized, built upon, and modified over time for the long-term benefit of the community's livelihood, local institutions must exist. Institutional development in this context can be taken in a somewhat abstract sense in that it does not merely refer to a group of organizations – private or governmental – but to the whole of the local groups, organizations, associations, and their relations with each other. The most readily available and achievable method for outside agencies, however, is to help develop the management and organizational capacity of local organizations, and work to develop and improve relationships with and between local organizations.

Social learning is described by Bryant as discovering relationships within communities, how information is shared, decisions made, and thus how learning occurs within the community. We need to be able to learn from our environment. As David Korten states (1980):

Aware of the limitations of their knowledge, members of (an) organization look on error as a vital source of data for making adjustments to achieve a better fit with beneficiary needs. An organization in which learning is valued is characterized by the candor and practical sophistication with which its members discuss their own efforts, what they have learned from them, and the corrective actions they are attempting. Intellectual integrity is combined with a sense of vitality and purpose.

Finally, Bryant lists collective action as a necessary component of participation. Collective action can occur as the more ubiquitous vertically oriented organizations, or as the more difficult-to-build organizations such as co-operatives (horizontally oriented). To effectively contribute to collective action development, one must consider motivational factors and circumstances under which people are inclined in any given situation or location to work collectively.
INCREASING PARTICIPATION

For the research organizations interested in increasing the participation of local farmers, there are a number of available strategies that have been tested over time. These have withstood the test of region after region of the world, as well as various ethnolinguistic groups, and types of research to be conducted. They are as follows:

1. Work directly at the local community level. This can be done even if a counterpart local organization is involved. In fact, that usually facilitates it. Serious consideration needs to be given to both the reluctance to co-operate, or readiness to co-operate by the local people. Some farmers may not actively participate in an activity if they can see that they will benefit from a 'spillover' of similar activities in the community. Co-operatives often have this problem. Working through local organizations enhances our effectiveness, and our efficiency. It enables us to have access to regions and people much more quickly and with much more credibility than if we were to go it alone.

2. Develop and improve your own communication skills. Effective listening is a skill that must be developed over time, with practice and patience. Communication is the responsibility of both the speaker and the listener – they both have a stake in clear, understandable communication. There are many recorded methods for communicating with local community groups, and they include role play, using the appropriate gender for interviews, audio-visual displays, ethnographic methods, and others. Being able to effectively communicate the purposes of a proposed research plan to local farmers as well as government officials has obvious benefits.

3. Build on the abilities and interests of the farmers themselves. These can be ascertained through site visits and appropriately designed questionnaires. Find out what motivates people. Are they interested in increasing production or productivity? How do they define these terms? Local knowledge and skills are very often overlooked in developing the strategic portions of research projects. The utilization of local abilities more often than not enhances the opportunity to have more successful outcomes. Some interests may be short-term rather than long-term. For instance, in the Philippines, we found that although our experience taught us that preventive medicine was cost-effective, local farmers were more interested in curative methods. So we began from there.

4. Build participation into the programme itself. Using farmers as promoters or demonstration site co-ordinators has many benefits – one being the development of a stake in the overall success of the programme by that farmer. HPI has had many local level promoters or extension workers go on to become community and regional leaders. They took the style of research and relating to communities that they learned, with them to their new positions.

5. Start small. Many projects have begun too quickly and with too many objectives, only to find out that it was an expensive way to do a feasibility study! By starting out small, you gain the acceptance of the local farmers, who can see something that is appropriate to their own level of farming, and you keep the costs down. Smaller research projects are also usually easier to manage and get funded in the first place.
(6) Be a partner. This means not only seeking information, knowledge, and skills locally, but working with the local structures in building your objectives and strategies. It also means that the local group should contribute to the project. This can be in the form of cash or labour, or it could be in kind contributions of materials, or leasing land at below market costs. We have found that the term partnership is taken seriously by the local groups, and that to be truly on a more equal basis, they need to contribute their resources too. This concept should extend into the progress review or evaluation stages too.

Farmers are becoming respected participants in the generation and dissemination of information. On-farm and internal knowledge and experience are becoming a highly valued information commodity. External, off-farm information is increasingly being viewed through various filters of values, such as environmental impact, sustainability, and the like.

As Chambers says, to serve the limited resource farm families we work, farmers' analysis should be the basis of most of our research priorities; farmers should experiment and evaluate; scientists should learn from and with them; and research needs to be decentralized, differentiated and versatile.

REFERENCES


C. CASE STUDIES
A SUSTAINABLE PRODUCTION SYSTEMS FOR GOATS IN INDONESIA

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Indonesia consists of a large number of islands, of which about 3,000 islands are inhabited. Java is the most densely populated island; its land area is only 6-7% of the total land area, population 60-70% of the existing 170 million and 60-70% of 10.5 million goat population of Indonesia (Table 1), hence the high pressure on limited land area available. The number of goats has increased at a rate of 3.4% over the past years (DGLS, 1990). They contribute 6-7% of the total meat production. On a national scale, meat consumption is relatively low (average consumption 4.3 kg/caput/annum or less than 2 g protein) compared to that of neighbouring countries. An overview of the state of art of goat meat production has been reported by Djajanegara and Chnaiago (1989). The demand of goats could be considered stable throughout the year, except during certain events like Idul Adha, when the demand and price of goats increases dramatically.

Table 1. Land area and goat population distribution in Indonesia

<table>
<thead>
<tr>
<th>Region/Island</th>
<th>Land area (km²)</th>
<th>Goat %</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumatra</td>
<td>473,606</td>
<td>24.67</td>
<td>2,031,770</td>
</tr>
<tr>
<td>Java and Madura</td>
<td>132,187</td>
<td>6.89</td>
<td>6,126,867</td>
</tr>
<tr>
<td>Bali and Nusa</td>
<td>88,488</td>
<td>4.61</td>
<td>768,976</td>
</tr>
<tr>
<td>Tenggara Islands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kalimantan</td>
<td>539,460</td>
<td>28.11</td>
<td>194,206</td>
</tr>
<tr>
<td>Sulawesi</td>
<td>189,216</td>
<td>9.86</td>
<td>1,029,335</td>
</tr>
<tr>
<td>Maluku and Irian Jaya</td>
<td>496,486</td>
<td>25.87</td>
<td>203,559</td>
</tr>
<tr>
<td>Total</td>
<td>1,919,443</td>
<td>100.00</td>
<td>10,353,813</td>
</tr>
</tbody>
</table>

There is no clear preference for goat meat or mutton but the income elasticity of meat is 1 (Anonymous, 1986). This suggests that the demand for goat meat will increase in conjunction with population growth and, in addition, better living standard through successful national development programmes.
PRESENT STATE OF ART OF THE PRODUCTION SYSTEM

The major goat breeds are the indigenous Kacang (KK), Etawah (E) and their crossings (PE). The Kacang goat is relatively small, of no uniformity in colour: black and brown is the base colour with many variation in between. The Etawah goat originated from India. It was imported between 1918 and 1931 (Merkens and Syariff, 1983; fide Obst et al., 1980) to improve milk production of the local Kacang goat. The PE goat is larger than the KK, but there has been little efforts towards selection of goats to improve milk production. Goat milk is in low demand, since in the majority of places in Indonesia goats are primarily kept for meat. The Saanen goat has been recently introduced into Central Java, but it is numerically insignificant.

Setiadi et al. (1985) reported some production traits of the Kacang and Etawah raised under controlled environments (Table 2). Goats do not follow a seasonal reproductive pattern but under the present village management systems the average kidding interval is 12 to 15 months. They are adapted to the various environmental conditions and under well-managed experimental conditions they can produce 3.5 kids/year with growth rate of over 100 g/day (Obst et al., 1980). It is likely that optimization of the production systems could improve the production of goats.

Table 2. Production parameters of goats in Indonesia

<table>
<thead>
<tr>
<th></th>
<th>Kacang</th>
<th>Etawah grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Birth weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>2.3 ± 0.1</td>
<td>2.0 ± 0.1</td>
</tr>
<tr>
<td>Twins</td>
<td>2.1 ± 0.1</td>
<td>1.7 ± 0.1</td>
</tr>
<tr>
<td>Weaning weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>10.1 ± 0.6</td>
<td>8.5 ± 0.9</td>
</tr>
<tr>
<td>Twins</td>
<td>9.4 ± 0.2</td>
<td>7.7 ± 0.9</td>
</tr>
<tr>
<td>Mature weight (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27.1 ± 0.8</td>
<td>24.2 ± 0.8</td>
</tr>
<tr>
<td>Litter size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.29</td>
<td></td>
</tr>
<tr>
<td>Litter sex ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(male : female)</td>
<td>44:55</td>
<td></td>
</tr>
</tbody>
</table>

Source: Setiadi et al. (1985).

The production system of goats has not changed over the past decade although development projects involving farmers’ participation have been carried out. The production is based on smallholder farms with 2-5 animals/farm raised under traditional management systems. Goats generally serve as living savings account for emergency cash needs, produce manure as fertilizer, hide and provide employment for the farm family. In addition, during religious ceremonies goats are important for the middle class society. It is apparent that the majority of farmers in Indonesia are financially limited, hence, probably
incapable of providing cash inputs related to improved feeding and management prac-
tices.

The ability of the farmer or farm family members to provide feed and their knowledge of
feeding, thus, determine the productivity of goats. Available roughage and agriculture by-products in the vicinity have been used effectively, although more often goats are
tethered on communal lands to graze. It is apparent that farmers do attempt to provide
palatable and nutritious feed whenever possible.

Developing the goat industry

Over the past years, development programmes to improve the goat industry implied the
distribution of 1 or 2 heads to farmers who had to return 2 offsprings for each animal
received for redistribution to other farmers. Although many technology transfer program-
mes have been implemented little progress appears to have been achieved. The
introduced changes may not have conditioned an attractive motivation for the farmers to
adopt the new technologies or the strategy of a low profile of changes was not the most
suitable at all. It is also possible that the present production systems may well be the
most sustainable, since this has been going on over decades. However, a more drastic
approach should be implemented if the goat industry is to be improved, taking into account
the limitation that exists under village conditions. The production system still relies on the
production of goats in the village that is geared towards a minimum economic farm size
to meet a production target. The target is set out to produce animals available for sale
at a monthly interval. The presence of a regular supply of animals of uniform size and
age, in turn, is expected to attract or motivate vertical farm operations.

Many believe that it will be difficult, if not impossible, to raise increased flock size. The
reasons put forward are that this would require collection of more feed and additional
manpower. With regard to the low adoption rate of new technologies introduced being
experienced in technology transfer activities, a new strategy to improve the industry
should be implemented. Increased weight gain as the main target may not be attractive,
while increasing farm size also faces problems. The poor resource farmer under the
cut-and-carry feeding system may not have the resources; however, there are individual
farmers who raise larger number of animals under similar agro-ecosystems and manage-
ment conditions. This indicates that a particular motivating agent probably has influenced
the decision to raise more numbers of animals. Where grazing is applicable, i.e. near
estates and communal grazing grounds like in North Sumatra and Eastern Islands of
Indonesia, raising more number of animals may not be a problem. In a cut-and-carry
system the dependence on farm family labour is high. It is not clear whether farmers
would sacrifice other income earning activities (on-farm and off-farm) in exchange for
raising goats if the contribution to their income is significant. Increasing farm size will
obviously increase cash income, on the assumption that additional labour input is possible
with minimal cash expenditure.
Alternative strategy

An alternative strategy is based on smallholder farmers as the basis of the production system is believed to guarantee a continuous supply of animals to large capital investment commercial farms. It is an unified strategy with the smallholder farms as the central unity of the industry.

The main target of the strategy is to develop a production system that produces goats of market size (which at present is about 20 kg live weight) and of certain age (assumed 8 months) at regular periods of the year. The latter is oriented towards providing a regular and uniform income over a year for the farmer. Off-farm jobs at the present wage rate could be overcome through sale of 1 animal per month. It is obvious that available information regarding breeding, nutrition, health and economics should be unified into a technical procedure to guarantee the intended production at minimum cost but maximum benefit.

The continuity and regularity of supply of animals of known quality is considered the major problem faced in large commercial operations. Through farmer groups that consist of 20-25 members, about 20-25 animals are expected to be available each month. Hence, a production target of 200 animals/month will involve 8 to 10 groups of farmers covering a stable herd size of 600-800 heads. If the system operates as expected then there are chances that large commercial farms may operate to meet the rising demand. The smallholder farms have the opportunity to be improved towards a sustainable production system with higher income.

The emphasis of the production system is the production of kids at the minimum biological possible inter-kidding interval. The does are exposed to the bucks as soon as their offsprings are weaned to obtain an average of 3 parturitions in 2 years.

The minimum farm scale is aimed at units consisting of 8 does and one buck. It is important that a buck is present, since this is a constraint at present as indicated by the long kidding interval. It will be possible to increase farm size to a larger operation, where the production is regulated and managed so as to provide a significant income for the farmers.

A sustainable income could be achieved through regular marketing of goats, although probably not daily as through raising dairy cows. It is considered feasible to generate a better cash income distribution over the year. The support to smallholder farmers to obtain sufficient number of animals is presumably necessary to start the operation. The feasibility of providing loan to farmers has been indicated by Djajanegara (1991) for sheep, which is similar to that for goats. This may be a high risk investment. However, through farmers' group approach the risk could be reduced taking advantage of an internal control mechanism within the group. The operation of a large breeding farm is not feasible.
A SUSTAINABLE PRODUCTION SYSTEM: DJAJANEGARA

in view of the present relatively long period to reach break-even point at prevailing market price conditions.

CONCLUSIONS

The proposed strategy is considered as a realistic approach in view of the slow development and existing production systems. Technology transfer efforts towards low profile changes have little success as farmers often return to their traditional management systems after a project is finished. This indicates that farmers are not motivated to adopt the introduced technology but are willing to co-operate. It is possible that economic drives may have stronger pressure on farmers.

REFERENCES


SMALL RUMINANTS IN THAILAND

S. SAITHANOO

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Thailand is an agriculture-based country located in south-east Asia and in the equatorial monsoon zone with a humid-tropic climate. Most of its agriculture involves intensive crop production and predominantly comprises small farms of up to a few hectares based on nucleus families. Livestock are generally secondary and support crop production. Buffaloes, cattle, swine and poultry are among the most important species found throughout the country whereas goats and sheep are important only in the southern region where there are large numbers of Thai Muslims (Saithanoo, 1987).

This paper presents an overview of small ruminant production in Thailand and research and development efforts to improve their productivity.

CURRENT PRODUCTION AND FUTURE TRENDS

A recent report of the Food and Agriculture Organization of the United Nations (FAO, 1991) showed that goat and sheep populations in Thailand were 121,000 and 162,000, respectively (Table 1); and, out of these, approximately 71 and 27%, respectively, were in the South. An average flock size was 5 head per family. The annual growth rates of goats and sheep populations between 1980 and 1990 were 9.7 and 25.9% respectively. There appears that a number of farmers raising small ruminants have increased, whereas an average flock size only changes slightly. The price (per kg) of goat meat was about 90, 26, 30 and 43% more expensive than that of buffaloes, cattle, swine and chicken respectively (Saithanoo and Pichaironarongsongkram, 1990).

In general, small ruminants are primarily raised for meat by small holders as a secondary enterprise in their farming systems (Falvey, 1977; Rengsirikul, 1989; Saithanoo, 1991, Smith and Clarke, 1972). Women and children are playing an important role in rearing these animals (Saithanoo, 1991). There is no large-scale commercial goat or sheep farming in Thailand. The main breeds are of the indigenous strains (Table 2). Milk and wool are secondary products of goats and sheep, respectively, and mainly for home consumption because of the small scale of production. Other products such as skin, hair and by-products are not economically important. Dairy goats, mainly crossbred goats, are estimated to be less than 1% of the total population (Saithanoo, 1985).
Table 1. Ruminant populations and trends in Thailand (x10³, 1980-1990)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat</td>
<td>79</td>
<td>108</td>
<td>121</td>
<td>9.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>56</td>
<td>131</td>
<td>156</td>
<td>25.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>5285</td>
<td>5669</td>
<td>5669</td>
<td>2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>5651</td>
<td>5998</td>
<td>5350</td>
<td>-1.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: FAO (1991)

Table 2. Goat sheep breeds in Thailand

<table>
<thead>
<tr>
<th>Special</th>
<th>Breed</th>
<th>Location</th>
<th>Function (priority)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goats</td>
<td>Indigenous</td>
<td>All regions</td>
<td>Meat</td>
</tr>
<tr>
<td></td>
<td>Burmese-Bangladesh</td>
<td>North west</td>
<td>Meat</td>
</tr>
<tr>
<td></td>
<td>Exotic¹ and crossbred²</td>
<td>Central plain</td>
<td>Milk, meat</td>
</tr>
<tr>
<td></td>
<td>Crossbred²</td>
<td>All regions</td>
<td>Meat, milk</td>
</tr>
<tr>
<td>Sheep</td>
<td>Indigenous</td>
<td>All regions</td>
<td>Meat</td>
</tr>
<tr>
<td></td>
<td>Burmese-Bangladesh</td>
<td>North centre</td>
<td>Meat</td>
</tr>
<tr>
<td></td>
<td>Crosses³</td>
<td>All region</td>
<td>Meat, wool</td>
</tr>
</tbody>
</table>

¹ Refer to Alpine, Anglo-Nubian, Saanen and Toggenburg
² Refer to crossed breeds between indigenous/Burmese-Bangladesh and exotic breeds.
³ Refer to crossed breeds between indigenous/Burmese-Bangladesh and exotic breeds (i.e. Dorset Horn, Merino, Polwarth)


The Thai indigenous goats are phenotypically similar to the Katjang breed of Malaysia but slightly smaller in size. The average mature body weights of male and female goats under village environment are 23.1 and 21.5 kg respectively (Saithanoo, 1990). Under improved management, the indigenous breed goats are about 53% heavier than those in villages (Saithanoo, 1990). This indicates that the indigenous breeds genetically have high potential productivity. Their annual kidding rate in villages is also high with an average of 190% (Saithanoo and Milton, 1988). However, a high annual mortality rate of 29% in young animals appears to be a major constraint to their productivity, particularly during the wet season. This could be reduced by introducing appropriate controlled breeding and strategic feeding managements.

The Thai indigenous sheep in the South have conformation similar to the Kalantan sheep of west Malaysia, whereas the main breeds of sheep in the North are native and Burmese Bangladesh strains. Mature body weights of local rams and ewes in the north Thailand highland are 30.1 and 26.2 kg respectively (Hoare et al., 1976). Hairy sheep were introduced into Thailand in recent years, but they are mainly kept in government breeding stations for crossbreeding purposes.
Development programmes to improve small ruminant production in Thailand, mostly involved crossbreeding between the indigenous and exotic breeds with the aim to increase size, meat (in goats) and wool (in sheep) production. Several exotic breeds (Table 2) have been intermittently imported for this purpose. However, there appears to be some problems regarding the health and performance of crossbred animals raised under village conditions where inputs and level of management are limited (Saithanoo et al., 1991).

**MANAGEMENT SYSTEMS**

The management systems used can be classified into 4 types: (1) tethering, (2) controlled grazing (animals graze under owner supervision), (3) feed-to-roam, and (4) cut-and-carry (zero grazing) systems. Saithanoo et al. (1991) reported that tethering was widely used in all seasons and more than 65% of owners employed this system. Controlled grazing and free-to-roam systems were mainly used where there was ample uncultivated grazing land (e.g. fishing villages). A cut-and-carry system was only employed in the wet season, mainly where areas were easily flooded. Animals commonly grazed natural grasses and weeds available in the areas. Supplements, mostly in the form of tree leaves, were given only in the wet season and at low level. Few treatments for health problems were used. Only a few owners provided shelter for their animals. However, most of their animals are allowed to stay underneath their high-set houses. Males are generally run with females all the year round but less than half of the owners had breeding males.

**CURRENT RESEARCH AND DEVELOPMENT**

Increased demand for small ruminants in Thailand in recent years has prompted farmers as well as scientists to require more information about breeds, feeding, management and health care, particularly for those raised under village environments.

At present, Prince of Songkla University plays a leading role in small ruminant research and development in Thailand, with a major objective to investigate productivity of indigenous and crossbred animals raised under improved management and village environments. Baseline quantitative information on the farmers as well as productivity of their animals in village situations is being accumulated. The main research areas for small ruminants in Thailand identified by Saithanoo et al. (1991) include baseline data, nutrition and management, reproductive management and breeding, animal health, and marketing. As compared to the others, the information on the last two areas (health and marketing) appears to be very scarce. This may be because (1) their impacts on production cannot be quantified easily, and (2) the expertise in these areas is limited. Another area that should also be considered as an important part of the research priorities is socio-economic aspects of small ruminant production, particularly under village production systems.
CONCLUSIONS

It is evident that there is a lack of well-planned and long-term breeding policies. Considering development programmes on small ruminants, it seems that we have given too much attention to crossbreeding in order to increase size, meat and milk production of the local animals. Saithanoo (1990) reported that although crossbred goats grow faster and are heavier, they are generally less prolific than the indigenous. This, therefore, implies that the productivity of indigenous breeds can be increased by improved management and hence introduction of exotic animals should only be made after the potential productivity of local animals under improved environmental conditions are assessed. Pattie (1991) suggested that genetic improvement of local goats could be obtained by selection and that the value of crossbred animals will depend on the availability of improved management and feeding systems, especially under village environments.

ACKNOWLEDGEMENTS

I sincerely thank the Agency for International Development of United States for financially supporting my participation in this meeting.

REFERENCES


SAANEN MILK GOAT PROJECT

C.M. KETKAR

Rural Agricultural Institute, Narayangaon, Maharashtra, India

The Institute was started in 1992. It is a non-Government, non-profit charitable trust registered under Societies Registration Act and Public Trust Act. Narayangaon is situated on Pune-Nasik Highway No.50, 75 km North of Pune and 233 km SE of Bombay. The climate is hot, dry with annual rainfall of only 300 mm with 26 rainy days.

The main objectives of the Institute are to improve agriculture and animal husbandry, to bring more income to the farmer with the help of application of modern technology. For achieving these objectives, Institute conducts: Training, Extension, Research, Publish literature, Demonstrations, Exhibitions, Rallies, Seminars, Workshops. It has established an up-to-date Library and a Museum.

The Institute has undertaken the following projects:

1. Soil and water conservation

Plugging of 2 km long gully with 25 bunds, complete soil and water conservation. This has benefited more than 30 wells downstream. Agricultural production increased from Rs 50,000 to Rs 500,000 with only Rs 25,000 capital cost.

2. Saanen milk goat project

It is essential to know why we selected goats.

Thirty five per cent of the meat supplied in the market is from goats. Still the population of goats increased from 37 million in 1951 to 91 million in 1987. In Maharashtra 0.17 million families have goats; 95% villages have goats and 26% household rear goats, i.e. average of 113 goats for every 100 households. Meat production is 421,000 M.T. which is worth Rs 1,348 million. Goats produced 144,400 million litres of milk worth Rs 519.84 million; 4,537 million pieces of skin worth Rs 204 million; 246 million tonnes of hair and Rs 385 million worth of manure. Between 1961 and 1982 the goat population recorded about 56% growth. They contribute substantially to the state's economy. They thrive even in environments which may be harsh for the large animals. Goat keeping is an attractive enterprise for the rural population below poverty line. Goat industry requires low investment on small flocks. They have speedy multiplication, high feed conversion efficiency, quick pay off and low risk, high productivity and greater resistance to diseases, ability to thrive on green and dry fodder or bushes, and adaptability to tropical conditions. Under stallfed conditions goats are not responsible for destruction of vegetation or soil erosion and deforestation. Man is much more destructive by cutting trees for fuel, furniture and p...kaging industry. Goats
require relatively much less investment and facilities in terms of housing, feed, labour and health care. Their small size, early maturity, high tolerance to diseases, high feed conversion efficiency and easy disposal are of distinct advantage to the smallholders to utilize their marginal land and feed resources efficiently. It is possible for 5 goats to yield higher returns from available feed energy on small farms than even the country cattle. Goats are 40 to 160% more economical than sheep and 130% more economical than cattle. Net income of Rs 23,100 from 100 goats, i.e. Rs 231/goat against Rs 1,146/- from 100 sheep (CAZRI Report 1983), i.e. Rs 11/- per sheep. According to Dr P.K. Ghosh, a major part of India being arid, the goat is more appropriate with lower maintenance needs, and lesser feed for production of meat and milk. Besides it consumes only scrub left over from overgrazing by cattle and sheep. Recognition must be given to the potentialities of the goat as the livestock of choice for arid and semi-arid regions. Goat is the right type of milk animal for rural women.

In the Saanen milk goat project goats are kept under stallfed conditions. The Indian goat gives on an average 60 litres of milk in a lactation of 120 days, which is sufficient to feed the kids of goats and very little milk is left to feed the children. To improve the milk yield of country goats, crossbreeding with pure Saanen milk goat was started at this Institute in 1973, with the acquisition of one pure Saanen male buck from Madar Sanitorium, Ajmer. Farmers were convinced of the increase in milk yield. Pure Saanen males and females were imported in 1977 from UK, Israel and Australia. The Saanen Breed Society, UK; donated 3 pure Saanen bucks in 1984 while Christian Aid, London, bore the transport charges. Pure Saanen males and females were again imported in 1988 from Israel and UK; milk yield improved from 60 litres to 340 litres in crossbreds. Country and crossbred goats (5,000) from 127 villages around Narayangaon, got the benefit of services of pure Saanen bucks. For breeding purpose the Institute supplied 508 pure and crossbred Saanen male bucks and 113 females all over India and Nepal also. "Dairy Goat Management" Manual in Marathi, Hindi and English was published and 1,437 manuals were sold. Since 1985 the Institute has conducted 25 "Dairy Goat Management" training courses, 18 in Marathi, 6 in English and 1 in Hindi, and trained 170 women and 297 men. AFPRO (New Delhi) and AFARM (Pune) NGOs were of great help in this respect. Crossbreeding with Saanen produced 2,850,000 litres of milk valued Rs 8,550,000/- and also got Rs 333,000 by selling 2,220 males, thus giving total benefit of Rs 8,883,000/- in the span of 17 years to the farmers around Narayangaon. The Institute also sold 188,524 litres of goat milk produced by stallfed goats in the span of 14 years. All the goats at the Institute above 6 months of age are insured. Crossbreeding programme was evaluated in 1982 through questionnaire and interview, and it revealed increase in milk yield which was partly used for feeding children and partly sold to purchase feed. The Institute is having goat shed, goat yard, foddershed, silo pits, chaff cutter, feedmill, laboratory, lecture hall, dormitory, kitchen, open well, bore well, goat museum, goat library, slides, 16 mm film and overhead projectors, films and slides on goats and 50,000 fodder trees.

3. Fodder development project in dry-land areas for goat by planting trees at the Institute

Narayangaon receives 300 mm rainfall in 26 rainy days, and is having meagre irrigated resources. Crossbred Sannen and pure Saanen dairy goats are kept under stallfed conditions since 1974. Green fodder supply throughout the year was achieved by planting fodder trees on 25.6 ha arid
wasteland taken on lease. Soil water conservation, digging bore, open well and barbed wire fencing were undertaken in 1980. *Leucaena leucocephala* (subabul/plipil) on 90% area, *Acacia nilotica*, *Azadirachta indica* and *Bauhinia purpurea* were planted in 1981 and 1983. Distance between trees and rows was 3 m x 3 m. Seedlings were hand watered during the first year; subsequently they thrived on the rain. *Stylosanthes hamata* legume seeds were broadcast in the interspaces of the trees. Goat droppings collected from stallfed goats and biogas slurry of droppings were applied to these trees and grasses @ 10 m tonnes every fourth year. Harvesting of tree leaves and grass underneath was commenced from 1985. Productivity of this land was estimated in October 1987. An average yield from tree was 3 kg green leaves/tree a year. The average yield of grass was 6 kg green grass /9m² a year. On an average crossbred goats weighed 60 kg and consumed 2.82 kg dry matter / day. This is supplied through 2.50 kg of *Leucaena* leaves and 6 kg green grass /day. Since 1985 vegetation cover under this project has produced 88,414 kg tree leaves, 29,926 kg green grass, 10,000 kg dry grass and 7,748 poles. This project does not require any expenditure except application of organic manure and harvesting.

4. Use of goat droppings

Small farmers with limited resources cannot afford to keep cows and buffaloes; for them goat is an alternative. Goat being browsing animal, its energy is lost in walking long distance, resulting in reduction in milk yield and loss of valuable goat faecal droppings in grazing land, making it difficult to collect. Grazing causes razing of the land and regeneration of the grass is stopped. Increasing the milk yield by crossbreeding and keeping them under stall fed condition is the only alternative. This makes goat keeping remunerative under stall feeding condition and at the same time collection of faecal goat droppings becomes easy. Goat droppings slurry (with 10% solids) under 35 days retention time gave 38.60 litres (0.038 m³) biogas / day for every 1 kg of fresh goat droppings at 26°C, 7.5 pH; 3 parts of water is added to 1 part of goat droppings.

Goat droppings contain:

<table>
<thead>
<tr>
<th>Goat dropping</th>
<th>% Degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids (TS)</td>
<td>70.00</td>
</tr>
<tr>
<td>Total volatile solids (TVS)</td>
<td>78.27</td>
</tr>
<tr>
<td>Fat</td>
<td>3.24</td>
</tr>
<tr>
<td>Crude protein (N1.9 x 6.25)</td>
<td>12.45</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>13.26</td>
</tr>
<tr>
<td>Ash</td>
<td>21.75</td>
</tr>
</tbody>
</table>

Biogas contains 61% methane and 39% CO₂. Biogas slurry is a very good organic manure; it contains N, P, K, humus etc. without weed and foul smell. Requirement of cooking gas / day a person is 0.227 m³. A Deenabandhu (fixed dome) biogas plant of 1 m³ capacity with attached latrine using indigenous material is suggested for a small family of 3 members owning 6 crossbred stallfed goats for cooking and manure needs. The Institute is having 3 types of biogas plants, viz. K.V.I.C. (moveble dome), Janata and Deenbandhu (fixed dome), run exclusively on the goat droppings. The Institute has constructed 913 biogas plants for the farmers with different capacities, also trained persons and conducted users training courses. For those who do not have cattle, the Institute supplied wood-saving burning stoves and constructed chullahs.
5. Conferences attended and papers presented

Mr S.R. Sabnis and Mr C.M. Ketkar attended III and IV International Conferences on Goat, held in 1982 in the USA and in 1987 in Brazil. Mr S.R. Sabnis, Mr C.M. Ketkar, Mr B.R. Vaze and Ms Chanda Nimbkar, all the 4 trustees of the Institute, will attend the V International Conference on Goats to be held in New Delhi, from 2 to 8 March 1992, and during the poster session will present:

"Fodder trees production and stallfed crossbred Saanen dairy goats by using goatshed waste on protected arid waste land"; and distribute to all the registered participants of the Conference our booklet called "Poor Woman's Cow".

Mr C.M. Ketkar attended Sixth International Conference of the Institutions of Tropical Veterinary Medicine held in Holland, in 1989, and presented four papers:

A) Performance of crossbred Saanen goats for milk production and disease incidence with farmers in villages around Narayangaon (1989)

B) Health and milk performance for a decade of crossbred and pure Saanen goats kept under stallfed condition at Rural Agricultural Institute, Narayangaon

C) Ten days intensive training courses in three languages to non-government organizations, farmers and especially women in dairy goat management (1989)

D) Use of goat droppings for biogas cooking, slurry as manure for fodder production and its uses for feeding crossbred goats by limited resources farmers for extra milk production for child nutrition (1989).

6. Training courses attended

Mr Ketkar took training in "Milk and meat production for sheep and goat in tropics" held in the Philippines 1984, under the guidance of Winrock International, USA.


7. Mr C.M. Ketkar was the member of the "Maharashtra Sheep and Goat Commission" formed under the chairmanship of Mr B.V. Nimbkar.

Mr S.R. Sabnis is the trustee of the "Maharashtra Goat and Sheep Research and Development Institute" Phaltan (M.S.), India

8. Research carried out at the Institute on goat

A) "Goat production in India" by Mr Stefan Nitzhe from Technical Universitat, Berlin (1985)

B) "Husbandry system adoption and diseases of Saanen goats and their crossbred with indigenous goats in Maharashtra State, India" by Ms Jutta Born from Giessen University, Federal Republic of Germany (1988)
9. Dr A.P. Gore, U.A. Lavaraj and Mrs Paranjape S.A. from Department of Statistics, Pune University, published two papers on the goat and one on biogas:


10. Awards received

A) R.A.I.N. got the "K.P Goenka Memorial Award" of Rs 100,000/- for Environment in 1985.

B) Mr Shreekant R. Sabnis, Managing Trustee of R.A.I.N. got late Vasantrao Naik Agricultural Development Award" of Rs 11,000/- in 1989 for his work in dairy and animal husbandry.

C) The film "Return to land" produced and directed by Mr Vishnu Mathur of the Canadian Broadcasting Corporation, Canada, depicting the work of R.A.I.N. and Gramayan, got the prestigious "BRONZE EAR" award during the 16th Berlin Film Festival in February 1990.

11. The Institute believes in recycling of the waste for production and protects the environment

**STALLFED MILKING GOAT**

Milk Production → Male kid → Goat droppings

1. For purchase of goat feed → Sold for meat → Biogas
   - Slurry
   - Used for fodder production
   - Fed to goats
   - Kept under stall-fed condition

2. Nutritious milk for human babies

**ACKNOWLEDGEMENTS**

D. RECOMMENDATIONS AND DISCUSSIONS ON RECOMMENDATIONS
RECOMMENDATIONS

GROUP I: SYSTEMS

1. There was consensus that there is a need for developing better small ruminant projects in the context of production systems. One primary problem is to have an adequate constraints analysis. The group felt that at this point in time, constraint analyses have not been sufficient to help guide the improvement of small ruminant production and fully utilize the research community. One of the largest constraints in evaluating production system constraints is that analyses are not time dynamic. By not being able to evaluate constraints with respect to time it is difficult to assess the true impact of the constraint as well as the impact of proposed interventions.

2. There was a growing appreciation that PVOs have better access to farmers than the government research/development system does. Therefore, efforts should be made to utilize their access to a higher degree than what has been previously the case. This also means that PVOs will have to have a higher level of expertise if they are to fulfill this role.

3. The group felt that to be effective in project design the target must be clearly identified, the system must be understood and the farmers' needs must be known.

4. The group considered how to operationalize small ruminant projects which would be able to address the concerns of farmers, researchers and the development community. The schematic (on page 122) proposes a mechanism of how such projects should be designed and implemented. Briefly, the rectangles represent major action phases, and the circles name the organizations responsible for either generating information, recommendations or research. The proposed schematic places a critical emphasis upon the use of simulation models. By placing simulation model use at such a critical stage in small ruminant programmes it serves to guide either the research or implementation process. This will have two major advantages: first, a reduction of research and implementation costs and second, simulation models will allow researchers and developers to evaluate the system constraints dynamically with respect to time. This diagram does not suggest that simulation models will replace applied or basic research but rather they will aid in the allocation of scarce financial and human resources.

GROUP II TECHNOLOGY

1. It would not be possible to give a blanket recommendation with regard to the breeding strategies. The choice of breed and breeding technology should be
chosen while considering the socio-economic conditions of the farmers in a particular area. While technologies such as crossbreeding can increase productivity, caution should be exercised in introducing such technologies. There is a greater need to give more emphasis on evaluation and exploitation of the genetic potential of locally available germplasm.

2. While technologies such as artificial insemination and embryo transfer are available, and can be used for fast propagation of the efficient genotypes it is necessary at this point to take a good stock of the available resources, to identify technologies which can be economically transferred in the farmers' flocks and can be adopted with ease.

3. Information is available on utilization of non-conventional feed resources, but a holistic approach is missing. Problems such as mechanical handling, transportation, conservation and method of feeding need to be evaluated. Furthermore, the economic feasibility of such technologies need to be established.

**DESIGN AND LINKAGES FOR SMALL RUMINANT PROGRAMMES**

4. There is scope for increasing production through integration of small ruminant rearing with plantation crops and horticulture crops. There is, however, a need to develop integrated farming system packages suited to different agro-ecological conditions.
5. The present system of putting up processing plants near major consumption centres away from production results in considerable wastage. There is a need for production with processing and improvement in marketing to increase returns to small ruminant farmers. This would require infrastructural development and attitudinal changes of the consumers through extension education.

6. Goat milk offers scope for production of value-added milk products, such as cheese, baby food and chhanna-based products. Research efforts are needed to develop appropriate technologies for utilization of goat milk in food processing.

7. Small ruminants will continue to be important source of animal fibre. In countries like India where large quantities of wool are imported, farmers would require pricing and technology interventions that will provide incentive to increase fibre production and their quality.

8. There is a misconception regarding the role of small ruminants in ecological degradation. Technologies that allow rearing of sheep and goats without any adverse effect on ecology are available. While there is a need to educate small ruminant farmers to adopt these technologies, there is also a need to educate people that small ruminants rearing can be environmentally friendly.

GROUP III : REACHING FARMERS

Group III discussed about reaching the farmers the extension mechanisms or transfer of technology in respect to small ruminants. The delegates took a lot of interest on the subject and shared their rich experiences coming from both developed and developing countries. The Group felt that the following 4 pillars of sustainability exist in any discipline, may it be small ruminants or any subject matter area:

(i) Research
(ii) Education
(iii) Extension
(iv) Training

Training for human resources development was considered a very crucial area deserving independent treatment and resources like other functional areas such as research or teaching. The suggestions emerging out of this Group, therefore, are dealt under these heads. In addition, there is also a general category.

General suggestions

1. Small ruminants have been neglected and deserve additional attention in all functional areas, viz research, education, extension and training, in the area of transfer of technology.
2. It is essential that our orientation to small ruminant production systems development be focused on key and critical issues, the environment and human factors being two primary examples of such issues. Scientists and developers must keep in mind not only the harsh, mostly rainfed environments under which small ruminants are reared, but also the groups which rear them (marginal farmers, agricultural labourers and nomadic shepherds).

3. Whenever political will and involvement was assured or available, development has been faster. For example sheep development in Rajasthan. Political will can be increased in the solid ground of good field work through pilot projects. The ten years of development work in Sri Lanka has lately resulted in a National Goat Development Programme for the country.

4. Low productivity of small ruminants, which results in farmers having to maintain larger flocks, was considered to be an important issue. While scientists work for increasing small ruminant productivity, there must be efforts to resolve issues relating to appropriate natural resource use, land tenure and management capabilities. In this process producers must have the opportunity to decide upon their level of commercial involvement.

5. Lobbying was considered as an essential requirement for promotion of small ruminants like in any other areas. Lobbying in the Governments, lobbying through NGOs and the strong lobby of the concerned clientele groups-small and marginal farmers, agricultural labourers, nomads etc.-needed organization and strengthening.

Research for better extension

1. Research was discussed in 2 contexts: (i) for evolving technologies, and (ii) research in transfer of technology. It was loudly discussed whether or not we have technologies for reaching the farmers with the appropriate packages of recommendations. There was a general agreement among the group that very limited work has been done in the area of small ruminants especially in the developing countries.

2. For better acceptance and adoption of the technologies, farming systems and participatory research it was suggested involving scientists as part of interdisciplinary group of extension workers and the farmers.

3. For effective technology transfer, available technologies need to be properly documented and database generated.

4. Field surveys on the status of small ruminants, farming conditions and problems should be the starting point for doing research as well as effective extension.

5. Research dealing with socio-economic aspects of the commercial farmers need promotion and support. Such studies have been neglected.

6. Research on the transfer of technology will be equally important to bring out the
RECOMMENDATIONS

appropriateness of extension, methodology and approach. Constraints of management are limiting factors impeding the development in the small ruminant sub-sector.

Education-specialized manpower for academics and extension

1. A long-term strategy for promotion of small ruminant development, identification of training needed for development of manpower both in the academics as well as in the development will be needed.

Extension reaching the farmers

1. The extension system for small ruminants has to face many harsh conditions: Therefore, to effectively promote science and technologies in this sub-sector, added attention, resources and infrastructures have to be provided.

2. A systems view of the transfer of technology has to be considered where all the elements of development area are properly aligned and linked from A to Z, from inputs support to the marketing of the products. The working cases of NDDB (National Dairy Development Board) and Amul (Anand Milk Union Limited) in Anand (Gujarat) were quoted as illustrations.

3. Harmful effects of goat rearing specially related to ecological degradation were also referred to and it was suggested that appropriate technologies should take care of such problems. Stall feeding, for example, is one such measure.

4. Governmental interventions in developing of small ruminants have been negligible all over the world and especially in the developing nations. Thus the political will of the Government and resource support have been insufficient. Since this sub-sector deals with the poorest of the poor, creation of minimum assets with sheep and goats with the farmers will be important. Like in the lab-to-land programme in India where a few such animals have been given free of cost to the farmers as starters. Such policy decisions will favour rapid transfer of technology in the area.

5. NGOs, being down to earth in their approach and intent, and devoted to the development of the poor, were quoted to have done a lot of good work in this respect. While promotion of NGOs and the right kind of support to them will help accelerate extension work, a caution was sounded that a large number of spurious NGOs have been started with the intention of keeping favourable Government policies towards funding them.

6. Like appropriate technologies, appropriate extension methodologies and strategies are needed for dealing with the poor farmers keeping in view their socio-economic conditions and cultural situations. A more personalized approach and monitoring of the programmes will be needed.

7. Co-operation, co-operatives and group actions require promotion, because such farmers have time and resource limitations. Marketing co-operatives, for example, have contributed a lot in this area.
8. In the rearing and management of small ruminants, farm women have played a dominant role. They should be treated as priority audience/target groups in this respect. In many cases, women extension workers can do a lot better vis-a-vis male extension counterparts in developing countries.

9. It was suggested to take advantage of the traditional wisdoms in rearing and caring of the small ruminants together with the modern technologies. A right mix or blending can be helpful.

10. In such clientele group, the young children have suffered a lot by not going to schools, for they are normally for grazing the animals. The concept of mobile schools has to be promoted for their education.

11. Bureaucracy in most developing countries was referred to as a hindrance to development in general and small sub-sectors like small ruminants in particular; technocrats should take precedence over the bureaucrats managing the development.

12. Rural infrastructure especially with respect to health cover for the small ruminants needs to be developed as a basic resource for continued use.

Training

1. Training was considered as an important input for human resource development both for the farmers as well as the extension workers. Such training demands are vast and continuous; basic training infrastructure has to be created, if not available already. Several NGO projects have to be highlighted. Farm Science Centres (Krishi Vigyan Kendras) in India have done considerable work in this area. Other existing allied institutions develop specific training programmes in this area.

2. Methodology for training target groups has to be by 'work experience' rather than lecture methods. The concept of 'teaching by doing' and 'learning by doing' needs to be promoted. Most courses may be short and should be offered in both situations: on-campus (residential) for farm youth and off-campus (in villages) for the working farmers and farm women.

3. Mobile training schools have to be organized for courses for the grazers, nomads, shepherds etc.

4. After training, support for initial inputs has to be provided so that trainees can start their own flock. Loans should be easily available on long-term basis to such trained and motivated farmers and farm women.

DISCUSSIONS ON GROUP RECOMMENDATIONS

Dr H. Grell
GTZ Germany

Farmers should be trained to become partners enabling them to solve their problems. They need training beyond the pure technical training. In this type of 'group support
training NGOs can do a good job.

If they know how to talk and express themselves and to address their problems in the right way, which can be very powerful if well organized, they could even develop into associations/co-operatives and lobby for themselves.

This type of training is already successful in Sri Lanka.

In the last phase of the Sri Lanka-German Government Project, we got NGOs doing group support training. This started in 1989-90. In October 1991, the Goat Breeders' Associations in Anuradhapuram District formed an umbrella organization at district level.

Dr A. J. John
AFPRO
25/1A ‘D’ Block, Janakpuri, New Delhi 110058

1. Technology Mission on Dairy Development (TMDD), Government of India, has not provided budget/programmes for goat development/milk procurement/marketing. TMDD envisaged to receive Rs 800 million from VIII Five-Year Plan for development activities. Let us request TMDD to help goat programme in India and provide money for PVOs.

2. Establishment of Goat Production Demonstration-cum-Training Units with PVO.

3. Experiences of PVOs could be utilized for community pasture land development and social forestry development with a package deal to feed goat/sheep with zero grazing.

4. Drought feeding strategy for sheep and goats. Disease control strategy against BT (blue tongue) and JD (Johne's disease).

5. PVOs could be involved for developing operational research projects specific to time and target oriented for appropriate technology for goat production.

6. Documentation of work of NGOs/PVO in India.

7. Suitable training course curriculum for women and rural goat owners.


9. Disease control strategy BT/JD.

10. Goat chocolate/UMB (Urea-molasses block with zero grazing)

B.V. Nimbkar

1. Evaluation of projects should be done regularly.

2. Research funding should be through a PVO who will ensure evaluation as also whether research is relative.
One type of donation by a donor agency is through supply of personnel or a reverse brain drain.

**Dr Ruth Gatenby**

People work much better if they are given incentives. Therefore, if we want the individuals involved in research and development projects to work with enthusiasm and put in a lot of effort, they should be given an incentive, may be in the form of money or promotion.

**Dr N S R Sastry**

*NIRD, Hyderabad*

A system of constraint analysis involving assessment once in 3-4 years. Record the income received by the farmer per animal or per ruminant unit and then see what contributes to increase or decrease in income at every time interval. Ultimately see how these contributory factors can be improved or eliminated as the case may be.

There is codification of the method followed by commercial banks, which has proved to be very useful as regards livestock development programmes financed by them.

e.g. Dairy schemes give below* average income, short lactation period and long dry period, feeding status poor, no land for fodder growing and fodder collection seasonal.

(*Milk marketing deficient, milk routes do not cover the beneficiary villages.)*

**Mohana (A.P.)**

**Regarding voluntary organization involvement**

- We must have dialogue with women regarding goat rearing
- Encourage women to grow fodder trees
- Provide veterinary services at their door steps
- Provide training facilities for women regarding goat rearing
- We must have action research cells along with the project
- Systematic documentation is necessary

A large number of NGOs are coming up and lot of investments are being made through the NGOs for development activities. A proper monitoring system should be developed to closely monitor the programmes and achievements made in relation to the investment. NGOs are also to follow certain rules and procedures for employing persons and observation of labour laws etc. Whether the benefits are already going to the needy or not should be assessed at regular intervals.
Dr T. A. Kadarbhai (Baramati)

It was suggested that on completion of the research work, if the implementation by the farmers does not occur, the researcher should present the reason or constraint in implementation.

On the same line, I think when any researcher completes and concludes the research work positively, he should also give the economics if implementation has to be done.