A WORLD BANK TECHNICAL PAPER

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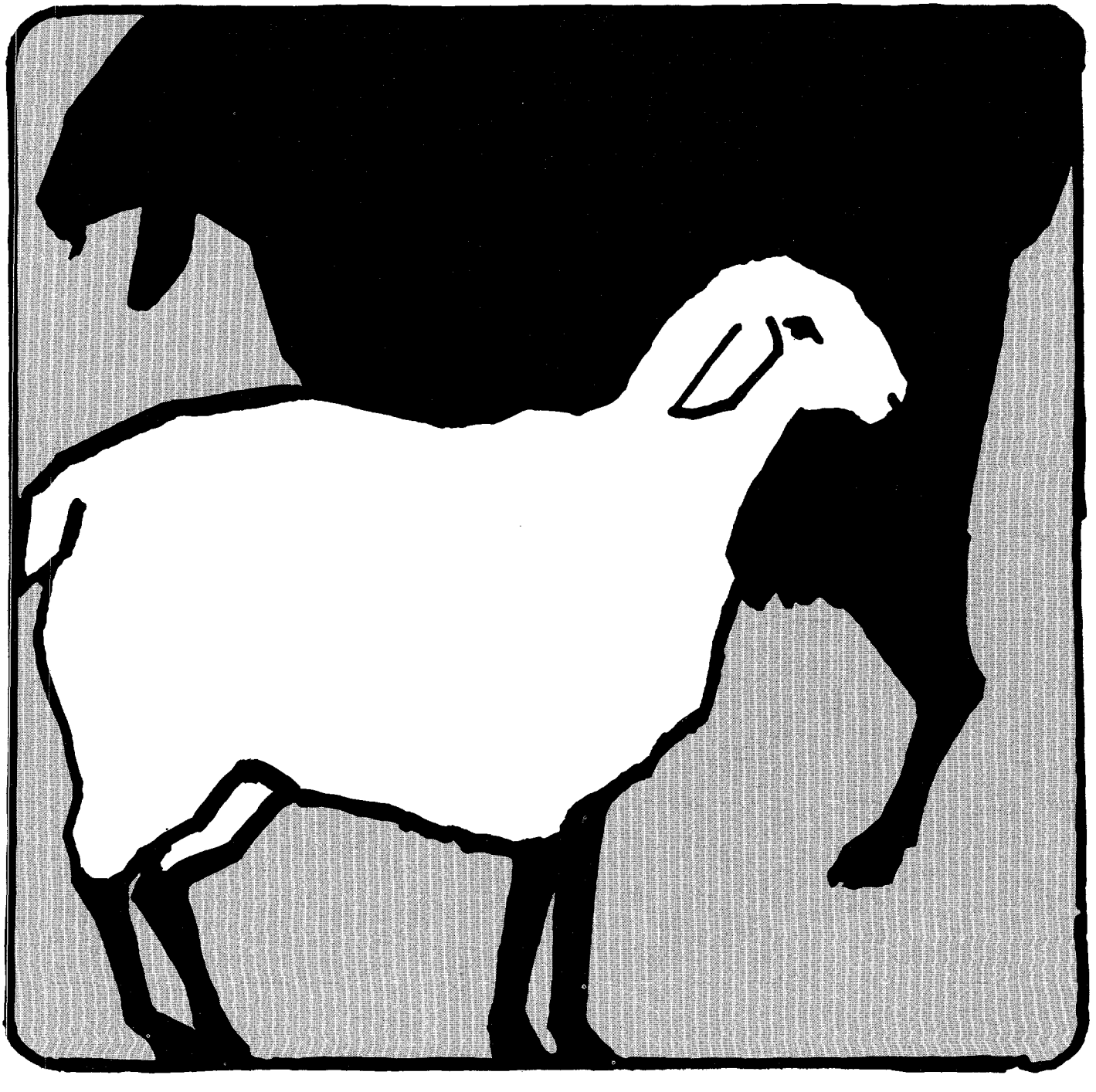
Sheep and Goats in Developing Countries

Their Present and Potential Role

Winrock International



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Sheep and Goats in Developing Countries

Their Present and Potential Role

Winrock International

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ABSTRACT

The objectives of this study are to assess the role of small ruminants (sheep and goats) in the food production systems of developing countries, examine their advantages and disadvantages, analyze the constraints limiting their further contribution to the welfare of small farm/low income rural producers, prescribe measures for overcoming these constraints, and make recommendations related to potential donor involvement in support of the development of sheep and goat production. Small ruminants are viewed as an integral, but not dominant component of complex agricultural systems. Particular emphasis is placed on sheep and goats in mixed herds grazing dry rangelands and in small mixed farm systems in medium to high rainfall areas. An analysis of major constraints -- ecological, biological, policy, and socio-economic -- leads to recommendations on the need for a balanced production system approach for research, training and development programs, and for a combination of support activities such as herd health programs, and formulation of favorable credit, marketing and pricing policies for small ruminants and their products.

ABSTRAIT

La présente étude vise à évaluer le rôle des petits ruminants (moutons et chèvres) dans le cadre des systèmes de production alimentaire des pays en développement, à examiner leurs avantages et inconvénients, à analyser les obstacles qui les empêchent de contribuer davantage à la prospérité des petits exploitants et des producteurs ruraux à faible revenu, à indiquer les mesures susceptibles de surmonter ces obstacles et enfin à formuler des recommandations sur la manière dont des donateurs d'aide pourraient éventuellement contribuer à l'accroissement de la production ovine et caprine. Les petits ruminants sont considérés comme faisant partie intégrante de systèmes agricoles complexes, sans toutefois en constituer l'élément prédominant. Une importance particulière est accordée au pâturage combiné de moutons et de chèvres dans des zones de pacage sèches et dans de petites exploitations mixtes situées dans des régions à pluviométrie moyenne à forte. Une analyse des principaux obstacles - écologiques, biologiques, politiques et socio-économiques - aboutit à des recommandations quant à la nécessité de fonder les programmes de recherche, de formation et de développement, sur un système de production équilibré, de combiner des activités de soutien telles que les programmes zoosanitaires, et de formuler des politiques favorables de crédit, de commercialisation et des prix pour les petits ruminants et leurs produits dérivés.

EXTRACTO

Los objetivos de este estudio consisten en evaluar la función de los pequeños rumiantes (ovejas y cabras) en los sistemas de producción de alimentos de los países en desarrollo, examinar sus ventajas y desventajas, analizar las limitaciones que impiden su mayor contribución al bienestar de los productores rurales con pequeñas explotaciones y bajos ingresos, prescribir medidas para superar estas limitaciones y formular recomendaciones relativas a la participación de posibles donantes que apoyen el desarrollo de la producción de ovejas y cabras. Los pequeños rumiantes se consideran un componente integral pero no dominante de sistemas agrícolas complejos. Se da especial importancia a las ovejas y cabras en los rebaños combinados que pacen en los terrenos de pastos secos y en pequeños sistemas agrícolas mixtos en zonas de precipitaciones medias y altas. Un análisis de las principales restricciones ecológicas, biológicas, políticas y socioeconómicas deriva en recomendaciones sobre la necesidad de un enfoque equilibrado de sistemas de producción en relación con programas de investigación, capacitación y desarrollo y una combinación de actividades de apoyo tales como programas de salud animal y la formulación de políticas favorables de crédito, comercialización y fijación de precios para los pequeños rumiantes y sus productos.

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1. SUMMARY OF STUDY AND RECOMMENDATIONS

1.1. Summary of Study

The objectives of this study are to assess the role of small ruminants in the food production systems of developing countries, examine their advantages and disadvantages, analyze the constraints limiting their further contribution to the welfare of small farm/low income rural producers, prescribe measures for overcoming these constraints, and make recommendations related to potential World Bank involvement in support of sheep and goats.

The small ruminants considered in this study are limited to sheep and goats in the developing countries of the tropics and subtropics, which are kept for multiple purposes including milk, meat, fiber, leather and manure.

The world sheep population increased from 1,043 million in 1972 to 1,131 million in 1981. The proportion of sheep in developing regions rose from 49% to 56% and sheep numbers in the developed regions actually declined during this period. The same trend is evident for goats. In 1972, 95% of the world's 392 million goats were in the developing regions while by 1981 these regions had 96% of the world population of 469 million goats. In 1981, production of meat and milk from sheep was, respectively, 6 million MT (45% from developing countries), and 7.9 MT (54% from developing countries). World production of goat meat was 2 million MT (93% from developing countries) and world goat milk output was 7.6 million MT (74% from the developing countries). Offtake rates (% slaughtered of total population) for sheep were 42% in developed regions and 35% in developing regions in 1981. Comparable rates for goats were, respectively, 61% and 37%. Sheep meat contributes 3.9% to total meat supplies in developed regions and 4.9% in the developing regions. Comparable percentages for goat meat were 0.2% and 3.5%. Sheep milk contributed 1.0% to total milk supplies in developed regions and 3.6% in developing regions. Comparable figures for goat milk were 0.6% and 4.6%. These figures for 1981 indicate the relative importance of sheep and goats in developing regions of the world and the substantial differences in productivity between populations in developed regions vs developing regions.

Sheep and goats in developing countries are generally an integral, but not dominant component of complex agricultural systems. Therefore, assessment of the current status of sheep and goats and development of recommendations for improvement strategies must consider this role within larger and more complex production systems. Particular emphasis is placed on the role for sheep and goats in mixed herds grazing dry rangelands and in small mixed-farm systems in medium to high rainfall areas.

Small ruminants, in common with other ruminants, can convert low quality fibrous feeds to high quality products. Moreover, certain characteristics of sheep and goats bear special mention because of their relevance to agricultural development efforts. Their small size, early

maturity and low capital investment per head particularly suit them to the needs of limited resource producers. They often contribute needs of household for cash income and food, in small but timely amounts. They can range over wider areas, select a larger variety of plants, and repopulate faster than large ruminants after droughts.
Their disadvantages, also related to their small size and grazing habits, include risk of theft and predation, low individual value relative to cost of inputs, lack of capability for draft power, and potential environmental degradation from uncontrolled grazing.

A recurring theme of the study is the lack of recognition of the current and potential role of small ruminants in many developing countries. This is manifested not only by a lack of support within developing countries, but also within international donor and lending agencies. Some 80 research and(or) development projects in developing countries were analyzed on a regional basis. There has been considerable attention given to mixed crop-animal systems but most of these efforts were directed towards larger scale commercial systems in more developed countries. Few projects had a primary emphasis on either research and training or on sheep and goats. The majority of resources were for projects in Eastern Europe and the more developed countries of South America and North Africa.

Major constraints--ecological, biological, policy, and socioeconomic--are usually interrelated through production system linkages. Thus, both general and specific recommendations focus on the need for, and requirement of, a balanced production system approach for research, training, and development programs. A combination of support activities are needed: regional and herd health programs, government assistance to research and extension programs, and formulation of favorable credit, marketing, and pricing policies for small ruminants and their products.

1.2. Summary of Recommendations

Recommendations were developed with emphasis on the following principal criteria:

- o Sheep and goats in developing countries contribute primarily as an integral, but not dominant, component of production systems. Therefore, project and other activities should emphasize the systems approach, rather than treat sheep and goats as an independent commodity.

- o Systems to be addressed should be those in which sheep and goats are currently of significant importance:
  - Mixed species herds grazing dry rangelands.
  - Small herds providing the primary source of food and income to landless peasants (e.g., India).
  - Small mixed farms in which sheep and goats add value to crop residues and serve as a food and cash reserve.

Also included are those systems in which potential for a significant contribution by sheep and goats remains unrealized because of one or more missing elements, such as seasonal feed shortages, health problems, suitable genotypes, and profitable markets. Examples include mixed farming systems in which dual-purpose goats can produce milk for family consumption and slaughter animals for income, and stratified systems where range based breeding animals produce slaughter stock finished on better quality feeds for urban or export markets.

- o Projects must be economically and technically feasible; however, in many instances, principal returns would be in social values (improved nutrition and health of family; insurance against food or cash shortages). Supporting policy analysis is also a high priority to identify further constraints on sheep and goat production and market development.

- o Finally, recommendations emphasize activities suited to implementation by the World Bank or those which the World Bank may indirectly influence through International Centers, national institutions, and national agricultural policy.

Specific Recommendations

1.2.1. Increase professional and institutional awareness of the current importance and potential value of sheep and goats to balanced agricultural production in developing countries:

- o The identification and design stages of project development should incorporate specific assessment of sheep and goats.

- o Review of government policy directly or indirectly influencing the small ruminant sub-sector and preliminary assessment of overall impact of these policies on production, marketing, pricing, and product demand for small ruminants and their products.

- o The portfolio of Bank projects, including rural development projects, should be reviewed with respect to sheep and goats, to identify opportunities, and to benefit from previous experiences.

- o Development of comprehensive databases on biological and economic characteristics of sheep and goats should be supported. A file of technical personnel with interest and experience in sheep and goats should be compiled and regularly updated.

The primary purpose of these data bases would be to organize available information to support project design and implementation.

1.2.2. There are major gaps in knowledge and technology necessary to formulate successful development plans. Results from research in developed countries can serve on a stopgap basis; however, research should be done with the types of animals under the environmental conditions to which results will be applied.
Biological research priorities include:

- o Supply of adequate feed throughout production year.

  Develop cropping systems which meet animal feed requirements without reduction in food or cash crop yield, including harvest and feed preservation strategies to maximize nutritive value of crop residues.

  Identification of crops which when intercropped or rotated increase food crop yield as well as providing feed for animals.

  Evaluation of seasonal differences in types of range vegetation selected by sheep, goats, cattle and other ruminants to design optimum mix of species in grazing herds.

- o Improve health.

  Develop prevention/cure for major diseases affecting sheep and goats in tropics.

  Develop herd health programs acceptable to producers (low cost, low labor).

- o Improve genotype.

  Characterize native types of sheep and goats for production and fitness traits and determine the extent to which differences are due to additive and nonadditive genetic effects.

  Evaluate strategies for combining the superior traits of different breeds with particular attention to breeds which have evolved in the tropics.

  Evaluate the apparent advantages and disadvantages of sheep and goats vs cattle.

Socioeconomic research priorities include:

- o Production and marketing economics.

  Evaluate the potential costs and benefits of biological and technical interventions to sheep and goat production.

  Estimate current and potential demand for sheep and goat products at the local, national and export trade levels with consideration to competition from other animal products.

  Evaluate the economic feasibility of developing market infrastructure to process and distribute sheep and goat products.

- o Supporting policy research.

  Conduct policy research to assess market-price relationship, impact of price policy and impact of other government policies on the small ruminant sub-sector and devise policies which directly support sheep and goat development activities.

- o Sociological factors.

  Evaluate goals of producers and their attitudes toward acceptance of new technologies, their willingness to change traditional practices and to invest labor and capital in improvements to sheep and goat components.

Systems research priorities refer to the need for research to synthesize and evaluate comprehensive packages of technology and knowledge:

- o Use of computer models to screen possible interventions for those most likely to work in the field.

- o Test promising interventions under actual production conditions to ensure they fit the environment and producers needs.

Research priorities may be addressed through financial support to existing research centers, through loans to upgrade national research capabilities, and, in the case of socioeconomic and systems research priorities, by incorporating a research component within development projects to utilize data produced and to monitor progress.

1.2.3. Training is needed to acquaint decision makers with the potential for these species and to produce qualified professionals to carry out research, extension and development activities. Priorities for training activities are:

- o Shortcourses in topics such as sheep and goat management in extensive and intensive systems, administration of credit to producers, market development.

- o Academic training of developing country nationals in both biological and socioeconomic disciplines in which research program involves sheep and goat production and marketing.

Because research and development activities should focus on sheep and goats as part of agricultural systems, training activities should also incorporate interdisciplinary approach. Workshops and shortcourses should be conducted in developing countries. Participants should include producers as well as agricultural professionals.

1.2.4. Development priorities focus on sheep and goat improvement within the framework of agricultural systems or rural development projects, where sheep and goats are currently important or where they have substantial potential.

Production of improved sheep and goat seedstock. More emphasis should be placed on using superior stocks which have evolved under tropical conditions. In order to meet demand for superior adapted genotypes, centers to produce performance tested, disease-free stocks for export may be developed in selected tropical countries. Genetic merit is best evaluated under a common environment, perhaps a research station. However, final evaluations should be done under actual farm conditions. Cooperating farmers may also multiply proven seedstock for distribution to the target population of producers. Alternatively, government stations may supply superior rams/bucks to villages or producer groups on a sale or loan scheme.

Capital and credit assistance. Capital investments must consider financial inputs for overall sector support, on-farm improvements and credit for animal purchases. Credit needs are production system specific with existing institutions generally able to service ranch and commercial seedstock units. Non-conventional approaches will be needed for transhumant/pastoral producers and for smallholder systems. Credit schemes must account for the fact that producers of sheep and goats are generally poor with limited collateral; sheep and goats are easy to move and difficult to identify; and administrative costs for small-scale schemes can be high. Particular consideration must be given to existing schemes that have worked well in developing countries such as provision of breeding stock on shares or animal sharing schemes which make maximum use of local organizational and social arrangements.

2. INTRODUCTION

2.1. Study Terms of Reference, Background and Objectives

2.1.1. Terms of Reference

The following terms of reference for a study on the role of sheep and goats in agricultural development were provided to Winrock International at the commencement of the project:

1. To date the Bank and other development agencies have given very little priority or support to the development of improved sheep and goat production and marketing systems in developing countries.

2. It is estimated there are over one billion sheep and about 400 million goats in the world. Over 80% of the sheep are located in a few regions--Europe, North Africa and the Middle East, Oceania, Russia, China and a few countries in South America. There are relatively few sheep in tropical areas. Goats are widely distributed, especially in developing countries.

3. Sheep and goats have a number of characteristics which offer considerable potential for increasing production of meat and milk and the incomes of smallholders in developing countries:

   - o the two species are adaptable to a wide range of environments; because of different grazing habits they are often complementary to each other and to cattle in utilizing range lands;

   - o they show a higher survival rate than cattle under drought conditions and because of higher reproductive rates, population can be restored more rapidly after drought;

   - o in many situations they may have higher biological efficiency than cattle in conversion of fodder to meat or milk;

   - o their short reproductive cycle and the high incidence of multiple births in many breeds are major advantages in some situations;

   - o their small size and early maturity makes them especially suitable for use on small farms and for meeting subsistence needs for meat and milk; and

   - o there are no major religious taboos on consumption of sheep and goat meat and in many countries there is very strong demand for such meat.

4. Despite these favorable traits, the world population of sheep and goats since World War II has grown at a much slower rate than that of cattle. The major physical constraints to increased sheep and goat population and productivity are their susceptibility to certain respiratory diseases and internal parasites, especially when they are kept in large flocks, and their susceptibility to predators because of their small size.

5. Sheep and goats have received very little priority in the development plans and programs of developing countries and in some cases there has been opposition to them, especially goats. Because of this, very little attention has been given to research and extension in relation to problems of breeding, feeding, management and disease control. Also very little attention has been given to identification of development opportunities.

6. In recent years there has been some evidence of increasing recognition of the potential role of these species in agricultural development in developing countries. USAID has sponsored a coordinated worldwide program for research on small ruminants. The Bank is now actively considering projects or project components for small ruminants in a number of countries.

7. The Agricultural and Rural Development Department is engaging Winrock International to prepare a paper which will provide technical guidelines for operational staff on the potential role of sheep and goats in developing countries.

8. The paper should outline the present state of knowledge on sheep and goat production with special reference to the developing countries. As specialist staff of the Bank are generally familiar with the systems of commercial production of wool and meat by sheep as practiced in Oceania, South America, and Europe the paper should concentrate principally on the potential for production in other situations e.g., on small farms in the humid, sub-humid and semi-arid areas, in certain highland areas, and under traditional, communal grazing systems.

9. The paper should outline the potential productivity of sheep and goats in these situations and also the technical constraints to production. In this respect it should discuss the characteristics of the various breeds and also the problems of feeding, management, and disease control.

10. It should indicate topics on which specific research programs need to be undertaken and it should also indicate the types of development projects which could be undertaken in the short and medium term.

2.1.2. Background to the Study

Fifty-six percent of the world's 1.1 billion sheep and 96% of the 469 million goats are in developing countries. They generally serve as a minor, but critical, component of balanced agricultural production systems--especially in pastoral herds grazing arid rangelands and on small mixed farms in higher rainfall areas. Wherever they are found, sheep and goats are producing much needed food and generating income, usually to the direct benefit of some of the world's poorest people.

Notwithstanding these contributions, sheep and goats have received relatively little attention in the formulation of research, training, credit, and development projects. There are several reasons why this has been so.

Relative to cattle, sheep and goats contribute only small fractions of the world's meat and milk production (% of world output for meat and milk, respectively, are: sheep, 4.3% and 1.7%; goats, 1.5% and 1.6%). Generally, cattle convey more status to their owners than sheep and goats, the "poor man's cow." Produce from sheep and goats is frequently consumed by the family. Since this household consumption does not enter commercial market channels, its economic importance often escapes the notice of government and international agency decision makers. The most publicity received by sheep and goats has been about their undeserved reputation as degraders of the environment.

This report does not dispute the relatively minor role of sheep and goats at the world or even the national level. However, by focusing this study on the disadvantages of sheep and goats as well as their advantages and by emphasizing the objective analysis of the role of sheep and goats in those production systems of which they are an important component, the study has as a major goal the identification of situations where sheep and goats have unexploited potential. By analysis of constraints which prevent this potential from being exploited, recommendations can then be made for project opportunities to improve the productivity of sheep and goats through applied research, training and technically feasible development projects.

2.1.3. Study Objectives

The objectives are to analyze the general role of ruminant animals in the world food system and the unique role played by small ruminants, particularly in developing countries; describe specific characteristics of sheep and goats, including their advantages and disadvantages; analyze the technical and socio-economic constraints to increased production by sheep and goats; and prescribe measures for overcoming these constraints, particularly with respect to the potential role of the World Bank.

2.2. Agriculture

Agriculture is the primary and fundamental preoccupation of mankind. Food is a daily basic necessity required by every human

being. In developed countries the percentage of the population directly employed on the land has declined sharply shifting economic and political power from rural to urban areas. In fact, however, the greatest strength of the developed countries is in their highly productive agriculture.

In the developing countries, most of the population is directly employed in agriculture. Here the spectre of severe food shortages looms at the family and national levels. It is appropriate, therefore, that international development agencies, be they of the national governments of developed nations, private banks, or voluntary organizations, should place priority on improving agricultural productivity in the developing countries.

2.3. Animals

Animals play a critical role in balanced agricultural production systems by adding nutritional and economic value to feedstuffs and other agricultural resources. Several excellent reviews have documented this role from several perspectives: economic, nutritional, ecological, and sociological. They leave no doubt that animals will remain an important, complementary component of agricultural production systems around the world (Byerly 1966, Ewing 1976, Hodgson 1971, McDowell 1979, Cunha 1982). In areas of surplus grain production, they are a way of marketing feed grains in the form of relatively expensive products to societies that can afford to pay the higher costs for meat, milk, and eggs. An additional payoff from consumption of animal products is that both organoleptic and the nutritional value of foods is enhanced. With some notable exceptions, the majority of people "like" animal products and as income rises more animal products are consumed. The quality of animal protein is also qualitatively superior to plant proteins.

The grain intensive animal industries are based upon the realities of the market place, not upon nutritional expediency. Farmers grow grain for profit, people prefer diets including animal products and will pay the cost. In the developed countries, people derive a third of their calories, two-thirds of their protein and approximately half of other nutrients from animal products (Van deMark et al., 1976). As long as people in developed nations retain this dietary preference, livestock producers can outbid the "hungry nations" for grain and the economic justification for feeding high concentrate diets to animals will remain. Nonruminants require these high concentrate diets; however, livestock industries involving ruminants may be justified on different grounds.

2.4. Ruminants

Ruminants are a special class of herbivore, and occupy a unique and critically important niche in the food chain. Their continued importance to mankind is unassailable because they bridge the gap between the vast resources of carbohydrate material naturally generated through photosynthesis but not directly useful for human consumption and the nutritional needs of mankind. By virtue of their unique symbiosis

Table 2.4.1. Ruminant Products Utilized by People[a]

Classification	Contribution	Main sources[b]
Meat	Food	All ruminants
Milk	Food	Cattle, buffalo, goats, sheep, camel, yak
Fiber	Wool	Sheep, camelids
	Hair	Goats, yak, sheep, camel
Skins	Hides	All ruminants
	Pelts	Sheep, camelids
Inedible products	Inedible fats	Cattle, buffalo, sheep
	Horns, hooves, bones	Cattle, buffalo
	Tankage	Cattle, buffalo, sheep
	Endocrine extracts	Cattle, sheep, goats
Traction	Agriculture	Cattle, buffalo, camel
	Cartage	Cattle, buffalo, yak, camel
	Packing	Camelid, yak, buffalo, cattle, reindeer
	Herding	Buffalo, camel
	Irrigation pumping	Buffalo, cattle, camel
	Threshing grains	Cattle, buffalo, camel
	Passenger conveyance	Buffalo, camel, yak, cattle
Waste	Fertilizer	Domestic ruminants
	Fuel (dung)	Cattle, buffalo, yak, camelids, sheep, goats
	Methane gas	Cattle, buffalo
	Construction (plaster)	Cattle, buffalo
	Feed (recycled)	Cattle
Storage	Capital	Domestic ruminants
	Grains	Cattle, buffalo, sheep
Conservation	Grazing	All ruminants
	Seed distribution	All ruminants
	Ecological	
	Maintenance	All ruminants
	Restoration	All ruminants
Pest control	Plants in waterways	Buffalo
	Weeds	Domestic ruminants
	Snails (paddies, canals)	Buffalo
Cultural, including recreation	Exhibitions, rodeos	Cattle, sheep, goat, buffalo
	Sport fighting	Cattle, buffalo, sheep
	Hunting	Game ruminants
	Pet	Goat, sheep, deer
	Racing, riding	Buffalo, cattle, camel
	Religious	Goat, buffalo, sheep, cattle
	Bride price	Cattle, sheep, goat, camel

[a] Adapted from McDowell (1977) and Fitzhugh et al. (1978).
[b] Species listed in order of importance, where identified.

with rumen microbes they convert resources unusable by man in their natural state into highly nutritious food. The rumen microbes also confer upon the ruminant independence from dietary requirements for essential amino acids, water soluble vitamins or soluble carbohydrates. Instead the symbiotic microbes can convert nonprotein nitrogen into the highest quality protein, synthesize all their own water soluble vitamins, and can make use of cellulosic materials as a primary source of energy.

The case for ruminants has been well documented (e.g., Fitzhugh et al., 1978, McDowell 1974, Van Soest 1982). Table 2.4.1. lists the many uses to which man has put the ruminant animal. In a world that has only one-third of its surface above sea level, and in which only one-fifth of that is suitable for cultivation--the rest being too dry, too hot, too high or too cold--the value of the ubiquitous ruminant is practically inestimable. In all of the dry, hot, wet, cold, and high environments of the world that man inhabits are to be found ruminants supplying food, fuel, power, clothing, and companionship.

Although the developed countries have included ruminants among the animals that are fed surplus grains along with pigs and poultry, the notion that ruminants are poor converters of high quality feeds and therefore should not be used in food production systems is entirely spurious. First, the vast majority of ruminants derive all or most of their diet from products unusable by man. Second, when ruminants are fed small amounts of highly digestible carbohydrates the "value added" to the base diet of fibrous feeds is enormous, making ruminants such as high producing dairy females among the most efficient means of producing animal protein. Third, ruminants do have a place in even the most sophisticated crop based agricultural systems because these systems generate by-products or wastes in quantity which can be converted by rumen microbial fermentation into products for human use. The value of skillful management of ruminant nutrition is exemplified by the simple fact that only one-third of the world's ruminants are in the developed countries but they produce 65% of the world's meat and 80% of the world's milk.

While the importance of ruminants in general has been well documented and is now becoming well understood by planners of food assistance programs, far less attention has been paid to the question of "which ruminant?" All the data available clearly indicate the predominant role of the large ruminants (cattle, buffalo, and camels) in supplying most of the meat and milk of ruminant animal origin. Small ruminants have received less attention. However, it is now apparent that small ruminants, notably sheep and goats, possess numerous potential advantages which apply in many of the agricultural systems of the developing world.

2.5. Small Ruminants

Sheep and goats are the principal domesticated small ruminants in terms of total numbers and production of food and fiber products. The genus Lama (including alpaca, llama, guanaco and vicuna) is concen-

trated in the Andean region of South America and is locally important for production of meat, fiber and, in the case of the llama, as a beast of burden. Undomesticated small ruminants (including most deer, gazelle and antelope) are hunted for food and sport and are a major tourist attraction in many African countries. Anticipated benefits from organized systems of game cropping and ranching primarily as a source of food from extensive rangelands of Africa are quite good; however, solutions to major problems of harvesting, processing, and marketing wild ruminants have not as yet been found.

In this report attention will be focused on sheep and goats and their current and potential role in agricultural production systems in developing countries. This role is primarily a function of their small size and correlated characteristics. Sheep and goats have certain advantages (and disadvantages) when compared to large ruminants, especially in the context of the specific characteristics of agricultural production systems. Criteria for classifying production systems are discussed in section 3. Comparative advantages and disadvantages of sheep and goats are described in section 4 along with consideration of genetic resources, types of products and levels of productivity of sheep and goats. Section 5 describes the principal biological and socioeconomic constraints to sheep and goat production while section 6 develops the recommendations based on the earlier sections. Finally, section 7 reviews a number of projects dealing with animal agriculture.

3. PRODUCTION SYSTEMS

Sheep and goats make important contributions within a broad range of production systems. Classification of these systems often facilitates identification of constraints and development of strategies to improve productivity. Two types of classifications used in previous Winrock International studies are described with reference to sheep and goat production. A third classification, based primarily on mixed farming systems in developing countries, is also described.

3.1. Ecological Classification

In the study, "The Role of Sheep and Goats in Agricultural Development," production systems were described for four tropical ecotypes--desert shrub, woodland shrub, tropical savannah, and tropical forest (Winrock 1977). The climatic and other characteristics of these ecotypes (table 3.1.1.) strongly influence the role of small ruminants in the prevailing agriculture systems. For example amount and distribution of rainfall (along with population density) determines the relative extent of cropping activity, which in turn offsets the nature of available feed resources and type of management potential.

The following extracts from the earlier study are relevant to evaluation of sheep and goat production systems in the context of ecological factors.

3.1.1. Desert Shrub and Woodland Shrub Ranges

Desert shrub ranges generally receive less than 250 mm annual rainfall and are subject to extreme drought periods. Vegetation is sparse, although nutritious. Utilization is generally limited to periods of favorable moisture conditions and where livestock water is available. Vast areas of North africa and the Middle East, portions of East and southwest Africa, Southwest Asia, the Indian Subcontinent and large areas of Argentina and Mexico can be classified as desert shrub ranges.

Woodland shrub ranges vary from 150 to 750 mm annual precipitation. One of the woodland shrub subclasses is the sclerophyll vegetation surrounding the Mediterranean sea and the Chapparal areas of California and certain coastal areas of South America. The thorned forests or woodlands, generally adjacent to arid tropical savannahs, are another subclass of woodland shrub.

Most of the world's fat-tailed and fat-rumped sheep and extreme coarse-wooled sheep are found on desert shrub ranges. In addition, a major portion of the world's milk sheep and a large portion of the milk goats are found on these two range types. The importance of milk and milk products to the human diet is underscored by the fact that these societies have selected sheep and goats over the centuries for milk production.

Table 3.1.1. World Distribution and Characteristics of Four Major Tropical Ecotypes

Range Type	Principal Locations	Precipitation Range (mm/year)	Temperature Range Daily max./min.C°	Soils
Desert Shrub	North Mexico Peru & N. Chile North Africa Arabia S. W. Asia East Africa S. W. Africa	0-250 Great irregularity Long dry season, up up to several years in most severe deserts	Great diurnal variation Max. 27-57 Min. 2-24 Frosts rare	Reddish desert soils, often sandy or rocky Some saline soils
Wood-land Shrub	Mediterranean region South America Central Chile	250-750 Almost all rainfall in cool season Summer very dry	Winter Max. 10-24 Min. 2-10 Summer Max. 18-41 Min. 13-27	Terra rossa, noncalcic noncalcic red soils; considerable variation
Tropical Savanna	Central America (Pacific coast) Orinoco Basin Brazil, S. of Amazon Basin N. Central Africa East Africa S. Central Africa Madagascar India S. E. Asia	250-1500 Warm season thunder-storms Almost no rain in cool season Long dry period during low sun	Considerable annual variation; no cold period Rainy season (high sun) Max. 24-32 Min. 18-27 Dry season (low sun) Max. 21-32 Min. 13-18 Dry season (higher sun) Max. 29-41 Min. 21-27	Some laterites; considerable variety
Tropical Forest	Central America (Atlantic coast) Amazon Basin Brazillian coast West African Coast Congo Basin Malaysia East Indies Philippines Papua New Guinea N. E. Australia Pacific Islands	1200-10000 Equatorial type: frequent torrential thunderstorms Tradewind type: steady, almost daily rain No dry period	Little annual variation Max. 29-35 Min. 18-27 No cold period	Mainly reddish laterites

Adapted from Billings (1966).

The dominant production systems are nomadic and transhumant. True nomadism is generally restricted to the pastoral societies inhabiting the desert shrub ranges of Africa and Asia. Land use is dictated by available forage and livestock water. The nomadic way of life has often implied aimless wandering, which is clearly not the case. Although grazing time and intensity are variable on specific lands, established grazing routes and traditional land use rights are generally followed by nomadic societies.

Nomadism as a way of life is declining in most regions. Increasing pressures from governments to establish settlements on government land are reducing nomadic grazing lands. Education and industrialization is attracting younger nomads to urban jobs. The consensus among planners and representatives of development institutions is that this transition is desirable; however, alternative plans to optimize land use on desert shrub ranges better than through properly managed nomadism have yet to be implemented.

Animal offtake from nomadic flocks is quite low. In order to purchase basic necessities, nomads may sell wool, milk or milk products and some male animals. Females are usually retained to maintain herd sizes because of reproductive rates of 40 to 60 percent and death losses of 20 percent during severe droughts. Flocks with over 30 percent males are not uncommon.

Transhumance, defined as movement from a home base along specified routes to other grazing areas and return, is the other principal system employed to utilize desert and woodland shrub range. Generally, the pattern is seasonal movement of animals into desert ranges during the rainy season and movement back into savannah and forest regions during the dry season. In much of West, Central and East Africa, this movement is as much to avoid the tsetse fly as it is to capitalize on grazing lands use.

The other principal use of desert shrub ranges through transhumance is for winter grazing areas with migration into higher elevation ranges during summer months. Late gestation, parturition and early lactation usually occur on the winter desert range.

3.1.2. Tropical Savannah Ranges

Savannahs are defined as having less than 40 percent tree overstory and vary in amount of rainfall from 250 mm to 1500 mm. Such a wide variation in rainfall also results in wide variations in vegetation and land use patterns.

Close to one-third of the world's cattle are found on the savannah ranges of Africa, Asia and South America. Sheep and goats are more important in lower rainfall areas where browse is more abundant. In most of Africa and Asia, cattle herds on the savannah ranges almost always include flocks or herds of sheep and/or goats as followers. Sheep and goats on the tropical savannahs of South America (excluding the Pampas of Argentina, Uruguay and Brazil from the tropical savannah classification), serve primarily as domestic meat supplies for ranch labor.

The savannah ranges generally have a rainy season of one to six months duration and the remaining months are dry. In some cases, long rainy seasons of two to four months will be followed by a shorter rainy season of one to two months in the opposite season (i.e., long rainy season in winter and spring with short rainy season in late summer or fall). Where rainfall patterns and amount (over 700 mm), soil types and topography permit, most of the savannah ranges are being cultivated. In fact, much of the range that is marginal in one or more of the above categories is being brought into cultivation, with severe ecological damage the likely long-term result. Cultivation of marginal savannah ranges is a major constraint to livestock production in much of Africa, the Middle East and India. Rapidly expanding human populations among traditional cultivator societies is producing tremendous pressures in many countries to expand the land under cultivation.

Nomadic production systems still exist in the more arid tropical savannahs of Africa and Asia, although migration patterns and grazing rights are becoming more defined and government services such as education and water development are encouraging transition to transhumant or sedentary production systems. Most nomadic systems utilizing savannah ranges include migration into desert shrub zones when vegetation growth and livestock water permit. Migration into the fringes of crop production areas to utilize crop residues has been a traditional part of their system, but this is becoming increasingly restricted. Sheep and goats are important livestock species with these nomads. These producers are generally receptive to programs that will improve their livestock (superior breeding stock, better grazing conditions, livestock water development, disease control) but are generally not willing to accept any program that restricts their movement or livestock numbers.

Vast areas of African and Asian tropical savannahs are utilized by transhumants. The Fulani tribe of West Africa is an example. Migration north and east into the tropical savannah and desert shrub regions occurs during the rainy seasons, with return to the Niger delta for crop residue grazing and even into the fringes of the tropical forest zones during the dry season.

Many transhumant production systems include sheep and/or goats. As the difficulty of migration or the severity of grazing conditions increase, the numbers of sheep and goats relative to cattle increase. Sheep and goats adapted to this system can go longer periods without water and, thus, utilize range areas not available to other breeds and species.

Sedentary production systems are of primary importance to a significant portion of the world's savannah ranges. Most of the savannah ranges of South America are managed under large-scale ranch conditions. Large-scale tribal ranches or commercial ranch schemes are becoming increasingly important on African savannahs. The size of the ranch is generally dependent upon the amount of land necessary to provide year-round grazing and water for economically viable units. Cattle are the principal livestock species although sheep and goats are increasing in popularity (in some areas). As bush density increases, goats become increasingly important for utilization and control of brush.

Smallholder mixed crop-livestock production systems are becoming more important in high potential savannah zones. In general, however, the potential importance of livestock is not recognized other than by the producers. The only livestock production system that has been widely accepted and emphasized in these areas in the past has been dairy cattle. At the same time, large numbers of sheep and goats may be seen in this area. Flock or herd sizes normally are two to ten animals, usually attended by young children or the elderly. These animals complement crop production by grazing or utilizing crop interstices, roadsides, canals, lands too steep for cultivation, crop residues, household and industrial wastes and other noncompetitive feed sources. The small ruminant clearly has a major role in smallholder production systems.

Goats and sheep normally are managed by smallholders as secondary enterprises to crop production, similar to the system described for high potential savannahs. In India and Southeast Asia, confinement systems with herds of 2 to 10 goats in cages or pens that are generally a part of or near the family home are not uncommon. Feedstuffs, such as coarse grasses, cassava leaves and other crop and tree leaves are cut and carried to the animals. Meat and/or milk are the primary products, with manure and hides as important by-products.

Research in Asia and West Africa indicates that sheep may have a complementary role in the production of plantation tree crops. Sheep are used for weed, grass and brush control while at the same time producing meat. Goats require more control, due to potential damage to the trees.

3.1.3. Tropical Forest Ranges

Tropical forests generally have greater than 1200 mm annual rainfall and no prolonged dry season. Central America along the Atlantic coast, the Amazon Basin, the Congo Basin and large areas of Southeast Asia typify this range type. Large areas have been cleared and are used for crop production. Major tropical forest areas of Africa with high potential for agriculture are not utilized due to tsetse fly infestation.

Plantation crops are important in tropical forest ranges. These include rubber, bananas, oil palm, plantain, coffee or tea. The "slash and burn" process is commonly used to clear crop lands. Two or three years of cropping without fertilizer and soil stabilizing crops are generally followed by severe erosion, reduced yields and eventual abandonment. Long-term damage to the ecosystem is the end result.

In those areas that have been cleared and developed for grazing, cattle production is generally favored. The major exceptions would appear to be among smallholders along the fringes of metropolitan areas or in the fringes of the tsetse fly belt of Africa. Small herds of sheep and goats are quite common in these areas.

3.2. Agriculture Use Systems

Following a different approach, production systems were classified according to predominant agricultural activities within the system (Winrock 1982). This classification served as the basis for evaluating priorities and designing strategies for livestock improvement programs. Three basic types of systems were described:

- Animal Based--animal component is the major, often only, source of production (food, fiber, etc.) from system; ruminants predominate because major source of food is grazing range or permanent pasture lands.

- Mixed Crop and Animal--animal component is an important, even essential, component of balanced production system; relative importance of crop and animal components varies widely among mixed systems in different regions.

- Crop Based--animal component plays a minor, complementary, but not essential role relative to cropping component; examples include weed control and utilization of crop processing by-products.

These classifications are not mutually exclusive by any means; examples of overlapping between animal based and mixed or crop based and mixed systems are common. Nine subclassifications were also identified. These subclassifications were specified on climate (primarily rainfall); predominant animal type (ruminants, nonruminants) and species

(cattle, buffalo, sheep, goats, camels; swine, poultry); and predominant type of crop. These subsystems are described here for reference purposes; because they are the starting point for the additional specifications used later in this section to classify production systems for small ruminants.

3.2.1. Animal Based

3.2.1.1. Pastoral migration of cattle, sheep, goats, and camels; in low rainfall areas--predominantly in Africa and the Near East. Although the system in Africa is relatively unimportant in terms of the percentage of the agricultural population using the system (12 percent), it is very important in terms of percent grazing land devoted to the system (35 percent) and percent of the total ruminant animal units associated with the system (35 percent). As would be expected, farmers using this system have very few nonruminants. In some areas of Africa, this system is linked with mixed farms (system 3.2.2.1.).

3.2.1.2. Pastoral sedentary, primarily cattle; in medium rainfall areas (1000 - 2000 mm)--predominantly in Latin America. While only 37 percent of the agricultural population is associated with the system, 70 percent of the grazing land and 74 percent of the ruminants in Latin America are associated with this production system. The system, which includes few nonruminants, has two basic subtypes:

Subtype 1: Extensive grazing, primarily to produce meat on large ranches.

Subtype 2: Intensive grazing to produce both milk and meat (dual purpose) on small and medium-size farms.

3.2.2 Mixed Crop and Animal

3.2.2.1. Mixed farms with cattle, sheep, and goats; millet and sorghum; in low rainfall areas (500 - 1000 mm)--predominantly in Africa, but also a few areas of Central America. The system sometimes includes chickens, but seldom includes pigs. (This is true in non-Moslem areas in Africa, as well as in the Near East). This system is often linked with migratory grazing systems (system 3.2.1.1.) in Africa.

3.2.2.2. Mixed farms with camels, cattle, sheep, and goats; wheat and clover; in medium rainfall areas or in low rainfall, irrigated areas; predominantly in the Near East. Camels are used for draft as well as for milk and meat in this system. Chickens are also included and pigs only in non-Moslem areas (such as Lebanon).

3.2.2.3. Mixed farms with cattle, sheep, goats, pigs, and chickens; in areas with enough rainfall (medium to high) to support a highly diverse mixture of ruminants and non-ruminants and different crops; major in all areas except the Middle East. Maize and/or wheat are dominant crops in this system. In

Africa and Latin America, maize is the dominant crop, but in South Asia (for example, India and Pakistan) wheat is dominant.

3.2.2.4. **Mixed farms with buffalo and cattle; rice or roots and tubers;** in high rainfall areas--predominantly in Asia (more than 50 percent of the agricultural population and ruminant animal units in Asia are associated with the system) and in both Africa and Latin America. Pigs and chickens are often included; small ruminants are sometimes important. Large ruminants often used for draft.

3.2.3. Crop-based Farms

This system could be subdivided into many different subtypes. The animals tend to be used for draft power, manure production, and holding of assets. In Africa, Asia, and Latin America, the system includes few ruminants. However, in the Near East (primarily Egypt) 24 per cent of the ruminant animal units and 1 percent of the grazing land are found in this category, indicating the importance of crop-residue as a feed source.

These basic subtypes of crop-based farms with which small ruminants may be associated include:

3.2.3.1. **Large scale plantation crops** (coconuts, sisal, etc.) in which small ruminants harvest weeds and clear undesirable plants growing among plantation crops.

3.2.3.2. **Specialized cash crop commercial farms** and associated agroindustry (e.g., canning plants) which yield substantial amounts of crop residues and processing by-products fed to livestock.

3.2.3.3. **Small scale farms primarily producing food crops** for family use in which livestock (often a backyard enterprise) are a source of small amounts of family food (e.g., milk, eggs) and/or income. This subtype differs from the previously described mixed farms primarily in the distinctly minor role of livestock in the system.

3.3. Small Ruminants in Mixed Farming Systems

Attention to improving the role of livestock, including small ruminants, in developing region farming systems has increased in recent years (McDowell and Hildebrand 1980, Fitzhugh et al., 1982). In many developing countries where mixed farming is important, a significant proportion--often the majority--of small ruminants are found on small farms (table 3.3.1.). Generally, the proportion of national populations found in small farms is greater for goats than for sheep, perhaps because wooled sheep are more often found in relatively large pastoral flocks.

Table 3.3.1. Proportion of National Populations of Sheep and Goats Found on Small Farms (<5 ha), %

Developed	Goats	Sheep
North America		
Canada	-	2
United States	1	1
West Europe		
Austria	64	6
Belgium	64	52
Finland	-	18
Italy	35	22
Luxembourg	-	41
Malta	85	83
Netherlands	22	8
Norway	48	44
Portugal	50	-
Spain	35	23
Sweden	-	14
Switzerland	57	50
United Kingdom	-	2
West Germany	-	18
East Europe		
Czechoslovakia	98	32
Hungary	39	5
Poland	-	26
Yugoslavia	74	45
Oceania		
Australia	-	-

Developing	Goats	Sheep
Middle America-Tropical		
El Salvador	67	20
Jamaica	82	61
Mexico	62	51
St. Lucia	71	73
Virgin Islands	30	8
South America-Tropical		
Brazil	26	4
Ecuador	53	64
Peru	74	53
Suriname	68	56
Venezuela	56	46
Venezuela	56	46
South American-Temperate		
Uruguay	-	0.1
North Africa, Mid East		
Algeria	53	44
Bahrain	33	43
Iraq	38	28
Pakistan	67	59
Saudi Arabia	74	60
Central & Southern Africa		
Lesotho	87	81
Reunion	94	-
Sierra Leone	96	83
Swaziland	80	73
South & Southeast Asia		
Guam	47	-
Korea	97	72
Pacific Islands	42	-
Sri Lanka	91	71

Source: 1970 World Census of Agriculture, FAO, 1973.

The role of small ruminants is generally as a minor, but complementary, component of small farm systems. Complementary interactions between small ruminants and other cropping activities include (Hart et al., 1982):

- o Adding value to crop residue by conversion to preferred animal products.
- o Production of manure used to fertilize crop areas.
- o Adding value to forage crops planted in rotation with food crops primarily to increase soil fertility and control plant disease.

While these complementary interactions also exist for other ruminants in mixed systems, the small size of sheep and goats often better fits the limited resource base of small farms.

Small farm systems in Asia, Africa, and Latin America involving animals were identified by participants in the Bellagio Conference, "Integrated Crop and Animal Production: Making the Most of Resources Available to Small Farms in Developing Countries," (McDowell and Hildebrand 1980). A listing of those small farm systems in which sheep and/or goats play a significant role is given in table 3.3.2.

Information presented on these systems was necessarily cryptic. However, it does appear that sheep and goats are often present and make significant contributions to small farm systems in developing countries. Of the ten major farming systems in Asia involving substantive crop and animal components, seven included small ruminants; of the ten systems identified in Africa, eight included small ruminants. In Latin America-Caribbean, four major systems involving crop and animal components were identified. Three of these involved medium to large (primarily commercial) farms on which cattle and, sometimes, swine were the major animals. But in the remaining type system (primarily small limited resource farms) small ruminants were identified as important animal components.

Because classifications for the three geographical zones were done by three separate panels, some differences in approach and perspective resulted. For example, the Asia and Africa group limited their consideration to small farms, whereas the Latin America group considered both large and small scale farming systems. It is interesting and perhaps significant that sheep and goats were listed for the majority of farming systems in Asia and Africa (all small, limited resource types) but only for the small, limited resource systems in Latin American farming systems. Once again, it appears that sheep and goats in developing regions are primarily in the hands of the poor agriculturists.

Table 3.3.2. Developing Regions Small Farm Systems in Which Small Ruminants are Important

Farming system	Major crops	Major animals	Locations	Feed sources
Asia				
Coastal fishing and farming complexes, livestock relatively important	Coconuts, cassava, cacao, rice	Cattle and goats	Sri Lanka Philippines Malaysia Indonesia	Pastured with coconuts
Highland vegetables and mixed cropping (intensive), livestock important	Vegetables, rice, sugarcane, sweet potatoes, Irish potatoes	Sheep, goats	Indonesia	Crop residues, rice bran, cut forage, sugarcane tops
Upland crops of semiarid tropics, livestock important	Maize, cassava, sorghum, kenaf, wheat, millet, pulses, oilseeds, peanuts, etc.	Cattle, buffalo, goats, sheep, poultry, swine	India Thailand	Bran, oilseed cake, straw, stovers, vines, hulls, hay
Multistory (perennial mixtures), livestock some importance	Coconuts, cassava, bananas, mangoes, coffee	Cattle, goats, sheep	Philippines India	Cut and carry feeds from croplands
Tree crops (mixed orchard and rubber), livestock some importance	Orchard, trees, rubber, oil palm	Cattle, goats, swine	Philippines Malaysia Thailand	Grazing or cut and carry
Swidden, livestock important	Maize, rice, beans, peanuts, vegetables	Swine, poultry, goats, sheep	All	Animals scavenge
Animal-based	Fodder crops	Cattle, buffalo, goats, sheep	Indonesia Malaysia India	Cut and carry fodder, crop residue
Africa				
Pastoral herding animals very important	Vegetables (compound)+	Cattle, goats, sheep	Savanna (Southern Guinea)	Natural rangelands, tree forage
	Millet, vegetables	Cattle, goats, sheep	Savanna (Northern Guinea and Sahel)	Natural rangelands, tree forage, crop residues

Table 3.3.2. (con't)

Farming system	Major crops	Major animals	Locations	Feed sources
Africa (con't)				
Bush fallow shifting cultivation, animals not very important	Rice/Yams/Plantains maize, cassava, vegetables, tree crops, soybeans, yams	Goats, sheep	Humid tropics	Fallow, crop residues
	Sorghum/Millet maize, sesame, soybeans, cassava, sugarcane, tree crops, cowpeas, vegetables, yams	Cattle, goats, sheep, poultry, horses	Transition forest/ savanna Southern Guinea, Northern Guinea & Sahel	Fallow, straws, stover, vines, cull roots, sesame cake
Rudimentary sedentary agriculture, shifting cultivation, animals important	Rice/Yams/Plantains maize, cassava, vegetables, tree crops, cocoyams	Goats, sheep, poultry, swine	Humid tropics	Rice bran, cull roots, straws, crop residues, vines, stover
	Sorghum/Millet maize, sesame, cotton, sugarcane, tree crops, cowpeas, yams, tobacco, groundnuts, vegetables	Cattle, goats, sheep, poultry	Transition forest/ savanna Savanna (Guinea & Sahel)	Stover, vines, sugarcane tops, cull roots, or tubers, tree forage, groundnut cake, brans
Compound farming and intensive subsistence agriculture, shifting cultivation, animals important	Rice/Yams/Plantains maize, cassava, vegetables, tree crops, cocoyams, yams	Goats, sheep, swine, poultry	Humid tropics	Rice straw, rice bran, vegetable waste, fallow, vines, cull tubers or roots, stover, tree-crop by-products, palm oil cake
	Vegetables sugarcane, tobacco, sesame, maize, tree crops, groundnuts	Goats, sheep, poultry, swine	Transition forest/ savanna	Vines, stover, tree-crop by-products, groundnut cake
Highland agriculture, animals important	Rice/Yams/Plantains maize, cassava, vegetables, plantain, cocoyams	Goats, sheep, poultry, swine	Humid tropics	Fallow, leaves, stover, rice by-products, cull tubers, cassava leaves, vegetable residues

Table 3.3.2. (con't)

Farming system	Major crops	Major animals	Locations	Feed sources
Africa (con't)				
	Sorghum soybeans, cowpeas, cassava, maize, millet, groundnuts	Cattle, goats, sheep, poultry	Transition forest/ savanna	Stover, vines, groundnut cake
	Millet/Sorghum maize, groundnuts, cowpeas, sesame, tobacco, cotton, vegetables, cassava, yams	Cattle, goats, sheep, poultry, horses, donkeys	Savanna (Guinea & Sahel)	Crop residues, some oil cake, brans, stover, vines, cull tubers
Flood land and valley bottom agriculture, animals of some importance	Rice/Yams/Plantains maize, vegetables, sugarcane, rice, yams, cocoyams, millet, groundnuts	Goats, poultry	Humid tropics	Crop residues, vines, grazing
	Rice vegetables, maize, millet, groundnuts, plantain, sugarcane, cocoyams	Cattle, goats, sheep, poultry, swine, horses, donkeys	Transition forest/ savanna	Straw, stover, molasses, brans, groundnut cake
	Yams/Sugarcane maize, cowpeas, cocoyams, groundnuts, vegetables, plantains, rice, yams	Cattle, goats, sheep, poultry, swine, horses, donkeys	Savanna (Guinea & Sahel)	Vines, brans, cull tubers, molasses, sugarcane tops
Mixed farming, farm size variable, animals important	Sorghum/Millet groundnuts, cotton, tobacco, maize, cowpeas, vegetables	Cattle, goats, sheep, poultry, horses, donkeys, camels	Savanna (Guinea & Sahel)	Stover, vines, fallow
Plantation crops, compound farms, etc., animals of some importance	Cacao vegetables, maize, plantains	Goats, sheep, poultry, swine	Humid tropics	Grazing or cut and carry, stover
	Tree crops sugarcane, plantains	Goats, sheep, poultry, swine	Transition forest/ savanna	Grazing or cut and carry, sugarcane tops

Table 3.3.2. (con't)

Farming system	Major crops	Major animals	Locations	Feed sources
Latin America - Caribbean				
Mixed cropping Small size in settled areas Medium size in frontier areas Subsistence or monetized economy Livestock relatively important	Rice, maize, sorghum, beans, wheat, cacao, plantains, coffee, tobacco	Cattle, poultry, goats, sheep, donkeys, horses, mules, swine	All	Natural pastures, crop residues, cut feed

Source: McDowell and Hildebrand (1980).

4. SHEEP AND GOATS

The practically universal distribution of sheep and goats attests to their abilities to adapt to a wide range of conditions. As ruminants they share the advantage of efficiently utilizing fibrous feeds; however, it is their special characteristics which have established their important role in supplying highly desired food and fiber.

4.1. Characteristics - Advantages and Disadvantages

4.1.1. Small size. Sheep and goats are small, ranging in mature weight from 15 to 75 kg. This small size is directly associated with other important traits such as earliness of maturing, quantity of product (meat, milk, fleece), and nutrient requirements for maintenance. These size related characteristics can be advantageous in some circumstances and disadvantageous in others.

Earliness of sexual maturity leads to shorter generation intervals, and thus increases potential response to selection over fixed time. Sheep and goats reach market weight and condition and start lactating often within their birth year and certainly months, if not years, younger than cattle and buffalo.

Lower per head nutrient requirements mean that sheep and goats may fit the limited resources of small farms or marginal grazing lands which cannot sustain larger ruminants throughout the production cycle.

Lower capital costs per head and potentially more rapid cash flow make sheep and goats less risky investments and more likely to be affordable by poor producers. Consequently, the economic impact of losses is less for sheep and goats than for cattle.

Small size is associated with small yields of meat per head slaughtered and milk per lactating female. These small quantities are often well suited to the daily needs of subsistence familes with limited ability to preserve surplus food products.

Small size generally makes sheep and goats easier to handle, especially by women and children. Housing and pens require simpler, less robust construction, dipping in barrels rather than vats is possible.

On the negative side, small animals are more susceptible to predators, including theft. Small per head product yields are a disadvantage under commercial conditions, especially when labor costs are relatively high. For example, breakeven prices for goat's milk are approximately double that for cow's milk in the U.S., primarily because of low yield per labor input (Yazman 1979).

4.1.2. Reproductive efficiency. Short gestation intervals (150 days) and lactation periods (60 days when suckling only) combined with the general lack of photoperiod anestrus in tropical latitudes make two parturitions per year biologically feasible, although management for three parturitions in two years is a more practical goal (Valencia and Gon-

zalez Padilla 1983). These 8 to 9 month parturition intervals often better fit the seasonal rainfall patterns in many regions than the 14 to 16 month (or greater) parturition intervals of cattle and buffalo. Thus, females may conceive in one period of good feed and lactate in the next.

A number of highly prolific sheep breeds have been described in recent publications (Mason 1980; Fitzhugh and Bradford 1983). These include:

Developed regions: Europe--Finnish Landrace, Romanov, Chios; USSR--Svanka; Oceania--Booroola Merino
Developing regions: Caribbean--Barbados Blackbelly, Virgin Island White; North Africa-Mid East--D'Man, Omani; China--Huyang, Hanyang; Southeast Asia--Priangan.

Prolific breeds generally produce twins and triplets and quadruplets are not uncommon. Prolific breeds of goats have not been highlighted; however, in general goats are more prolific than most sheep (Gall 1981).

The advantages of multiple births to increased meat offtake and increased selection potential are realized only if the neonates live and their mothers produce sufficient milk to raise them to weaning. Under limited feed conditions, multiple births can actually be a disadvantage reducing productivity by stressing the breeding female and reducing her productive lifetime.

The reproductive efficiency of sheep and goats favorably impacts on the ability to rapidly build herd numbers in response to favorable prices or feed surpluses (Dahl and Hjort 1976). Jahnke (1982) gives estimates of herd growth rates in Africa following the Sahelian drought of the early 1970s in table 4.1.2.1.

Table 4.1.2.1. Growth Rates of Animal Numbers in Tropical Africa (% per annum)

	1969-71/1979	1974/79	1978/79
Camels	0.8	5.4	1.4
Cattle	1.2	2.8	2.1
Sheep	1.6	4.9	1.4
Goats	1.2	4.3	1.6

Source: Jahnke (1982).

The recovery and restocking period of 1974-1979 clearly indicates the rapid growth potential of sheep and goat herds relative to cattle herds; whereas the 1978/79 period represents more normal long-term herd growth rates.

4.1.3. **Feeding behavior.** Sheep and goat are more selective feeders than cattle, tending to select the better quality portions of plants. Mouth size and shape facilitate this selectivity. While both cattle and sheep are grazers, goats are browsers and utilize a broader range of plant species than either sheep or cattle (Demment and Van Soest 1982). The preferred browsing strategy of goats is especially advantageous under dry range conditions in which the surviving vegetation tends to be on deep rooted shrubs and bushes.

Sheep and goats are complementary in their feeding strategies to each other and to cattle in mixed herds of ruminants. They therefore contribute a flexibility which is of time-honored value to the pastoralists of the world. They include sheep and goats in their herds as a hedge against disease or disaster, as a tool to trade, a reserve of ready cash, an easily expandable bank account and as a source of readily obtained food and fiber.

Sheep and, especially, goats are more agile and thus are able to feed over much rougher terrain than cattle. This agility combined with an ability to travel further without water can greatly increase their feeding range.

Examples of land degradation blamed on sheep and goats are invariably attributable to negligence and mismanagement on the part of man. Sheep and goats, contrary to many misconceptions, are capable of stabilizing or regenerating land subject to erosion. In Indonesia sheep are grazed on pasture sown to stabilize steep slopes that had been denuded of forest and cropped to their summit. The offtake from such projects has been greater than from cropping. Likewise goats have been used to control brush and rehabilitate rangelands overtaken by noxious shrubs (Ewing 1976). Trypanosomiasis resistant goats have been used to clear the low bush which is a favored habitat of the tsetse fly in Africa.

4.1.4. **Feed utilization efficiency.** A combination of physical and physiological factors interact to determine efficiency of feed utilization. Factors listed by Van Soest (1982) include type of diet selected, time spent feeding, feeding behavior, rate and extent of rumination, anatomy of reticulo-rumen, capacity of rumen relative to body size, and digestive ability (especially fiber). Claims made in favor of the comparative efficiency of one class of ruminants must be evaluated in terms of the type of diet offered, maturity of experimental animals and other conditions (McDowell and Woodward 1982). Van Soest (1982) generalized that larger ruminants tend to better digest high fiber diets than smaller ruminants, especially browsers. An experimental comparison (Huston 1978) on high fiber, low quality diets ranked cattle, sheep, goats, and deer in decreasing order of digestive ability. On the other hand, the practical ability of goats to thrive on poor quality bushy rangelands is well documented (McCammon Feldman et al., 1982). Also, goats have relatively greater rumen capacity compared to body size. Although experimental evidence documenting differences among species in efficiency are limited, it does seem clear that comparative advantage will vary with specific production conditions (McDowell and Woodward 1982).

Since ruminants are relatively independent of dietary protein quality (although not of dietary nitrogen intake) the primary nutritional constraint is metabolisable energy. Efficiency of protein production can therefore be most usefully estimated on the basis of dietary intake of metabolisable energy. Calculations have been made for both the developed and developing countries (Fitzhugh 1981). The results in table 4.1.4.1 illustrate two important points:

- Milk protein production is a more efficient biological process compared to meat production.

- Higher yielding animals (in developed regions), while requiring more feed, are also more efficient.

While developed country farmers enjoy the benefits of relatively abundant high quality feeds from either the primary or by-products of crop production most of the small producers in the developing world do not share this abundance. In the dryer areas, they are constrained by the highly variable productivity of rangelands along with increasing inroads from cropping. In the higher rainfall, more intensive agricultural areas, they are often unable to effectively utilize crop by-products.

4.1.5. Fitness. As in the case of reproductive traits discussed earlier, the fitness advantages conferred by specific characteristics largely depend on the production environment. For example, the browsing behavior of goats reduces their exposure to endoparasites but, when heavily stocked on grass, goats seem more prone to heavy infestation than cattle.

With respect to specific diseases, sheep and goats appear to be less susceptible to foot and mouth disease and trypanosomiasis than cattle (ILCA 1979a). However, they are subject to serious losses from internal parasites and such diseases as mycoplasmosis, bluetongue, pasteurellosis, peste des petits ruminants (PPR), and scrapie. Diseases which appear to affect goats more than sheep include caprine arthritis encephalitis (CAE), brucellosis (B. melitensis), and caseous lymphadenitis (Thedford 1983a,b).

A special problem with respect to health problems of sheep and goats is that their relatively low value per head is a disincentive to producer expenditures on prevention and treatment. Similarly, public and private investments in study of diseases and development of therapeutics for small ruminants has lagged behind that for cattle.

Adaptive characteristics of sheep and goats, especially compared to cattle, include their coat type consisting of coarse hair over an undercoat of finer fibers. In cold regions (or where night

temperatures are substantially lower than daytime temperature), this coat type provides good insulation. In the hotter, and especially humid, regions, the undercoat has been lost.

Rate of water turnover measured for animals grazing under same conditions suggests that goats are second only to camels in this important adaptation to arid range environments (table 4.1.5.1).

Table 4.1.4.1. Comparison of Efficiency of Food Protein Production From Sheep and Goats in Developed and Developing Regions

	Developed regions	Developing regions	World
Sheep			
Feed energy, Mcal[a]	710	602	655
Protein, g[b]	929	700	818
Meat	(627)	(347)	(491)
Milk	(302)	(353)	(327)
Efficiency, g/Mcal[c]	1.31	1.16	1.25
Goats			
Feed energy, Mcal[a]	645	455	465
Protein, g[b]	3282	695	808
Meat	(485)	(322)	(325)
Milk	(2797)	(373)	(483)
Efficiency, g/Mcal[c]	5.09	1.53	1.74

[a] Annual average per head requirements of metabolizable energy (Fitzhugh et al., 1978).
[b] Annual net protein value of meat and milk yield per head for sheep and goat populations in 1972 (FAO 1978); estimated as 89 g/kg sheep and goat carcass weight, 48 g/kg sheep milk, 28 g/kg goat milk.
[c] Protein/feed energy.
Source: Fitzhugh (1981).

Table 4.1.5.1. Daily Water Turnover Among Animals Grazing Together, $(_{ml}{}^{-.82})$

Species	Spring	Fall
Goats	230	167
Sheep	554	271
Donkeys	245	205
Cattle	591	362
Camel	143	114

Source: MacFarlane (1982).

4.1.6. **Socioeconomic.** Sheep and goat meat are free from religious taboos such as those against consumption of beef by Hindus and pork by Moslems.

Small ruminants serve important functions related to the accumulation and exchange of capital assets. In remote areas, livestock or livestock products are often easier to transport long distances over rough terrain than are crop products. The product (wool, meat, mohair, cashmere) can be transported on the animal until the herd/flocks are driven to the point of collection.

In arid areas of the west African Sahel, cattle and goats are often raised in mixed herds. Goats survive drought better than cattle. After years in which cattle numbers have been reduced due to severe drought, herders use goats to rebuild their capital stock--eventually converting goats to cattle (Josserand and Ariza-Nino 1982, Jahnke 1982). Small ruminants are widely used by small farmers to build and store wealth until cash is needed to meet an emergency (Dahl and Hjort 1976). References to small ruminants as a "living bank" are often used to describe this function (Sabrani and Knipscheer 1982, Singh 1982). The cash value of small ruminants is often more appropriate to the immediate cash requirement (e.g., school fees) than the more valuable cattle.

4.2. Genetic Resources

Goats and sheep are thought to have been the first ruminants domesticated, probably in southwestern Asia before 7500 B.C. Goats belong to the genus, Capra; sheep to the genus, Ovis; both within the tribe Caprini of the family Bovidae. Over the milennia, sheep and goats have been carried by man throughout the world (Terrill 1979). Both natural and artificial selection have yielded breeds and types which vary greatly in appearance and performance. This considerable heterogeneity provides a useful pool of genetic resources to be tapped to meet production requirements under the widely varying environmental, managerial, and market conditions in developing regions.

Definite opportunities exist for mixing and matching these genotypic resources to fit production conditions and product demand. Short generation intervals, often less than 24 months, and frequent multiple births combine to favor rapid genetic progress through selection. Heterogeneity among breed types resulting from generations of genetic isolation of these breeds suggests substantial hybrid vigor may result from crossbreeding and in new "synthetics" established from multibreed combinations.

4.2.1. Breed Types

Mason (1969) identified the major breeds and types of sheep and goats and classified these according to purpose (meat, milk, fiber, pelts) and in the case of sheep other characteristics such as coat and tail types. These breed types are listed alphabetically in Appendix tables 1 and 2 and summarized by region, purpose and type in tables 4.2.1.1, 4.2.1.2, and 4.2.1.3.

The majority of the major goat breeds originated or are principally found in developing regions. Of the 75 breeds listed, 22 originated in North Africa-Mid East, 10 in India, and 24 in Europe. Forty-three of the goat breeds are kept primarily for milk production and another 10 are milked as a secondary purpose. Eleven are kept primarily for fiber production with another 8 producing fiber as a secondary purpose. Twenty-one breeds were classified as primarily meat production; these include the large populations of native meat types such as the

Table 4.2.1.1. Summary of Goat Breeds and Types by Region and Principal Purpose[a]

Region	Meat	Milk	Fleece	Total
North America	-	-	-	-
Middle America-Tropical	1	-	-	1
South America-Tropical	-	-	-	-
South America-Temperate	-	-	-	-
West Europe	1	23	-	24
East Europe	-	1	-	1
USSR	-	3	3	6
North Africa-Mid East	6	11	5	22
Central & Southern Africa	6	1	-	7
India	2	5	3	10
China, Mongolia	1	-	-	1
South & Southeast Asia	2	-	-	2
Oceania	-	-	-	-
Total	19	44	11	74

[a] Summarized from Appendix Table 1.

Table 4.2.1.2. Summary of Sheep Breeds and Types by Region and Principal Purpose[a]

Region	Meat	Milk	Wool	Pelt	Total
North America	1	-	7	-	8
Middle America-Tropical	2	-	-	-	2
South America-Tropical	2	-	-	-	2
South America-Temperate	-	-	1	-	1
West Europe	52	25	57	-	134
East Europe	13	15	15	-	43
USSR	30	-	24	6	60
North Africa-Mid East	19	5	22	-	46
Central & Southern Africa	10	-	2	-	12
India	2	-	10	-	13
China, Mongolia	1	-	6	1	8
South & Southeast Asia	1	-	-	-	1
Oceania	-	-	4	-	4
Total	133	45	148	7	333

[a] Summarized from Appendix Table 2.

Table 4.2.1.3. Number of Sheep Breeds Classified by Coat, Tail Type and Region

	Coat Type						Tail Type							
Region	H	FW	MW	CW	Fur	Total	ST	MT	LT	FR	LFT	SFT	FT	Total
1	-	2	4	2	-	8	-	7	-	-	-	-	1	8
2	2	-	-	-	-	2	-	2	-	-	-	-	-	2
3	2	-	-	-	-	2	-	2	-	-	-	-	-	2
4	-	1	-	-	-	1	-	1	-	-	-	-	-	1
5	1	9	79	45	-	134	7	122	2	-	2	1	-	134
6	-	5	7	31	-	43	2	36	5	-	-	-	-	43
7	-	16	14	26	4	60	2	27	7	8	4	3	9	60
8	3	-	3	40	-	46	5	14	3	1	2	4	17	46
9	10	1	-	1	-	12	-	6	1	2	1	1	1	12
10	2	-	-	10	-	12	5	6	-	-	-	-	1	12
11	-	1	1	6	-	8	2	1	-	-	-	2	3	8
12	-	-	-	1	-	1	1	-	-	-	-	-	-	1
13	-	1	3	-	-	4	-	4	-	-	-	-	-	4
Total	20	36	111	162	4	333	24	228	18	11	9	11	32	333

Coat Type: H - hair; FW - fine wool; MW - medium wool; CW - coarse wool.

Tail Type: ST - short-tailed; MT - medium length, think tail; LT - thin tail; FR - fat-rumped; LFT - long fat tail; SFT - short fat tail; FT - fat-tailed.

Summarized from Appendix Table 2.

Criollo (Spanish) of Latin America, the West African Dwarf, the Small East African, the Indian Bengal, the Southeast Asian Katjang, and the Chinese Ma.

In contrast, the majority (248) of the 333 sheep breeds and types originated in developed regions, primarily Europe. Most of these were developed for wool or for wool and mutton production; although some breeds such as the Chios, Lacaune, and East Fresian are primarily dairy types. This listing from Mason (1969) does include some of the major African hair sheep including the fat-rumped Somali (and the similar Blackhead Persian), the Masai, and the West African Dwarf (more generally known as the Forest or Djallonke). Although less numerous, breeds of hair sheep in the Western Hemisphere, such as the Barbados Blackbelly, Virgin Island White, Pelibuey (or Pelo do Boi in Brazil) and West African, are well adapted to subhumid tropical conditions (Fitzhugh and Bradford 1983).

4.2.2. Genetic Improvement Strategies

Strategies to improve productivity and efficiency of sheep and goats should be developed in terms of the production environment and projected market requirements (consumer preferences as well as quantity). Available tools include the traditional selection and mating plans and the new technologies including artificial insemination and embryo transfer.

Decisions must be made in regard to the relative technical and economic feasibility of changing the genotype vs changing the environment. For example, disease may be an overriding constraint. Which will be best: developing preventatives and/or treatments or genetic improvement of resistance? The decision will be influenced by current availability of technology, projected cost (and probability) of developing new technologies, feasibility of delivering technology to production areas, and levels of genetic variation in resistance among available animal resources.

A first step in any genetic improvement program is characterization of animal populations for the multiple traits which cumulatively determine productivity and efficiency (table 4.2.2.1). These traits are expressed by individual animals, but it is the herd, not the individual, which is the economic unit of concern.

Assessment of herd productivity and efficiency are facilitated by the development of indexes (ILCA 1979a, Fitzhugh and Bradford 1983). An example of the use of indexes to compare the productivity of breeds is given in table 4.2.2.2. The Flock Productivity Index (FPI) was calculated as

$$FPI = (\text{litter size} \times \text{lamb survival} \times \text{birth weight})/\text{lambing interval}$$

and the Efficiency Index (FEI) as

$$FEI = FPI/(\text{adult ewe wt})^{.75}.$$

Table 4.2.2.1. Important Traits for Sheep and Goat Production in Developing Countries

Category	Traits
Fitness	Adaptations to environmental stress - coat type, resistance to disease and parasites, neonatal survival, longevity, temperament Adaptability to environmental change
Fertility	Prolificacy - ovulation rate, fertilization rate, embryo survival Parturition interval - postpartum interval to conception (postpartum anestrus, conception rate), gestation period Weaning rate - maternal behavior, milk production, vigor of young Age at sexual maturity Male traits - libido, semen quality
Size and Efficiency	Growth and maturing rates Body weight Birth weight - neonatal survival Slaughter weight - meat yield Mature weight - maintenance requirements Body composition - edible tissue Voluntary feed intake Composition of diet Efficiency of nutrient utilization for maintenance and production
Lactation	Days of lactation Amount and persistency of daily yield Composition of milk
Fiber	Weight and yield of fleece Fineness and uniformity of fiber diameter Strength of fiber

Birthweight of singles was used as a proxy for slaughter weight, which was not known for these data. The Barbados Blackbelly ranked highest because the larger litter size did not depress lamb survival or lengthen lambing interval; however, the relative advantage for efficiency was reduced by the heavier weight (and higher maintenance requirements) of the Blackbelly ewes.

Table 4.2.2.2. Averages for Production Traits and Indices for Hair Sheep Breeds

Trait	Pelibuey	Virgin Islands	Barbados Blackbelly	Blackhead Persian	West African Forest
Litter size, no. lambs	1.24	1.61	1.84	1.08	1.22
Lambing interval, days	245	248[a]	248	248[a]	284
Lamb survival	0.79	0.78[a]	0.78	0.65	0.72
Birth weight, kg	2.5	2.7	2.7	2.4	1.7
Ewe weight, kg	34	35	40	27	27
$W^{.75}$	14.1	14.4	15.9	11.8	11.8
Flock Productivity Index	10.0	13.6	15.6	6.8	5.3
Flock Efficiency Index	0.71	0.95	0.98	0.58	0.45

[a] Average for Barbados Blackbelly substituted for unknown value.
Source: Fitzhugh and Bradford (1983).

Weighting of traits in index by genetic statistics (heritability, genetic calculations) and relative economic values yield a selection index.

This characterization step is especially critical to formulating strategies for improving populations in developing countries. Relatively little is known about these populations. Is their small size and poor performance relative to "improved" breeds in temperate regions due to genetic inferiority or, perhaps, these characteristics reflect the consequences of favorable adaptation to disease, climatic stress, and seasonal shortages of feed. Only through simultaneous comparison of improved and native types under the prevailing production environment can these important questions be adequately answered.

When genetic resources have been adequately characterized and production objectives have been carefully formulated, appropriate strategies can be implemented. Generally, selection for the measurable traits affecting productivity will be done in conjunction with the chosen mating plan. Options include:

Straightbreeding. An established interbreeding population such as a breed or local type (e.g., Barbados Blackbelly sheep, West African Dwarf goats) is maintained to preserve and (through selection) improve favorable characteristics of the population such as prolificacy or disease resistance.

Crossbreeding. Two or more established genetic populations are intermated to gain advantage of hybrid vigor and to combine complementary traits (e.g., milk yield of dairy breeds with fitness of native stock). Rotating breeds each generation can maintain all or most of the hybrid vigor of the original first cross.

Grading. An improved breed can be introduced into a region by breeding of the improved purebred (usually males) to the native type and to the successive generations of topcrossed stock. A continual source of purebred males (or semen) is required for the 4 to 5 generations needed to make the graded-up population essentially the same as the introduced breed. Favorable characteristics of the original native stock may be retained by directed selection during the grading process.

New Breed Development. Two or more breeds are used to synthesize a new breed combining all or most of the favorable characteristics of the original breeds or types and often retaining a substantial portion of the hybrid vigor resulting in the original cross. These synthetics have proven especially valuable as a means of incorporating improved productivity with fitness. Examples include Dorper sheep and the Boer goat. Synthetics are often most useful in situations where more complex schemes of rotational crossbreeding are not practical or where one or more of the original breeds cannot be maintained because of susceptibility to disease.

Introduction of Improved Breeds. During the colonial period, numerous European breeds were introduced to developing regions. Generally, these were breeds noted for high levels of productivity under temperate conditions. Except in environments such as the East African highlands and the Latin American altiplano, these "improved" breeds often failed to perform as well as the local breeds under tropical conditions. Their impact has largely been in crossbreeding and development of breeds such as the Dorper.

The relatively poor success of breed introduction should not, however, discourage efforts to transfer productive genotypes to new environments. Rather a different strategy should be followed. Instead of transferring temperate breeds to the tropics, the emphasis should be placed on transfer of superior genotypes which have evolved under developing country conditions. Examples of highly productive, tropically adapted breeds include prolific hair sheep available in the Caribbean and dairy goat breeds from India.

Principal obstacles to these transfers include lack of well characterized stocks from which to select animals to be transferred and the potential for spreading diseases. These obstacles could be overcome by establishment of evaluation/multiplication centers on disease controlled stations--either in the country of origin or perhaps on tropical islands which do not have significant livestock populations at risk from disease introduction. The rapidly developing technology of embryo transfer offers additional potential for the safe introduction of exotic genotypes.

This international approach would likely require the support of an international institution to be successful. The costs of introducing breeds from temperate regions are often part of an "aid" package from the developed country to the developing country; part of the incentive is that livestock producers in the developed country benefit from sales of breeding stock. This incentive would not be present if stocks are transferred from developing country to developing country. Investment in animal evaluation and station establishment would, therefore, likely have to be made by a multilaterally supported international agency, such as the World Bank.

4.3. Population, Products and Productivity

4.3.1. Population

Population and growth statistics for sheep and goats are summarized for the periods of 1961-65 to 1980 by regions in table 4.3.1.1. Classification of regions according to degree of development (or industrialization) is a convenience and the considerable variation between and within countries and regions in degree of development is well recognized.

The majority of the world's small ruminants are found in developing regions--56% of the sheep and 96% of the goats. During the past decade (1970-1980), the world population of sheep increased 3% and all of this increase was in the developing regions. Similarly, the 14% increase in world population of goats has been in the developing regions. In fact, numbers of sheep and goats in the developed regions have actually declined during the past decade.

Reasons for the continuing growth of small ruminants populations in developing but not developed regions can only be speculated upon. However, it seems likely that these reasons are based on the relative advantages/disadvantages of small ruminants discussed in another section. Suffice it at this point to take note of these growth trends in developing countries and thus their potential relevance to World Bank Projects.

Indicators of the relative importance of sheep and goats are presented in table 4.3.1.2. Numbers per 100 ha of land area are fairly low; this is probably a reflection of the fact that small ruminants, especially goats, tend to be found on poor quality range and pasture lands which cannot support heavy stocking rates. Numbers per 100 people are higher for sheep in developed than in developing countries because of the overwhelmingly influence of Australia and New Zealand. In the case of goats, however, the much greater relative numbers per human are in the developing regions reflecting the importance of this species in the developing countries.

4.3.2. Products

Sheep and goats are truly multiple purpose animals. Some breeds have been developed as specialized producers of milk or fiber, but all contribute to meat supply.

World production data for sheep and goats were weighted by Shelton (1976) according to market values of their various products. Relative values are shown in table 4.3.2.1 on a world basis.

Table 4.3.1.1. Changes in Regional Cattle, Sheep, and Goat Populations From 1961-65 to 1980[a] [b]

Region	Cattle					Sheep					Goats				
	1961-65	% change	1969-71	% change	1980	1961-65	% change	1969-71	% change	1980	1961-65	% change	1969-71	% change	1980
Developed Regions															
North America	115,157	8	123,999	-0	123,595	29,990	-29	21,168	-38	13,185	3,770	-29	2,661	-46	1,426
Western Europe	84,798	5	88,803	7	95,007	91,137	-7	84,435	6	89,258	10,878	-11	9,715	-0	9,673
Eastern Europe	32,543	5	34,132	14	39,068	42,836	-0	42,760	5	44,868	3,559	-25	2,658	-35	1,736
USSR	83,493	16	96,707	19	115,100	133,867	2	136,434	5	143,599	6,422	-17	5,355	9	5,824
Oceania	25,003	24	31,116	11	34,580	211,460	12	236,959	-14	204,757	33	97	65	260	234
Total	340,994	10	374,757	9	407,350	509,290	2	521,756	-5	495,667	24,662	-17	20,454	-8	18,893
Developing Regions															
Middle America	36,627	18	43,071	23	52,866	7,138	38	9,851	-11	8,779	11,354	-0	11,331	-17	9,432
South America - Tropical	94,766	24	117,601	21	141,954	44,210	3	45,730	4	47,469	20,496	-41	12,123	28	15,477
South America - Temperate	54,587	11	60,505	16	70,385	77,002	-10	69,488	-15	58,761	6,058	3	6,237	-42	3,612
North Africa - Mid East	49,287	24	61,217	20	73,577	144,545	20	173,902	24	215,463	79,058	10	87,150	24	108,423
Central and Southern Africa	117,479	11	130,527	10	143,696	109,057	8	118,320	6	125,140	93,712	20	112,184	8	121,286
India	175,726	1	177,447	3	182,500	40,936	-1	40,657	2	41,300	62,334	7	66,529	8	71,650
China & Mongolia	63,085	-5	59,700	-8	54,968	76,637	24	94,665	24	116,968	58,655	12	65,968	30	85,477
South & S.E. Asia	55,706	15	63,789	17	74,513	7,048	-8	6,500	29	8,417	21,170	1	21,363	21	25,815
Total	647,263	10	713,857	11	794,459	506,573	10	559,113	11	622,297	352,837	9	382,885	15	441,172
World	988,257	10	1,088,613	10	1,201,810	1,015,863	6	1,080,867	3	1,117,964	377,500	7	403,339	14	460,065

[a] 1971 FAO Production Yearbook and 1981 Production Yearbook.
[b] Populations are in thousands.

Table 4.3.1.2. Relative Importance of Sheep and Goats[a]

Region	% Arable land	Sheep per:			Goats per:		
		100 Ha	100 People	100 Cattle	100 Ha	100 People	100 Cattle
Developed Regions							
North America	12.6	.7	5.3	10.6	.08	.6	1.1
Western Europe	25.1	26.5	26.2	98.0	2.9	2.9	10.8
East Europe	42.9	35.9	33.2	117.0	1.4	1.3	4.5
USSR	10.4	6.4	52.9	123.0	.3	2.2	5.1
Oceania	5.7	25.9	1151.0	606.1	.04	1.6	.8
Total	12.2	9.3	48.4	121.7	.4	1.9	4.8
Developing Regions							
Middle America	13.6	3.6	7.5	17.7	3.5	7.5	17.6
South America--Tropical	6.0	3.5	23.4	33.1	1.1	7.6	10.7
South America--Temperate	11.6	15.6	137.6	83.0	1.0	8.7	5.2
North Africa--Mid East	8.1	14.3	62.9	300.5	7.1	31.4	149.9
Central and Southern Africa	6.7	5.8	33.6	86.5	5.7	33.1	85.3
India	56.9	14.0	5.9	22.8	24.3	10.3	39.6
China and Mongolia	9.2	11.0	11.8	214.0	8.0	8.6	155.6
South and Southeast Asia	16.3	1.4	1.3	11.0	4.5	3.9	34.0
Total	10.4	8.2	18.2	79.1	5.8	12.9	56.0
World	11.1	8.6	25.1	93.5	3.6	10.4	38.7

[a]From 1981 FAO Production Yearbook.

Table 4.3.2.1. Relative Value of Sheep and Goat Products, %

Product	Sheep	Goats
Meat	43.4	35.6
Milk	15.0	58.4
Fiber	39.3	1.7
Hides	2.3	4.3
Total	100.0	100.0

Source: Shelton (1976).

The economic importance of specific small ruminant products varies substantially between regions of the world. A few examples illustrate the products and differences in the regional importance of major small ruminant products.

Meat. Carcass yields are approximately 50% of live weight, declining to 40% when pelts are heavily wooled or slaughtered stock carry little fat. Location of fat deposits vary considerably between sheep and goats (table 4.3.2.2), with goats having relatively less subcutaneous fat and sheep less visceral fat. An American taste panel scored goat meat lower than lamb, beef or pork (table 4.3.2.3); however, elsewhere goat meat, such as "cabrito" in Mexico, is preferred.

In coastal West Africa, small ruminants are raised in village herds, almost exclusively for meat (Josserand and Ariza-Nino 1982, Gefu 1982). In the semiarid zone of northern Africa, sheep and goats provide 31% of the meat while only accounting for 16% of the live weight biomass (Wilson 1982). In Lebanon, Yemen, the United Arab Republic, and the Yemen Democratic Republic, goats are the source of over 50% of meat consumed and in Somalia, Jordan, and India, about 30% of the total meat

Table 4.3.2.2. Location of Separable Fat in Goats and Lambs (%)[a]

	Subcutaneous	Intermuscular	Cavity[b]	Visceral
Goats	14	40	15	30
Lambs	30	45	11	15

[a]Adapted from Ladipo (1973) as presented by McDowell and Bove (1977).
[b]Kidney, pelvic, and heart fat.

Table 4.3.2.3. Sensory Panel Rating for Palatability Characteristics of Cooked Loin[a,b]

Palatability characteristic	Goat	Lamb	Beef	Pork
Flavor	5.7	6.3	6.3	6.4
Juciness	5.5	6.6	5.8	5.4
Tenderness	5.0	7.2	5.9	6.6
Overall satisfaction	5.4	6.6	6.2	6.2

[a]Scores could range from 1 (extremely bland flavor, extremely dry, extremely tough) to 8 (extremely intense flavor, extremely juicy, extremely tender).
[b]Adapted from Smith et al. (1974).

supply is from goat meat (FAO/World Bank 1977). Goats are particularly prized in arid areas for their ability to survive drought periods, and as a result, stabilize the meat supply during periods when sheep and cattle production is low (Wilson 1982).

Milk. Selected breeds of sheep and goats milked for human consumption commonly lactate for 6 to 7 months; average daily yields range from .5 to 4 kg with European dairy goat breeds at the higher end of this production range (tables 4.3.2.4, 4.3.2.5). Most sheep and goats in developing countries are milked for family use; yields are low and must be shared with the preweaned young. Nevertheless, these small quantities can be an important dietary supplement to protein deficient people.

Sheep milk is as much as 75% higher in fat and total solids content than cow or goat milk (table 4.3.2.6). Goat milk has a reputation for being easily digestible and also for use by humans who are allergic to cows milk. Differences in allergic response are probably not associated with lactose intolerance since cow and goats milk are similar in percent lactose (table 4.3.2.6). Fat globules in goats milk are smaller and more dispersed (naturally homogenized) than in cows milk.

In the tropics, where there is little or no photoperiod effect on conceptions, milk is produced throughout the year. In Sahelian West Africa, goats are primarily raised in large herds with milk the most valued output (Josserand and Ariza-Nino 1982). In Bangladesh and Cyprus, goats produce 33% and 57% of the milk consumed (Devendra 1982a). In many countries, the relatively small yields of

Table 4.3.2.4. Lactation Traits for Some Breeds of Dairy Sheep[a]

Breed	Location	Lactation length (days)	Total milk yield (kg)
East Fresian	Germany	260	500
Awassi	Middle East	260	130-270
Chios	Greece, Turkey	170-260	100-250
Sardinian	Italy	170-250	110-230
Lacaune	France	100-210	135

[a]From Gall (1975).

Table 4.3.2.5. Lactation Traits for Dairy Goat Breeds in Temperate and Tropical Environments[a]

	Temperate environment		Tropical environment	
Breed	Lactation length (days)	Milk yield (kg)	Lactation length (days)	Milk yield (kg)
Saanen	260-365	430-1277	240-336	292-1037
Alpine	260-305	470-916	209-264	232-904
Toggenburg	266-305	468-878	212-283	250-532
Anglo Nubian	276-365	752-989	124-300	143-300
La Mancha	276-305	800	--	--

[a]Adapted from summary of literature by Sands and McDowell (1979).

Table 4.3.2.6. Composition of Fresh Milk from Sheep, Goats, and Cattle (%)[a]

Species	Total Solids	Fat	Protein	Lactose
Sheep	16-20	5-8	5-6.5	4.4
Goats	11.5-13.5	3.5-8.0	2.8-3.0	3.9-4.4
Cattle	13	3.4-5.4	3.5-4.0	4.6

[a]From Gall (1975).

sheep and goat milk are consumed by the household, but elsewhere, such as Mexico, milk is processed for commercial sales of specialty products such as candy and cheese (Winrock 1977). Pastoralists in northeastern Iran process milk into clarified butter and cheese that is both consumed by the household and the surplus sold to generate cash income (Martin 1982).

Fiber. Undomesticated species of sheep and goats generally have an outer coat of coarse hair over an undercoat of finer hair or wool. Selection in commercial fiber producing breeds of sheep has favored finer unmedullated (solid core) fibers which tend to be softer and to have preferred dyeing properties to coarser, medullated fibers. Mohair and cashmere, like wool, are generally unmedullated. Wool varies in fiber diameter from about 15 to 40 $^{e}_{m}$; mohair, from 25 to 40 $^{e}_{m}$; and cashmere from 15 to 20 $^{e}_{m}$. A principal difference is smoothness of fiber surface with cashmere the smoothest, followed by mohair and wool. Both sheep and goats produce kemp, an undesirable fiber which is relatively coarse (100 $^{e}_{m}$ in diameter) with a medulla (hollow core) constituting 65 percent of the cross-sectional area and extending the length of the fiber.

White fibers are preferred because of their favorable dyeing properties. Mohair and most commercial wool is white. However, the finest grades of cashmere are dark colored and must be bleached before dyeing. Brown, red, gray, and black colored wool and hair--solids and spots--are common among breeds of goats and sheep not kept primarily for fiber production.

Cashmere and mohair from goats are specialty fibers whose demand is closely linked to changing fashions in developed countries. Over the long run, prices for these fibers are projected to be favorable (De Boer 1982). Carpet wool is a significant product in certain developing countries but is not considered here. Fine wool production is restricted to higher income developing countries and high altitude regions of the tropics and sub-tropics and is not considered in this paper.

The production of quality mohair fiber is extremely location specific with South Africa (32%), Turkey (31%), and the USA (25%) dominating the world supply of mohair. Of these producing countries, only South Africa has the capacity to increase quality mohair production (De Boer 1982). A constraint for developing countries is the high levels of management required to compete in the high quality end of the market, limited areas of suitable land and difficulties of maintaining high quality breeding stock.

Manure is often an important product of sheep and goat systems, serving as a source of both fuel and fertilizer (Buvanendran 1978). Wilson (1982) estimated that an 18 kg goat produces 74 kg dry matter/year with a nitrogen, phosphate, and potash value of 1.5%, 1.5%, and 3%, respectively.

Skins and pelts are used to make tents, water holders, saddles, clothing and other items (Bharat n.d.). In many developing regions, especially where protein is in short supply, skins are eaten--cooked or pickled (Josserand and Ariza-Nino 1982). Major African ex-

porter of skins/hides are Sudan and Ethiopia. In Brazil, another major exporter both of skins and finished leather, the value of the skin is 25 to 30% of total goat value (Gutierrez and De Boer 1982).

The demand for skins is largely set by the market for finished leather goods in developed countries. About 60% to 70% of sheep and goat skins are used to produce shoes and 20% for garments (De Boer 1982). In recent years, synthetic substitutes have made inroads into the leather market, but a strong demand for sheep/goat skins in developed countries is forecast by 1985 with potential demand exceeding production by from 100,000-170,000 m.t. of skins (Barat, n.d.). A major constraint is the farm level processing of skins to maintain quality standards and the development of economical methods of local assembly of skins.

Skins are a by-product of animals slaughtered for meat. As such, supply is relatively independent of demand. For technical and economic reasons, skins cannot be stockpiled so prices fluctuate in response to demand changes. Increasingly, primary processing is being done locally with some countries banning the export of hides/skins.

4.3.3. Productivity in Developing Regions vs Developed Regions

Productivity of small ruminants in developing countries was strikingly lower than in developed countries in the early 70s and, unfortunately, remains so in 1981 (table 4.3.3.1). Thus, while total

Table 4.3.3.1. Comparison of Changes in Small Ruminant Numbers and Productivity Between 1972 and 1981

	1972			1981		
	World totals	Developed regions[a]	Developing regions[a]	World totals	Developed regions[a]	Developing regions[a]
Sheep						
Number[b]	1,043	51	49	1,131	44	56
Meat[c]	5.8	63	37	6.0	55	45
Milk[c]	7.1	48	52	7.9	46	54
Goats						
Number[b]	392	5	95	469	4	96
Meat[c]	1.4	8	92	2.0	7	93
Milk[c]	6.8	28	72	7.6	26	74

[a] Expressed as percentage of world total.
[b] Million head.
[c] Million metric tons.
Sources: 1974 FAO Production Yearbook.
1981 FAO Production Yearbook.

product from small ruminants in developing regions has increased, these increases are a consequence of increased numbers, not increased productivity. Significant opportunities exist in developing regions to improve production environment, genotype and marketing structure for small ruminants.

In terms of productivity per animal the yield of meat and milk from both sheep and goats is very much higher in developed countries (tables 4.3.3.2 and 4.3.3.3). In developing countries meat production from sheep is only 64% and milk production from sheep 94% of that in developed countries, while goat milk production is only 12% and goat meat production only 62% of that in developed countries.

With respect to fiber (scoured wool) only 33% of world total is produced in the developing regions even though 56% of the world's sheep are in these regions. This relfects lower productivity and also the predominance of hair sheep in the developing regions as opposed to wool sheep in the developed regions. The weight of hides and skins from sheep is approximately equal in both the developed and developing regions of the world at around 14%, while goats contribute approximately 5% in the developing regions but only 15% in the developed countries (table 4.3.3.4). Clearly there is enormous potential for improving the productivity of sheep and goats in the LDCs.

4.4. Consumption and Trade

4.4.1. Consumption

World production, consumption, and trade of meat for the period 1967 to 1977 has been recently analyzed (Wheeler et al., 1981). These regional designations--developed, developing, and centrally planned--correspond to those used by FAO.

During this period (1967-1977) world output of meat increased at an average annual rate of 3 million tons. On a percentage basis, the greatest rate of increases in meat tonnage occurred in the developing region (figure 4.4.1.1). Increases in the developing region's percent of world totals occurred for all species but the greater share of increases were for poultry and small ruminants.

The significance of the data for goats lies in the fact that 93% of the goat meat and 73% of the goat milk is produced in the developing regions although goat products (meat and milk) both account for less than 2% in each case of the world's production of meat and milk from all sources as shown in table 4.4.1.2.

Average per capita consumption of all meat increased by 2.9 kg from 1967 to 1977. Increases by region were: Developed, 10 kg; Centrally Planned, 5 kg and Developing, 2 kg. Although meat consumption for developing regions increased 40% over this period, average daily consumption in 1977 still amounted to less than 31 grams. Between 1967 and 1977 the developing region's percentage share of world meat consumption increased slightly for beef, declined slightly for pork, and increased more substantially for poultry and sheep and goat meat (figure 4.4.1.2).

Between 1967 and 1977 per capita consumption of mutton--sheep and goat meat--declined on a worldwide basis (figure 4.4.1.3). However, consumer preferences, income changes, and other factors combined to in-

Table 4.3.3.2. Productivity of Regional Goat Populations[a]

Region	Total number (millions)	Head slaughtered (% total)	Carcass yield (kg)[b]	Milk yield (kg)[b]
Developed Regions				
North America	1.4	-	-	-
Western Europe	10.1	80	7.6	145.0
East Europe	1.7	59	8.6	78.4
USSR	5.9	46	6.9	67.6
Oceania	0.3	27	7.2	-
Total	19.5	61	6.9	103.0
Developing Regions				
Middle America - Caribbean	9.5	31	3.2	34.6
South America - Tropical	15.5	28	3.5	8.1
South America - Temperate	3.6	33	3.0	2.8
North Africa - Mid East	112.2	39	5.2	22.2
Central & Southern Africa	123.3	32	3.7	6.6
India	72.1	43	3.9	13.1
China & Mongolia	86.9	29	4.4	3.5
South & Southeast Asia	26.2	43	4.4	20.6
Total	449.2	35	4.3	12.4
World	468.7	37	4.4	16.1

[a] Population and production statistics for 1980 summarized from 1981 FAO Production Yearbook.

[b] Yield per head in regional herd.

Table 4.3.3.3 Productivity of Regional Sheep Populations[a]

Region	Total number (millions)	Head slaughtered (% total)	Carcass yield (kg)[b]	Milk yield (kg)[b]
Developed Regions				
North America	13	47	11.8	-
Western Europe	92	62	9.4	27.9
East Europe	45	38	5.7	20.7
USSR	142	37	5.8	0.7
Oceania	205	35	5.8	-
Total	497	42	6.6	7.2
Developing Regions				
Middle America - Caribbean	10	19	2.3	-
South America - Tropical	48	15	1.9	0.7
South America - Temperate	57	18	3.0	-
North Africa - Mid East	225	38	5.9	15.2
Central & Southern Africa	125	28	3.4	2.4
India	42	33	3.0	-
China & Mongolia	119	26	4.1	4.6
South & Southeast Asia	8	43	4.7	1.9
Total	634	30	4.2	6.8
World	1,131	35	5.3	7.0

[a] Population and production statistics for 1981 summarized from 1981 FAO Production Yearbook (1982).
[b] Yield per head in regional herd.

Table 4.3.3.4. Production of Scoured Wool and Fresh Hides from Small Ruminants, 1981

Region	Wool, scoured[b]	Total wt hides & skins[b]	Sheep skins		Goat skins	
			Wt[b]	% of total[c]	Wt[b]	% of total[c]
Developed Regions						
North America	26.3	1,115.1	19.1	1.7	-	-
Western Europe	92.9	1,019.0	124.5	12.2	10.9	1.1
East Europe	70.2	332.2	40.8	12.3	2.1	0.6
USSR	272.4	830.0	106.0	12.8	6.2	0.7
Oceania	662.1	486.3	264.7	54.4	.2	0.03
Total	1,123.9	3,782.5	555.1	14.7	19.5	0.5
Developing Regions						
Middle America	4.2	193.6	6.7	3.4	7.7	4.0
South America - Tropical	33.0	510.4	21.6	4.2	10.9	2.1
South America - Temperat	150.3	598.0	60.8	10.2	3.0	0.5
North Africa - Mid East	134.5	640.4	238.5	37.2	99.4	15.5
Central & Southern Afric	74.9	528.3	82.5	15.6	80.8	15.3
India	23.0	916.0	36.9	4.0	72.9	8.0
China & Mongolia	119.7	530.0	88.9	16.8	57.6	10.9
South & Southeast Asia	3.3	331.2	8.8	2.7	28.6	8.6
Total	543.0	4,247.9	544.8	12.8	360.9	8.5
World	1,666.9	8,030.4	1,099.9	13.7	380.4	4.7

[a] 1981 FAO Production Yearbook (1982).
[b] 1000 MT.
[c] Percentage of total hides and skins; does not include wool.

Figure 4.4.1.1 World Meat Production, by Region
Source: Wheeler et al. 1981.

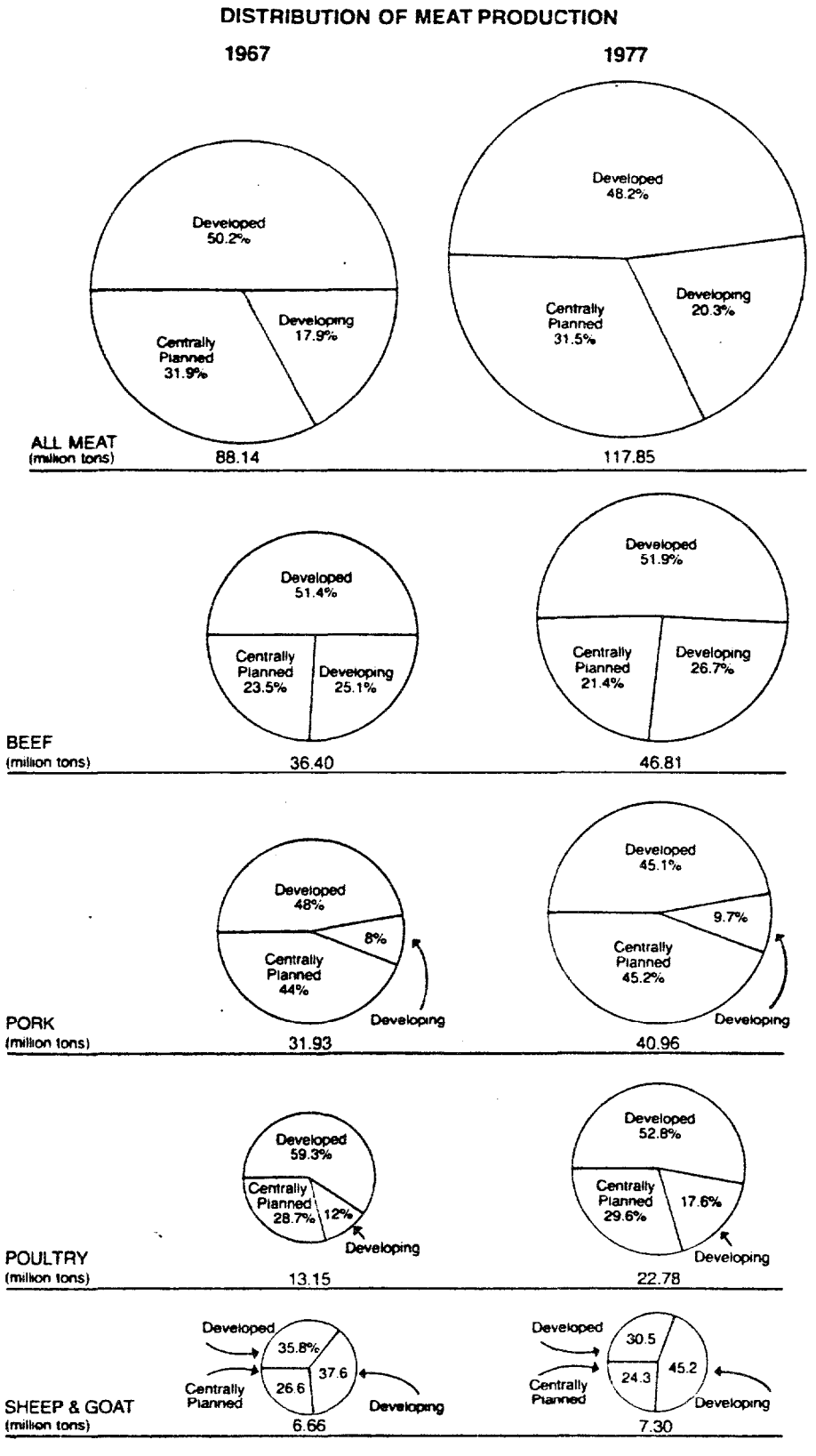


Figure 4.4.1.2 World Meat Consumption by Region, 1967 - 1977
Source: Wheeler et al. 1981.

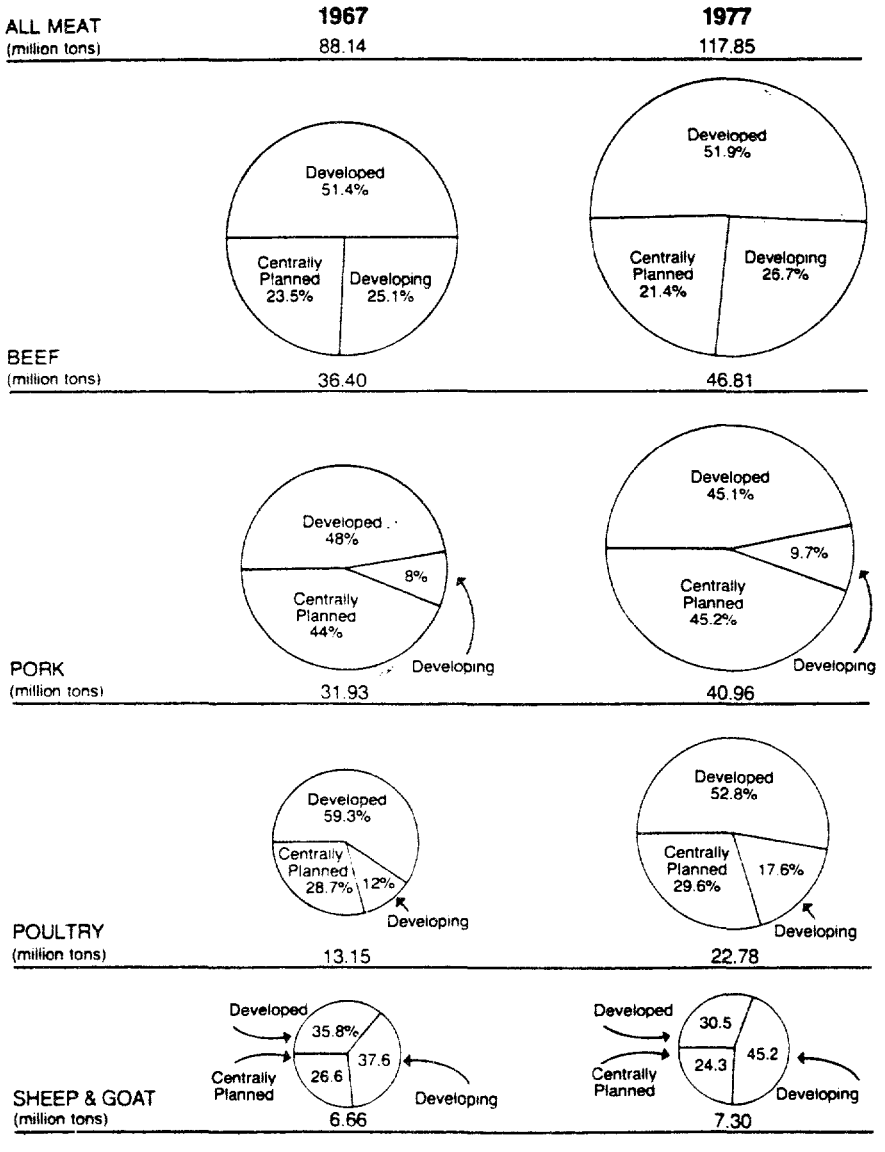


Table 4.4.1.2. Contributions of Sheep and Goats to Regional and World Supplies of Meat and Milk[a]

Region	Total meat 1000 MT	Sheep meat[b] 1000 MT	Sheep meat[b] % of total	Goat meat[b] 1000 MT	Goat meat[b] % of total
Developed Regions					
North America	27,105	159	0.6	-	-
Western Europe	26,635	865	3.2	77	0.3
East Europe	10,989	256	2.3	15	0.1
USSR	15,097	816	5.4	41	0.3
Oceania	3,780	1,193	31.6	2	0.1
Total	83,606	3,289	3.9	135	0.2
Developing Regions					
Middle America	2,806	22	0.8	30	1.1
South America - Tropical	7,152	92	1.3	54	0.8
South America - Temperate	4,587	170	3.7	11	0.2
North Africa - Mid East	4,886	1,324	27.1	583	11.9
Central & Southern Africa	4,494	428	9.5	459	10.2
India	808	125	15.5	280	34.7
China & Mongolia	22,901	493	2.2	381	1.7
South & Southeast Asia	7,535	40	0.5	116	1.5
Total	55,169	2,694	4.9	1,914	3.5
World	138,776	5,984	4.3	2,049	1.5

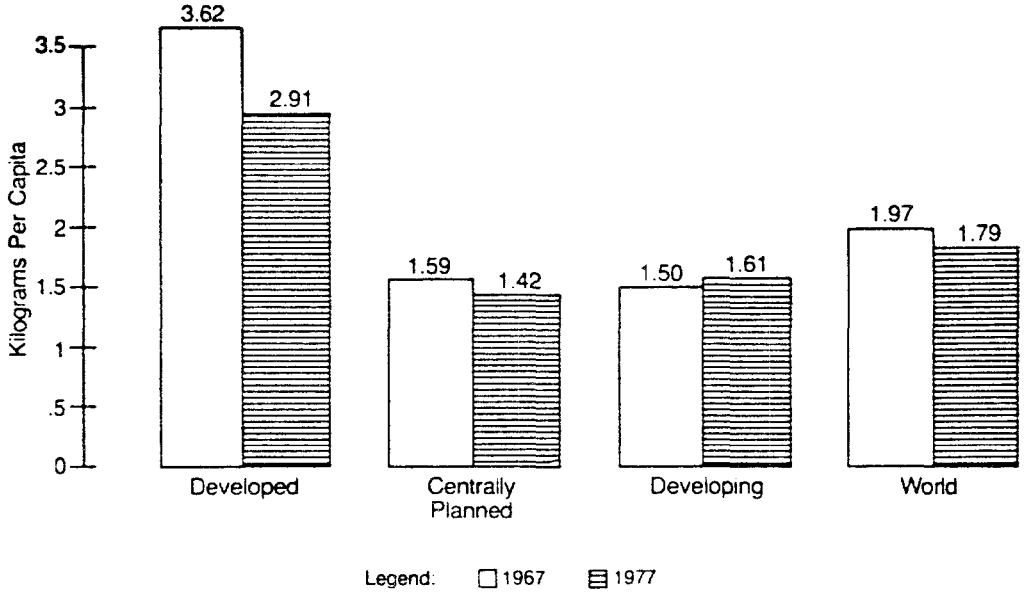
Region	Total milk 1000 MT	Sheep milk[c] 1000 MT	Sheep milk[c] % of total	Goat milk[c] 1000 MT	Goat milk[c] % of total
Developed Regions					
North America	68,186	-	-	-	-
Western Europe	138,481	2,568	1.9	1,470	1.1
East Europe	44,346	932	2.1	136	0.3
USSR	88,500	100	0.1	400	0.5
Oceania	11,824	-	-	-	-
Total	351,337	3,600	1.0	2,006	0.6
Developing Regions					
Middle America	10,734	-	-	327	3.0
South America - Tropical	16,449	35	0.2	126	0.8
South America - Temperate	7,184	-	-	10	0.1
North Africa - Mid East	27,299	3,416	12.5	2,488	9.1
Central & Southern Africa	8,387	297	3.5	813	9.7
India	31,948	-	-	948	3.0
China & Mongolia	7,967	547	6.9	301	3.8
South & Southeast Asia	10,319	16	0.2	539	5.2
Total	120,287	4,311	3.6	5,552	4.6
World	471,625	7,910	1.7	7,559	1.6

[a] 1981 FAO Production Yearbook.

[b] Carcass weight expressed as a percentage of total carcass weight production from cattle, buffalo, sheep, goats, poultry, and swine.

[c] Fresh milk yield expressed as a percentage of total milk production from cattle, buffalo, sheep, and goats.

Figure 4.4.1.3 Per Capita Sheep and Goat Meat Consumption, by Region, 1967 - 1977
Source: Wheeler et al. 1981.



crease mutton consumption in developing regions, primarily in North Africa, Middle East, Central Africa, and Southeastern Asia (Wheeler et al., 1981). In these three regions, the 3.5 kg of sheep and goat meat consumed per capita (substantially higher than the 1.6 kg average for developing regions) constituted approximately one-third of total annual meat consumption.

4.4.2. Meat Trade and Relative Prices

International trade of meat amounted to 7% of world production in 1977. Beef was the most important meat traded both in value and volume.

Trade of mutton (essentially all sheep meat) accounted for 13% of total production in 1977. Oceania exported 655,300 tons, 77% of the international trade. The EC-3 (Denmark, Ireland, United Kingdom) was the major importer, counting for 47% of all imports. Exports to North Africa-Middle East increased from 4,000 tons in 1967 to 128,100 tons in 1977, and probably represents the market with the greatest potential for expansion (figure 4.4.2.1). These statistics do not show movements of live animals and meat across national boundaries within regions. These movements can be locally significant and provide the major market for producers in countries with limited demand due to limited population and/or limited buying power.

With limited exception of speciality products, such as cheese, there is no significant international trade in sheep or goat milk products.

Potential for developing export trade from developing countries is limited by several factors: anticipated increases in local demand could absorb increased productivity; endemic disease problems limit movement of animals or uncooked meat; major exporters such as Australia have well established trade channels. In those cases where trade development appears feasible (e.g., East Africa to Mid East), significant efforts in developing market infrastructure, transportation and trade agreements will be required.

On a regional basis, there does not appear to be any major price advantage favoring sheep and goats relative to cattle.

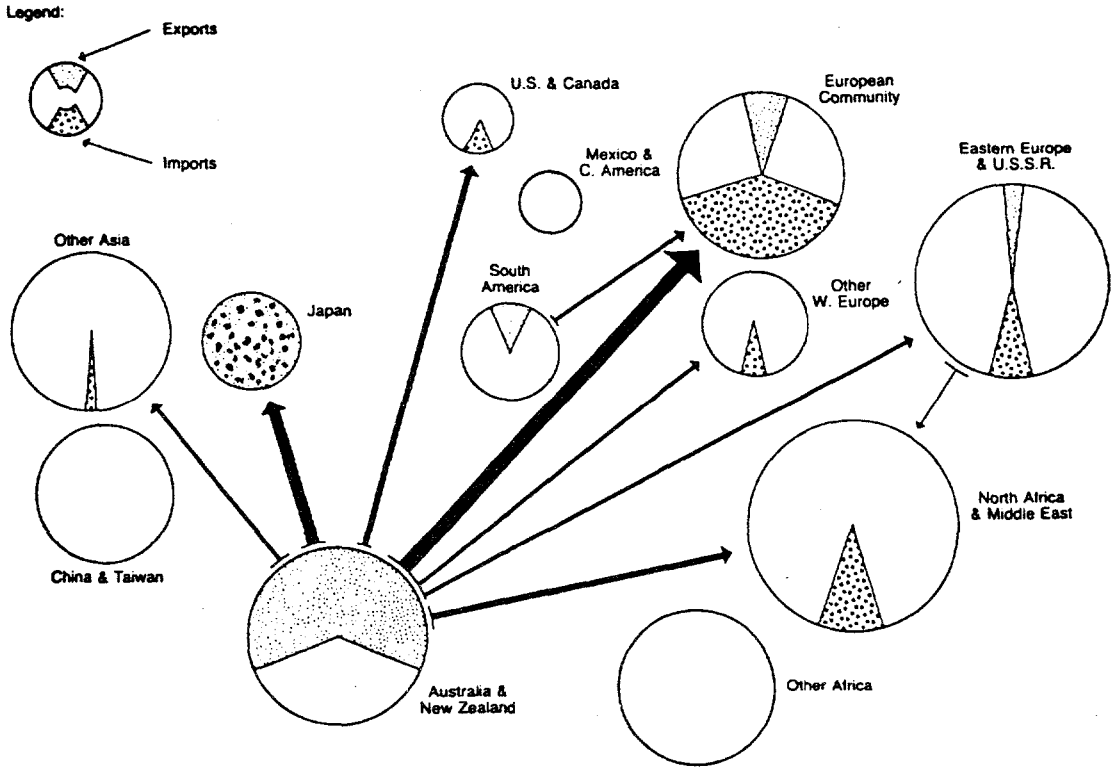
Table 4.4.2.1 and Appendix tables 3-5 indicate that on a regional basis, live animal prices (per kg basis) tend to be similar between cattle, sheep and goats. After taking into account the

Table 4.4.2.1. Unweighted Ratio of Live Weight Farmgate Prices of Cattle/Prices of Sheep and Goats in Africa and Latin America for 1962, 1966, and 1970

	1962	1966	1970
Africa	1.02	0.98	0.99
Latin America	1.10	0.95	0.98

Source: Appendix Tables 3 and 4.

Figure 4.4.2.1 Interregional Trade Flow of Sheep and Goat Meat, 1977
Source: Wheeler et al. 1981.



generally lower dressing percentages of sheep and goats, the prices of retail meat would generally be expected to be 5% to 10% above those for beef on a regional level. Based on these tables as well as on recent field investigations, it is obvious that there can be great variation in relative prices between as well as within countries. Therefore, local studies of prices and price variations are required to supplement the analysis which follows.

Long-term prices for sheep and goat meat are assumed to follow beef, the major meat traded internationally. Table 4.4.2.2 gives the most recent estimated and projected prices for beef entering international trade. In terms of constant 1981 prices, the outlook through 1995 is for virtually no change in price from the 1980-81 period. Prices are projected to remain well below those of the boom period (1960-1970) in world beef trade when prices (1981 constant) averaged 315 cents per kg. Table 4.4.2.3 shows actual trends over the 1961-1980 period and also presents comparable figures for coarse grains, rice, and wheat. The consumption shares of beef and veal in the developing countries and semi-industrial developing countries has remained virtually the same. The major shift has been a decrease in the share by the industrial countries and a commensurate increase in the share of the Centrally Planned Economies. The worldwide rate of growth of consumption of beef and veal over the 1961-1980 period was only 2.6% per annum. With world population growth averaging 1.9% over this period, worldwide per capita consumption increased about 0.7 of 1% per year.

Table 4.4.2.2. Export Prices of Beef in Current Dollars and in 1981 Constant Dollars (US cents/kg F.O.B.)

	Actual							Estimated		Projected			Average
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1985	1990	1995	1960-70
Current	133	158	151	214	288	276	248	240	280	325	425	590	93
Constant	206	241	212	254	307	266	248	231	254	256	250	268	315

Source: World Bank (1982).

Table 4.4.2.3. Growth of World Consumption of Beef and Selected Cereal Products and Changes in Consumption Shares, 1961-1980

Commodity	Worldwide rate of growth 1961-80 (% per annum)	Consumption shares																Semi-industrial developing countries rate of growth 1961-80
		Industrial Countries				Centrally Planned Economies				Developing Countries				Semi-Industrial Developing Countries				
		1961	1970	1975	1980	1961	1970	1975	1980	1961	1970	1975	1980	1961	1970	1975	1980	% per annum
Coarse grains	2.5	42.1	41.2	40.5	35.5	21.1	20.5	19.8	22.7	36.7	38.3	39.7	41.8	10.2	11.3	13.4	14.6	4.2
Rice	2.7	7.8	5.8	6.0	3.7	6.3	7.1	5.9	5.6	85.9	87.1	88.2	90.8	7.2	7.7	7.8	7.8	3.0
Wheat	3.4	27.5	21.8	24.3	20.1	35.6	38.2	28.0	32.9	36.9	40.0	47.7	47.0	13.0	11.0	13.2	12.6	3.1
Beef and veal	2.6	50.0	48.6	48.3	44.3	14.6	18.9	20.0	20.3	35.2	32.4	31.7	35.4	17.2	16.3	16.4	17.8	2.9

Source: World Bank (1982).

5. CONSTRAINTS TO INCREASED SMALL RUMINANT PRODUCTIVITY

Any of the components of livestock production systems--resource inputs, production processes, and product outputs--can be a constraint to system productivity. Alleviation of constraints is the implicit goal of most research, training, and development projects.

The three general categories of constraints used here include:

- o Ecological: land, climate
- o Biological: livestock nutrition--water, feed; livestock health--disease, parasites, and predators; livestock genotype--production and adaptation traits
- o Socioeconomic: labor availability and management skills; consumer taste/preference and disposable income; credit availability and cost; marketing infrastructure; and policies--trade, prices, and land tenure.

Generally little can be done to change ecological constraints. However, well-designed strategies to resolve biological and socio-economic constraints can have major impact on sheep and goat production.

Constraints are listed and discussed as if they were discrete factors, each affecting livestock production independently. In fact, interactions among constraints are the rule, not the exception, with their effects often multiplicative rather than additive. One constraint may mask the effects of others. Thus, it is necessary to consider the total system so that multiple interacting constraints can be systematically resolved in order to achieve substantial improvement.

5.1. Ecological

Land and climate are primary determinants of the plant species that can be grown and, in turn, of the livestock species that can be produced in an ecosystem. Constraints that impact on livestock production are: land (topography and soil fertility) and climate (rainfall, temperature, and growing season). Of these, only soil fertility is readily amenable to change, and only if required nutrients can be applied economically. Application of fertilizers would be limited primarily to crops in crop/livestock systems and to nominal amounts on seeded pastures. Nitrogen fixation and animal manures can provide significant amounts of the nitrogen required in grazing and crop/livestock systems.

Ecological factors need to be carefully considered in sheep and goat production systems for several reasons. First, the indiscriminate introduction of these species (particularly goats) has been blamed for the degradation of environments giving the goat an undeserved bad reputation which remains a serious deterrent to projects involving goats. Second, a small ruminant system cannot persist if the environment changes negatively due to the introduction of sheep and goats.

5.2. Biological Constraints

5.2.1. Nutrition. Feed supply is the most pervasive constraint to livestock production. It is directly dependent upon the production of plant biomass, both in grazing and crop/livestock systems. It is an absolute requisite that must be treated in the broadest context, including native and improved pastures, forage crops, feed crops, crop residues, and by-products. Feed supply has both quantitative and qualitative dimensions. Quantity can be increased by the proper stocking of rangelands, the establishment of improved pastures to complement native pastures, the planting of forage crops, soil and water conservation practices, and the timely harvest and storage of crop residues. Quality relates to the overall nutrient adequacy of pastures, forages, and other feeds consumed, as well as the means to correct any deficiencies through improved pasture management, fresh cut and stored forages, and/or supplementation.

Seasonal fluctuations in feed supply can be a special problem, especially in the wet/dry tropics. Whereas feed may be abundant in the rainy season, inability to preserve this abundance leads to dry-season deficiencies. The impact of these shortages in constraining the higher potential reproductive efficiency of sheep and goats is critical to the economics of investing in cropping/forage systems to provide feed and in preserving and enhancing the digestibility of roughages commonly found on small farms in the tropics and sub-tropics.

The availability of water as a nutrient is often a primary constraint to livestock production, particularly in arid and semiarid regions. Many projects have been dedicated to finding and delivering livestock water. Often results have been beneficial with new lands opened for grazing and increases in productivity. However, in other instances, there have been unanticipated problems, such as overstocking and land degradation near water. These experiences emphasize the need to first understand the nature of the water constraint and its environmental and economic ramifications before programs are implemented to alleviate this constraint.

The impact of attending to these particular problems is often spectacular. A comparison of goats fed under traditional village systems with those adequately fed in an experimental group showed more than 50% increase in live weight at comparable age (Devendra 1981). Other evidence that nutrition is a primary constraint in the tropics comes from observations of lower productivity of high producing animals when moved to the tropics due to reduced intake, (Mba et al., 1975, Chenost and Geoffrey 1971, Devendra 1972) and also significant increases in productivity of local goats when energy and protein levels are deliberately increased (Sachdeva et al., 1973). These responses may be accentuated when genotypes of higher potential productivity are introduced (McDowell 1974).

In developing countries, nutrition of sheep and goats is basically provided by two vastly different systems--seasonally variable, extensive range and intensive mixed farms which tend to be small, with

limited resources for producing feed. The nutritional problems of the extensive systems are extremely difficult to solve primarily because they are subject to uncontrollable forces, particularly rainfall, and in part because proper range management is difficult under common property ownership.

Overcoming the constraints will require two basic approaches--improved feeding strategies and improved resource conservation. These efforts in the extensive system include:

Improved drought feeding strategy, especially:

- Conservation by deferred grazin.
- Flock segragation to feed females.
- Earlier offtake of growing stock.
- Possibly improving range pastures.

In the intensive mixed-farm systems, they include:

Improved by-product feeding strategies, especially:

- Conservation of by-products (hay, silage).
- Use of multipurpose crops for feed and food.
- Cropping systems (intercropping, relay cropping, rotation) with forage legumes.

5.2.2. **Health.** Constraints imposed on sheep and goat production by diseases, parasites, and predators are substantial and highly visible. Trypanosomiasis and its vector, the tsetse fly, sharply limit livestock production in Africa from the southern edge of the Sahara to 15°S. On a worldwide basis, ticks take a heavy toll in blood loss, skin irritation, and disease transmission.

In much of the world, predators threaten small stock so that they must be kept under constant watch during the day and closely confined at night. Thus, grazing is limited to areas relatively close to the night pens, often during midday when animals suffer heat stress. In these situations, poor nutrition--rather than actual predation--reduces productivity.

Substantial progress has been made in technology for prevention and treatment of animal health problems. However, the means to deliver this technology is frequently lacking in developing countries where health officers are in short supply, roads are poor, and producers are suspicious of government programs.

Small ruminant health problems in the developing countries fall into the broad categories of:

- o Lowered resistance caused by poor nutrition leading to death from disease, parasitism, or accidents that might otherwise have been avoided.

- o Transmissible disease controllable only by the direct intervention of vaccination, vector control, treatment or prophylactic measures which may be beyond the means of the limited resource farmers or the local government.

As in other systems the animal health problem is complex and closely interrelated to other biological and socio-economic constraints. Examples that illustrate the point include the need to shelter animals from predators which lead to crowding for several hours each day exposing animals to transmission of contagious diseases, parasites and, at the same time, interrupting feeding, increasing stress and lowering resistance. However, in southeast Asia confinement becomes a positive factor in disease control. Removing manure through slatted floors provides valuable fertilizer and reduces endoparasite burdens.

Overcoming the major constraints to the health of small ruminants will require attention to:

- o Providing adequate nutrition which leads to decreased susceptibility to disease and parasitism.

- o The use of disease resistant animals and studies on the mechanism and inheritance of disease resistance.

- o Improved parasite control.

- o Improved control of endemic disease.

5.2.3. **Genotype.** For most sheep and goats in developing countries, genetic potential for adaptation takes precedence over improved productivity. Often there may be negative genetic correlations between traits for adaptation and production. The genetic merit of most adapted breeds and types in developing countries remains untested. Without this knowledge, the formulation of sound breeding plans as discussed in section 4.2.2 is not feasible and improvement of genetic potential is unlikely. As shown in table 4.2.2.2, even for the more prolific breeds of sheep grown under tropical conditions, large differences in efficiency exists and genotype improvement can undoubtedly play a role. Constraints exist both in terms of defining and implementing a breeding research program and also in devising effective multiplication schemes to implement the research results.

5.3. Socio-Economic Constraints

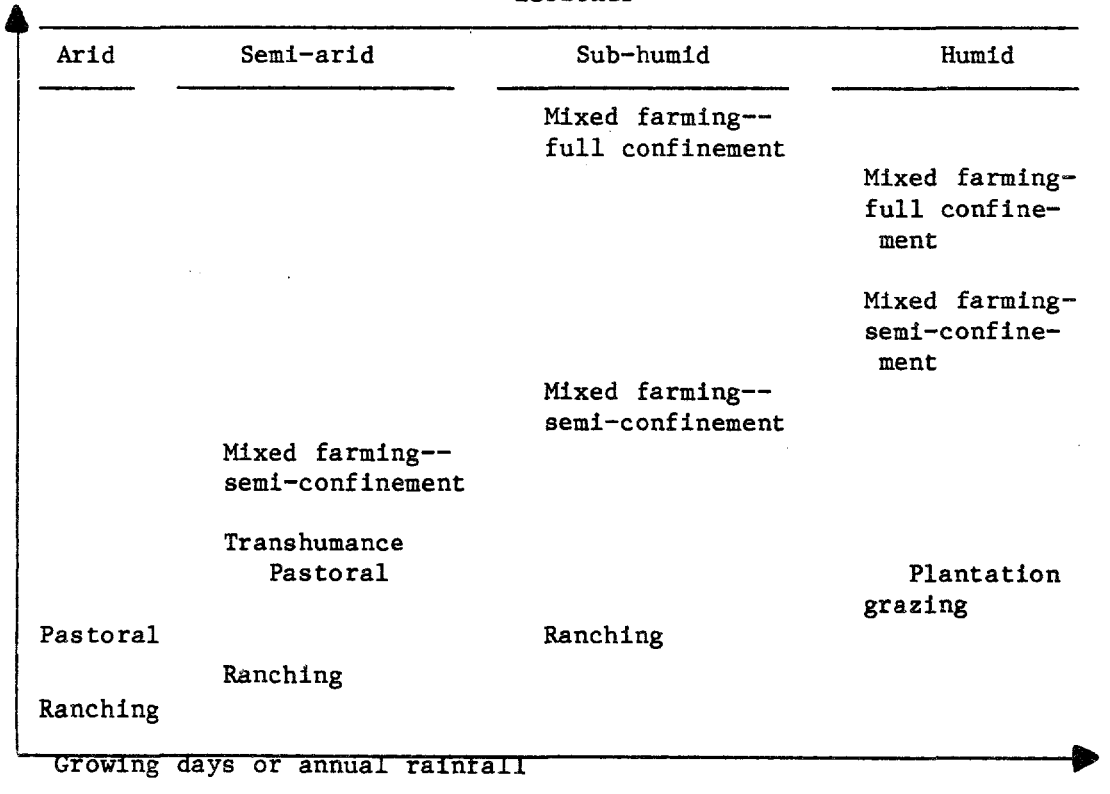
Many factors which impede the transfer of existing temperate zone sheep and goat production technology to the production systems described above are socio-economic in nature. These are focused at the producer or organizational (e.g., ranches, cooperatives, marketing agencies) level in sections dealing with major economic and social variables which influence small ruminant numbers and productivity. Finally, institutional and policy constraints are noted.

5.3.1. Inputs and Outputs

5.3.1.1. Labor use. Labor requirements for sheep and goats are dependent upon the production system and herd/flock size. Production systems are dependent primarily on ecozone but within an ecozone, several distinct production systems may coexist. In general, as we move from extensive production systems to more intensive systems, more labor per animal unit and per unit of output is required (Peters et al., 1982). Ranching is an important exception. Figure 5.3.1.1 sets out an approximate ranking of different systems within and between ecozones. The differences within a management system (e.g., ranching) between zones depends upon the ecological characteristics which are labor specific such as increased labor needed for brush clearing in the semi-arid and sub-humid zones, for maintenance of fences, and animal protection. Differences between full confinement systems are a function of distance required to collect the daily feed and water; the more humid the ecosystem and the more intensive the agriculture practiced, the smaller are daily labor requirements needed for sheep and goat production.

For the arid pastoral regions of Africa, Jahnke (1982) estimates livestock population of 3 Tropical Livestock Units (one TLU = one 250 kg live weight animal) per economically active rural person. Ranching schemes in this zone increase this to over 100 TLU per economically active person. In countries where extensive grazing dominates (Mauritania, Somalia, Botswana) the respective ratios of TLU/economically active rural person are 7.7, 12.3 and 7.9. Using 10 sheep or goats per TLU gives each economically active rural person control of herd/flocks of 80-120 animals. In comparable ecozones of Kenya, full-time

Figure 5.3.1.1 Approximate Rankings of Labor Requirements for Small Ruminants Within and Between Ecozones



hired herders can handle about 200 sheep or goats (De Boer 1981). Traditional pastoral systems have high employment capacity at low levels of output per person engaged in pastoral pursuits. Despite the low productivity per person, labor constraints for specific operations or for specific times of the year are often cited as limiting factors in increasing productivity or herd/flock sizes.

In the semi-arid and sub-humid zones, the interaction of livestock with crops becomes an important factor in labor use (Delgado and McIntire 1982, Little 1982). This is reflected in (a) higher labor inputs in the transhumance system based on pastoralism plus grazing crop residues and (b) the necessity for semi-confinement with close herding and/or tethering for animal control in crop-animal systems. This begins to place definite limits on herd/flock size and labor requirements rise rapidly. Cattle must often be herded by males whereby sheep or goats can be herded by children, thus reducing the labor competition with crops. Labor budgeting between alternative management systems for mixed crop-livestock farms has been carried out recently in Kenya (De Boer 1981, Stotz 1980) and in Indonesia (Sabrani et al., 1981). Labor inputs for tethering or herding small flocks/herds are fairly similar but the labor inputs into full confinement systems are highly dependent upon the types of feed available and on distances traveled to collect feeds.

In most instances, labor used for sheep and goat production is supplied by family members. The persons providing the labor vary widely due to cultural factors and difficulty of tasks involved. If large herds are maintained or if predators are a serious problem, adult males will most likely provide the required labor. Smaller flocks are typically herded by women or children. In Africa and in most other regions where goats are milked, women and children provide most of the milking labor. Low labor requirements and limited skill required to maintain a small flock of sheep and goats makes it possible for a household to generate an economic return from family labor that has little or no opportunity cost. However, as children in poorer regions begin to attend school, labor bottlenecks may occur.

5.3.1.2. Capital use. Capital requirements for sheep and goats consist mainly of the stock. In some production systems (e.g., Indonesia and the Philippines), sheep and goat owners rent out breeding stock to neighbors and jointly share the offspring. This system provides an opportunity for owners of large flocks to transfer labor costs to others, reduce disease risk associated with high animal populations, and creates social bonds. Also, lending of sheep and goats provides a mechanism for poor farmers to acquire initial breeding stock which can be used to build their own flock (Mink 1982, Devendra 1982b). In most small farm systems the value of land devoted specifically to sheep and goats is generally small or negligible. Land is either communally owned or devoted to other primary activities (food crop, fallow, plantation crops, field margins). Under private ranching schemes, the value of standing livestock is generally less than the value of land and improvements. A detailed study of a major small ruminant producing area (Northeast

Brazil) by Gutierrez et al., (1982) found sheep and goats comprised 4% of all farm assets (including value of land) while cattle represented 32% of total farm assets.

Capital needs for sheep and goats must be analyzed as capital needed (a) for inputs required to improve an existing system in which they are important, (b) for inputs needed to introduce them into systems where they currently are not important, and (c) for building up herds/flocks of improved genotypes. Capital and credit needs must be related to the three major types of sheep and goat production systems towards which World Bank resources may be directed--ranching systems, transhumant or nomadic systems, and small farm systems. Traditional commercial credit operations are generally applicable to the first system. However, repayment difficulties on many of the externally assisted ranching schemes have indicated that many problems still exist.

The problems inherent in supplying credit to sheep and goat producers, particularly those in the last two systems, are similar to those for smallholder credit problems in general. Institutions are not geared to meet the needs of the smallholder, commercial institutions are reluctant to make loans because administrative costs are high, there is often a lack of viable technologies needed to provide high rates of return needed to repay the loan, the farmer often lacks the complementary inputs needed to achieve maximum efficiency of loan funds or loans in-kind, the fungibility problem where loan proceeds are used for other purposes, problems of loan security, and loan repayment difficulties.

There are three major types of capital assistance efforts for sheep and goats that require consideration by the World Bank. These include direct loans for stock, farm-level credit directed towards improving the on-farm production environment for small ruminants, and overall production system support activities (research, extension, land development, marketing infrastructure) directed towards the small ruminant sector as a whole.

Given the enormous diversity of small ruminant production systems described above and the great diversity of needs for system improvement, no general statements can be made about priorities for capital assistance or about specific types of credit programs needed.

Note should be taken of the animal sharing schemes which have evolved in certain small farm systems of Southeast Asia. These systems have obviated the need for cash credits and may represent a viable form of small ruminant credit in other areas of the world.

Also, the earlier analysis indicated that one advantage of sheep and goats was their ability to reproduce rapidly and build up herd/flock numbers quickly. To some extent, this obviates the need for large amounts of capital for herd expansion. Another argument in favor of capital investments in production system support activities (research, extension, physical facilities, land development, marketing facilities) rather than in animal purchases is that many tropical sheep and goat breeds have good ability to respond to higher levels of feeding, management and health.

However, credit or capital constraints can pose a serious problem for many sheep and goat producers in the tropics because they tend to be the smaller, limited resource producers or landless laborers. The challenge is to design efficient credit programs which can influence several constraints which impact on the overall productivity of the system. This will generally require simultaneous support at several different levels (public institutions, farm level, marketing or processing) and the efficiency of capital allocated to these needs, rather than the absolute amount provided, will be a major constraint for improvement under the often complex systems described earlier.

5.3.2. **Comparative Economics.** Any studies on comparative economics of ruminants must be treated with caution unless accompanied by an intensive biological study since an underlying assumption is that species easily substitute for another. Analysis needs to consider at least the following aspects (many of which are treated in more detail in Section 4):

- o Feed selectivity and dietary preferences.
- o Pre-weaning mortality rates--The high reproduction rates of some sheep and goat breeds often leads to high rates of neo-natal mortality which tends to counterbalance the advantage of high prolificacy.
- o Sheep and goats are typically raised in subsistence or semi-commercial systems. In practice it is difficult to impute a monetary value to the major production inputs or outputs.

While various procedures exist for dealing with these complex methodological issues, studies reported in the literature seldom describe the assumptions used. Consequently, the results of the following studies must be treated with caution:

- o India. In Himachal Pradesh State, Raut and Nadkarni (1974) reported that in mountainous, high altitude areas where both migratory and sedentary management systems are used, the income derived from goats in both systems (11.8% to 72% of total income) was substantially higher than from sheep (10.0% to 25.6%).
- o Another study in a semi-arid region of Rajasthan compared flocks of 30 Malpura sheep and 30 local meat goats maintained on free-range grazing on highly degraded land. Over three years the sheep gave an average net profit of $11.34/year/sheep compared to $142.08/year/goat due to higher prolificacy and lower mortality (Swain et al. 1982) for the goats.
- o Malaysia. Intensive meat goat production in a mixed farming system with one buck and five does gave a net profit of $115/year over five years; exclusive of interest on capital invested, cost of unpaid family

labor and land rent (Devendra 1982b). The same author (1980) calculated that goats grazed on Guinea grass gave a gross margin per hectare of Malaysian $9.90 compared to $5.39 for cattle.

- o Pakistan. Transhumant goat and sheep rearing by a landless family owning 10 does and 15 ewes gave a net family income of $291/year, about half of which was in cash, exclusive of interest on capital and family labor input (McDowell 1976).

- o Kenya. A study reported that for farms of less than 1.6 ha, and without access to credit and inputs, dairy goats were less risky and more attractive than dairy cattle. Yet on larger holdings with access to credit and inputs, dairy cattle gave a higher return (Stotz 1982). Another study showed that relative enterprise profitability (dairy goats, Angora goats, meat goats, sheep, dairy cattle, and beef cattle) differed between ecological zones (De Boer et al., 1982) but within the same zones, goats gave higher returns per animal unit and per hectare.

- o Niger. A comparative study (Swift 1979) of meat and milk offtake/kg live weight/year for ruminants kept under the same conditions showed that goats were most productive (0.21, 1.50), followed by sheep (0.12, 0.59), cattle (0.06, 0.43) and camels (0.04, 0.60). Particularly innovative is Swift's estimation of the returns to herding labor in terms of kg of millet. While millet production generates 0.4 to 0.9 kg/man-hour, livestock herding (average across all species) give a return of 1.7 kg of millet/man-hour.

- o Brazil. Analysis by Gutierrez et al., (1982) indicated the rates of return to capital invested in sheep and goats was greater than for investments in cattle or cropping. It was concluded that technical factors limited the substitution of small ruminants for cattle or else small ruminant herds would have been growing at the expense of cattle and cropping, a trend not evident in this region.

In mixed crop-livestock systems, comparison should take a systems approach and estimate returns to labor from alternative livestock production systems (intensive vs. extensive), species, cropping alternatives, as well as off-farm and non-farm employment options. Since in many instances producers will be faced with allocating labor resources between several of these alternatives, a simple comparison of net returns between two or more species will not generally indicate the attractiveness of the livestock enterprises.

5.3.3. Sociological and Cultural Aspects

In general, within the developing countries, sheep and goats have fewer socio-cultural beliefs and constraints attached to them than do large ruminants, particularly cattle. In Moslem countries, sheep are often preferred to goats because of their religious significance (Wilson 1982). Generally, goats have been raised by the poorest people in many societies and as a result, have low status (Gilles 1982). Also, goats have been blamed for environmental damage and transmitting such diseases as brucellosis and tuberculosis, resulting in a poor image (Galina et al. 1982). In some areas of India, sheep and goats are associated with lower social castes.

Sheep and goats possess important economic characteristics which are also reflected in socio/cultural aspects relating to asset reserves, provision of cash for schooling and special or unanticipated occasions, and forms of exchange and sharing of animals to help provide income opportunities for landless or land-scarce producers. The dietary and religious factors are important in Muslim countries where two major Islamic holidays are traditionally celebrated by slaughter of intact male sheep, although for the less fortunate, intact goats will suffice. Since these are movable feasts, adjustment of production systems to meet the periods of peak demand is very difficult, especially for smallholders with very limited ability to adjust feed resources and animal inventories to meet the market.

Efforts to introduce new species or new products meet with local resistance where producers are consuming a competing product. For example, in northern Mexico, a goat milk project found no local demand for goat milk and had to develop processing and external marketing links (Galina and Juarez 1982) to overcome local reliance on cow milk.

On the other hand, experience suggests that it has not been difficult to introduce new species such as dairy goats into systems where there was a critical shortage of milk and/or meat. In one study, the women recipients used goat milk to feed their children (Stanton 1982).

Sociocultural constraints must also be analyzed in terms of (a) constraints in making the necessary adjustments to increase production from existing systems where sheep and goats are important versus (b) constraints applicable where sheep and goats may be introduced into a system where they are not currently important. In the former case, the set of constraints associated with keeping goats and utilizing their products are not relevant and the sociocultural factors must be considered within the wider context of making changes in the overall production system or to specific sheep/goat production practices. The critical role of the production system in meeting subsistence food requirements, the role and sources of risk, land use rights and resource sharing arrangements must all be considered.

When the focus is on potential sociocultural constraints that could arise from a scheme to introduce sheep and goats into a non-

traditional system, then the constraints analysis must focus instead on the potential producers underlying values towards the animals themselvestowards their products, and towards the potential adjustments in resource use, food consumption patterns, and daily work routines that will be required. Obviously, the sociocultural constraints are generally much more severe in the latter case (Noble and Nolan 1982).

5.3.4. Marketing System Constraints

Demand and supply characteristics of sheep and goat products marketed domestically are affected by culture, season, urban-rural migration and production systems.

5.3.4.1. Demand. In many countries, sheep and goat meat is an important source of animal protein to low income farmers throughout the year. Frequently, animals are butchered and consumed in the village--never formally entering the marketing chain (Sandford 1982).

Sheep and goat meat demand is sometimes affected by seasonal factors such as those mentioned above for Islamic festivals. As another example, in West Africa small ruminant consumption increases at the end of the dry season when cattle are relatively scarce (Josserand and Ariza-Nino 1982). In an animal market in northern Ethiopia, the number of buyers varied by a factor of 25 over the year (Gabre Mariam and Hillman 1975). As a consequence, prices also fluctuate over the year and in some West African markets the holiday price for live sheep is double the normal price (Josserand and Ariza-Nino 1982). Sheep and goats often fill the dry season meat demand and generate cash to purchase grain. Producers are often reluctant to sell cattle during this season.

Most developing countries are experiencing significant population increases, rural-urban migrations and increases in income. As a consequence, the demand for sheep and goats is increasing in urban areas as rural migrants often prefer consumption of these meats.

Some sheep and goat purchases are made to redistribute animals between producers. For example, in Kano, Nigeria, the price of breeding females was 64% greater than comparable age males as producers were demanding breeding stock to increase their own herd size (Josserand and Ariza-Nino 1982). In Niger, a market study showed that 45% of the buyers were also sheep and goat producers (Sandford 1982). In some cases, sales are also made to adjust animal inventories to desired sex and age composition.

There is generally little commercial demand for milk products from sheep and goats. With the possible exception of cheese, these products are consumed by producing households, sold to neighbors, or the milk is given to young animals (Devendra 1971). An exception is Mexico, where commercial goat dairies have been established to process milk produced under intensive management (Fitzhugh 1981, Winrock 1977).

5.3.4.2. Supply. The supply of sheep and goats should be more price responsive than cattle given the shorter reproduction cycle, but several phenomena affect market supply independently of price.

In both arid and tropical areas, where pronounced seasonal effects (winter and/or dry season) reduce the availability of feed, producers typically sell animals to equate herd size to the anticipated carrying capacity during the feed deficit period (Martin 1982). In addition, because sheep and goats are often used to accumulate and store assets to meet emergency cash needs, individual producers may sell--at significant price discounts whenever the need arises (Sandford 1982).

5.3.4.3. Marketing processes and functions. The marketing processes for sheep and goats and their products in developing countries are best described as labor intensive and capital extensive. Relatively little capital is invested in equipment or facilities for marketing, processing, and transporting animals or products because sheep and goats are easily slaughtered by individuals and the products disposed of locally. The complexity of the marketing process, in terms of participants and requirements for knowledge about prices and animal characteristics, depends largely on the distance between producers, markets, and final consumers.

In small countries like the Caribbean Islands, direct marketing by the owner is common while in dispersed situations, a complex series of intermediaries is involved, often with highly specialized functions. The difference between the producer price and the final price paid by the consumer or butcher represents the higher cost of marketing dispersed populations of animals over long distances (Josserand and Ariza-Nino 1982, Sandford 1982, Sabrani and Knipscheer 1982). While differences in price paid/animal may vary significantly in each transaction, studies have shown that price is set after taking into consideration animal age, sex, breed, and weight (Sabrani and Knipscheer 1982).

Because the demand and supply of live animals can be quite erratic, particularly in drier ecozones, there is a need for an open, heterogenous marketing system which can quickly adjust to such changes. The resulting large price fluctuations, which are necessary in such situations, are often used as a pretext by public authorities to intervene in the marketing system whereas such intervention are often undertaken to generate tax revenues or provide low cost animal products to urban consumers.

While direct government intervention may not be necessary, there are benefits in periodically providing producers with information about prices in various markets and requiring the documentation of ownership where theft is a problem (Sandford 1982). The government can also play a positive role in helping to provide orderly marketing areas where sellers and buyers can gather and in providing capital for

additional middlemen to enter the marketing process. Support for the improved utilization of sheep and goat skins also represents a potential role for the public sector although the often dispersed slaughter of small ruminant's by unskilled persons is a major economic constraint to quickly being able to gather up and process large numbers of skins soon after slaughter. When export of live animals or meat is considered, then a potentially much larger role for the government needs to be considered, particularly in quality control.

5.3.5. Institutional and Policy Constraints

This section summarizes the institutional and policy constraints underlying many of the problems associated with low productivity of sheep and goats and with specific sets of constraints discussed earlier. These constraints may influence the production environment under which the farmer operates, may change price relationships, and may influence the generation of technological change through research, education, and extension inputs. Some major institutional/policy constraints most likely to impact upon World Bank supported activities in the sheep and goat sector are now summarized.

International agencies--complementary international support in research, training, and technology transfer activities will continue to be a constraint relative to activities associated with other livestock species (cattle, swine, poultry) or to crop production programs. Despite some promising international work on sheep and goat production and marketing problems in the tropics, the level of such support is very small, the ongoing work is not comprehensive in terms of disciplines, products, or ecozones, and coordination with other institutions with capacity in these areas is lacking.

National research and extension support problems--In general, developing country support for agricultural research is weak and fragmented. Support for animal sciences has traditionally gone to veterinary medicine and very few production system oriented support programs have evolved. The level of capacity in sheep and goats research and extension programs is either totally lacking or is given little emphasis. The approach recommended in this paper will require some restructuring in the focus and organization of groups working on sheep and goats under limited resource conditions as well as considerable investment in training and field testing of technology components.

Institutional focus--Current sheep and goat programs focus on the animal itself as the critical constraint. This is reflected in the proliferation of multiplication schemes to distribute "improved" animals to producers, and in animal importation programs to introduce superior genotypes. These approaches focus on the symptom, not the problem and reflect a severe institutional constraint.

Direct prohibitions--An example is the attempts to eliminate goats, which removes a low cost source of food for the rural and urban poor, and increases prices leading to illegal herd expansion. Animal quarantine regulations and slaughtering restrictions may also retard the

potential of sheep and goats.

Price policy--In general, the direct impact of price controls on sheep and goat prices and production has not been major since it is very difficult to control the trading, slaughtering, and consumption of sheep and goat's or their products. A more important indirect effect is the impact that low agricultural prices have on general rural purchasing power which limits the ability of farm families to purchase sheep and goats or their products and also limits their ability to invest in and improve sheep and goat production.

Credit policy--Since sheep and goats tend to be dispersed in small herds among many small producers, providing direct credit for sheep and goat programs can be difficult, administratively costly, and it is also difficult to keep track of the collateral. Innovative approaches with a maximum of local level initiative and administration is called for if credit is seen to be a major constraint in specific situations.

6. RECOMMENDATIONS

The terms of reference for this assessment call for recommendations on specific research activities and on development projects to be undertaken by the Bank. These recommendations were developed with emphasis on the following principal criteria:

- o Sheep and goats in developing countries contribute primarily as an integral, but not dominant, component of production systems. Therefore, project and other activities should emphasize the systems approach, rather than sheep and goats as an independent commodity.

- o Systems to be addressed should be those in which sheep and goats are currently of significant importance:

  - Mixed species herds grazing dry rangelands.

  - Small herds providing the primary source of food and income to landless peasants (e.g., India).

  - Small mixed farms in which sheep and goats add value to crop residues and serve as a food and cash reserve.

  Also included are those systems in which there is potential for a significant contribution by sheep and goats but where this potential remains unrealized because of one or more missing elements, such as seasonal feed shortages, health problems, suitable genotypes, and profitable markets. Examples include farming systems in the humid tropics using dual-purpose (meat, milk) goats to produce milk for family consumption plus slaughter goats for income, and stratified production systems in which breeding animals based on range produce slaughter stock finished on better quality feeds (improved pasture, agricultural by-products, feed grain) for urban or export markets.

- o Projects must be economically and technically feasible; however, in many instances, principal returns would be in social values (improved nutrition and health of family; insurance against food or cash shortages).

- o Finally, recommendations emphasize those activities to be implemented by the World Bank or those which the World Bank may indirectly influence through International Centers and national institutions.

6.1. Specific Recommendations

6.1.1. Increase professional and institutional awareness of the current importance and potential value of sheep and goats to balanced agricultural production in developing counries:

- o The identification and design stages of project development should incorporate specific assessment of sheep and goats. This recommendation does not mean forcing sheep and goats into projects where they do not belong but only that they be given due consideration.

- o The portfolio of Bank projects, including rural development projects, should be reviewed in more detail than was possible in this study to learn if sufficient attention has been directed to sheep and goats, to identify further opportunities, and to benefit from previous experience.

- o Development of comprehensive databases on sheep and goats should be supported. These databases would bring together in easily accessible format the available information on characteristics of sheep and goats, production systems and market requirements in developing countries. A file of technical personnel with interest and experience in sheep and goats should be compiled and regularly updated.

  The primary purpose of these data bases would be to organize available information (good starts have been made by institutions such as ILCA and Winrock) so that it would be readily available to support project design and implementation.

  The process of data base development will also identify major gaps to be filled by research, training and development projects and will provide a means of monitoring the success of these projects in filling gaps.

- o Review of government policy required to assess net impact on small ruminant sector. There is a need to determine if a specific policy towards small ruminants exists; how general agricultural and livestock sector policies impact upon the small ruminant sector; the effectiveness and impact of price policies on incentives for producing and marketing small ruminants; the institutional setting for provision of research, extension, and credit services to the sector; the types of direct prohibitions governing small ruminants and the impact upon producers; and credit policies directed towards the livestock sector and the small ruminant sub-sector.

6.1.2. Because relatively little research has been conducted with sheep and goats in developing countries, there are major gaps in knowledge and technology necessary to formulate successful development plans. Results from research in developed countries can serve on a stopgap basis; however, research on the following priority problems should best be done with the types of animals under the environmental conditions to which results will be applied.

Biological research priorities include:

- o Provision of adequate feed supply throughout production year.

  Develop cropping systems which supply animal feed requirements without reduction in food or cash crop yield (e.g., relaying forage legumes into food crops toward end of their growing season to provide a standing feed crop during dry season);

  Harvest and feed preservation strategies to maximize nutritive value of crop residues (e.g., drying technology for early harvested maize so that stover can also be harvested early while nutritive value is high);

  Identification of crops which when intercropped or rotated to increase food crop yield as well as providing feed for animals;

  Evaluation of seasonal differences in types of range vegetation selected by sheep, goats, cattle and other ruminants to provide basis for design of optimum ratios of species in mixed herds on a production year basis.

- o Improve health.

  Develop prevention/cure for major diseases affecting sheep and goats in tropics (e.g., trypanosomiasis, pleuropneumonia, peste des petits ruminants) probably to be implemented at regional or national level.

  Develop herd health programs acceptable to producers (low cost, low labor) including parasite control. Attention should be given to issues such as the short-term vs long-term consequences (good and bad) of farm level tick eradication.

- o Improve genotype.

  Characterize native types of sheep and goats for production and fitness traits and determine the extent to which differences are due to additive and nonadditive genetic effects.

Evaluate strategies for combining the superior traits of different breeds with particular attention to breeds which have evolved in the tropics (e.g., prolific Caribbean hair sheep and Indian dairy goat breeds).

Evaluate the apparent advantages and disadvantages of sheep and goats vs cattle to aid choice of appropriate species for production conditions on objective bases rather than subjective opinion.

Socioeconomic research priorities include:

- o Production and marketing economics.

  Evaluate the potential costs and benefits of biological and technical interventions to sheep and goat production; including extent of enterprise competition (crops vs livestock) within production system, and opportunity costs for labor and capital.

  Estimate the current and potential demand for sheep and goat products at the local, national and export trade levels with consideration to competition from other animal products.

  Evaluate the economic feasibility of developing new market infrastructure to process and distribute sheep and goat products.

  Evaluate the impact of national agricultural policies, especially national livestock policies, on sheep and goat production and marketing economics. Policies for analysis include product price controls, input pricing, land policies, taxation, rural credit, exchange rates, trade restrictions, and slaughtering regulations.

- o Sociological factors.

  Evaluate goals of producers and their attitudes toward acceptance of new technologies, their willingness to change traditional practices and to invest labor and capital in improvements to sheep and goat components.

  Identify factors which may limit acceptance of practices such as selling young stock to be fed in a stratified system.

- o Policy research.

  To support the policy needs relating to sheep and

goats that were outlined earlier, some specific policy analysis is needed to support production and marketing programs for sheep and goats. At a minimum, information is needed on demand and supply characteristics for the primary products such as meat, milk, skins, and fiber. For meat, in particular, cross-price and income elasticities of demand are critical if large increases in output are anticipated. Seasonal effects on demand and supply are often important for small ruminants and quantitative estimates of these factors are needed for policy purposes. Research on price policy for the agricultural and livestock sectors is critical in identifying needs and constraints for sector development strategies. The welfare impacts of direct prohibitions need research as do larger questions relating to land use and resource conservation and the potential role of small ruminants in these programs.

Systems research priorities refer to the need for research to synthesize and evaluate comprehensive packages of technology and knowledge:

- o Use of computer models as a relatively inexpensive method of screening the wide range of interventions to determine those most likely to work in the field.

- o Test promising interventions under actual production conditions to ensure they fit the environment and producers needs.

It is envisioned that the Bank will address these research priorities through financial support to existing research centers, through loans to upgrade national research capabilities, and, in the case of socioeconomic and systems research priorities, incorporating a research component within development projects to utilize data produced and to monitor progress.

6.1.3. Training with emphasis on sheep and goats is needed to acquaint decision makers with the potential for these species and to provide qualified professionals to carry out research, extension and development activities. Priorities for training activities are:

- o Shortcourses in topics such as sheep and goat management in extensive and intensive systems, administration of credit to producers, market development.

- o Academic training of developing country nationals in both biological and socioeconomic disciplines in which research program involves sheep and goat production and marketing, preferably with focus on developing countries. Trainees should return with knowledge and special interest in sheep and goats.

Because research and development activities should focus on sheep and goats as part of agricultural systems, training activities should also incorporate interdisciplinary approach. Periodic workshops on interdisciplinary research and development will reinforce the attention to this approach among personnel involved in these projects. Workshops and shortcourses should be conducted in developing countries. Assignment of responsibility for design and conduct of workshops to a professional institution would maintain continuity and permit efficient modification and restructuring to suit needs of individual audiences. Participants could include groups of producers as well as agricultural professionals (research, extension, administration).

6.1.4. Priorities for development activities focus on incorporating a sheep and goat improvement component within the framework of agricultural systems or rural development projects. As discussed previously, priorities for development are those systems where sheep and goats are currently important or where they have substantial potential. These include mixed species herds grazing nonarable lands and small mixed crop-animal farms. Other opportunities include use of small ruminants in crop-based systems where they control competitive vegetation in plantation crops (coconuts, oil palms, rubber, sisal, etc.) and in heavily populated, intensively cultivated areas.

In general, development priorities follow those listed in previous sections where attention was drawn to incorporating awareness of sheep and goats in the project design stage and to conduct research needed to provide knowledge and technology to be used in development. In addition to these previously discussed priorities, development of the sheep and goat component will require attention to the following:

Credit. Credit must be considered as part of an overall capital assistance package which may provide financial inputs for overall support of the small ruminant sector, on-farm improvements to support small ruminants, and for purchases of animals. Detailed analysis is needed of the effectiveness of World Bank support to each type of activity. The provision of credit to producers must consider the type of production system. Increasing credit for small ruminants under commercial ranching systems may be straightforward and involve commercial or government banks directly. In transhumant/nomadic or small farm systems, special attention must be given to credit needs and the effective provision of credit based on past experiences. Credit will likely be required if the last two groups of producers are to utilize new technology or superior breeding stock. Most producers of sheep and goats are poor with limited resources for use as collateral; sheep and goats are easily moved and difficult to identify. These factors limit the security of loans. Credit procedures are needed which fit the needs of producers and are reasonably secure. Possible options are provision of breeding stock on animal shares (as in the Fondos Ganaderos which have proven successful in Colombia and elsewhere in Latin America).

Establishment of sheep and goat seedstock production units. If proven, superior local breeds are available, it may be possible to move directly to a multiplication/dissemination phase. More generally,

evaluation of genetic merit of local and introduced stocks will be needed under a common environment. This is best carried out under a research station environment with special attention required for health problems which often arise when sheep and goats are kept under high stocking rates. Next, on-farm evaluation should be carried out if at all possible. To ensure reasonable reliability of data, larger farmers should be used if possible. These farmers may then be able to assume the role of seedstock multiplication for distribution to the target population of producers. These commercial producers may require additional resources and technical assistance to fulfill this role. An alternative approach is for government stations to provide selected rams/bucks to villages or other types of producer groups on a sale or loan scheme. These rotating studs serve as the basis for upgrading local herds/flocks.

If none of the above options are viable for a specific country or region due to a lack of qualified commercial producers, shortages of facilities and a lack of trained personnel, the direct support to the public sector to implement multiplication schemes may be necessary. Previous experience with this approach for beef cattle, dairy cattle, and water buffalo in developing countries has not been encouraging, however, and all efforts should be made to learn from past problems, treat these as long-term efforts, and provide adequate training and technical assistance.

Related to the above activities is the need to place more emphasis on identifying and transferring superior stocks which have evolved under tropical conditions; e.g., the previously cited breeds of hair sheep and Indian dairy goats. If genetic improvement is to be implemented on a large scale, commercial sources of performance tested disease-free stocks for export will have to be developed either in the exporting country or in some intermediate site such as an island which does not have a substantial livestock population at risk from possible disease introduction.

7. REVIEW OF PROJECTS INVOLVING SHEEP AND GOATS

7.1 Introduction

An attempt was made to assess sheep and goat research, training, development, and credit programs. The objectives were to analyze (a) the amounts of resources being invested, (b) where and for what purpose these investments were being made, (c) what types of production systems involved and (d) the relative mix between research, training, development, and credit types of projects.

The data were assembled from literature searches (e.g., Sands and McDowell 1979), requests for project information from both funding and implementation agencies, from personal knowledge of major programs, and review of World Bank documents in Washington. The limitations of data gathered preclude a comprehensive, balanced picture of activities involving sheep and goats. The following limitations should be kept in mind regarding the discussion which follows:

7.2 Limitations

- The projects reviewed are a limited sub-sample, and the degree of limitation is not well known.

- World Bank projects are probably overrepresented relative to those of other institutions because the research team had better access to World Bank documents and did not have time or resources to carry out similar desk studies of project documents from USAID, United Nations Development Program, F.A.O., Regional Development Banks, International Research Centers or developing country institutions.

- Even where project documents were available or where project summaries were submitted by correspondents, information was usually lacking on funding (particularly local or counterpart funding), staffing, progress to date, specific production systems impacted upon, and the role of sheep and goats in these production systems.

- Bilateral aid projects are poorly represented. The authors are aware of sheep and goat programs supported by West Germany, Netherlands, Australia, New Zealand, and France, but obtaining adequate information on these activities would have required visits to the specific donor agencies and/or project sites.

- Data on activities by Private Voluntary Organizations (PVO's) were not collected although the authors were again aware of several activities sponsored by PVO's in support of sheep and goats in developing countries.

- In many cases involvement of sheep and goats in projects is an incidental part of a larger package focused on crops, other livestock species, general credit support for agricultural or integrated rural development. Often this involvement is not described in project documentation or, therefore, in our summary.

- Project data from some major producing countries (China, Mongolia) were not available for the analysis.

Despite these limitations, the data set is included here as a first attempt to assemble such information, which may stimulate more comprehensive efforts. Also, the data do indicate certain important patterns of assistance to the sheep and goat sector.

7.3 Results

Regional summaries of the 80 projects from which conclusions could be drawn are presented in Appendix Tables 9-13. A summary based on groupings by production system, project objective, and species emphasis is presented in table 7.3.1. Recognizing the limitations of data, the following observations can be made:

- A considerable emphasis is being placed on mixed crop-animal systems. However, many of these projects involve mixed commercial systems in the more developed countries, such as Chile, Argentina, Uruguay, Romania, Yugoslavia, Spain, and Portugal. Many of the animal-based system projects also provided support to commercial producers within these same groups of countries.

- Despite the fairly large number of projects listed under research and training, only a few projects had those objectives as their primary focus and most research and training objectives were in a supportive role to development or credit activities.

- Awareness of the need to take better advantage of the potential of sheep and goats--especially as a means to improve the productivity of poor agriculturists in developing countries--is reflected in major research initiatives undertaken by ILCA in Mali, Nigeria, Ethiopia, and Kenya (ILCA 1980). The first Collaborative Research Support Program (CRSP) funded by USAID under Title XII is supporting research on small ruminants in Indonesia, Kenya, Morocco, Brazil, and Kenya; USAID funding is $11 million for eight years plus approximately $6 million each from participating U.S. institutions and host countries. In addition, several UNDP/FAO Sheep and Goat Development Projects and national research institutes are working primarily on sheep and goats. However,

Table 7.3.1. Summary of Projects by Production System Focus, Primary Objective and Species Focus*

Primary External Funding Source	Production System Focus			Primary Focus				Primary Species Focus:			
	Animal Based	Crop Based	Mixed System	R	D	C	T	Sheep	Goats	Sheep & Goats	Other
IBRD/IDA	13	7	30	5	37	21	14	2	--	--	45
U.S.AID	5	--	6	7	--	--	6	1	--	6	2
UN Organizations	2	--	4	1	6	1	4	2	1	4	--
Others, including only local funding	8	--	12	10	10	1	8	1	7	4	4
TOTALS	28	7	52	23	53	22	32	6	8	14	51

*Totals exceed total number of projects summarized since many projects had a multiple focus.
Source: Appendix Tables 9-13.

other types the vast majority of projects had beef cattle, dairy cattle, swine or poultry as their primary focus. None of the IBRD/IDA projects reviewed had primary emphasis on goats and the two projects with primary emphasis on sheep were on large commercial systems in South America.

- o A cursory review of the number of projects and, where available, the amounts of external funding, indicated that little emphasis was placed on research and training, and of that limited support, most was for projects in Europe and the more developed countries of South America and North Africa. This subsample of projects included little research support in Central America and the Caribbean, the less developed countries of South America, Sub-Saharan Africa, and Asia.

If this lack of project-specific information is seen as a constraint in terms of efficient programming of development assistance or in terms of implementation of specific conclusions of this report, then the following would be essential to an improved analysis:

- o list of bilateral programs
- o list of World Bank programs supporting research
- o list of support programs from International Centers
- o full list of FAO/UNDP/WHO/IAEA/APHCA projects
- o list of projects supported by private voluntary agencies
- o list of national programs
- o estimated local counterpart support for the above
- o clear distinction of project focus, species emphasis, and production systems.

APPENDIX TABLES

Appendix Table 1. Goat Breed Types Classified According to Region of Origin and Purpose

Name	Origin	Purpose		
		Meat	Milk	Fleece
Agrigento	West Europe	2	1	
Anatolian Black	North Africa	1		2
Anglo-Nubian	West Europe	2	1	
Angora	North Africa	2		1
Appenzell	West Europe	2	1	
Apulian	West Europe	2	1	
Assam Hill	India	1		
Baladi	North Africa	3	1	2
Baluchi	North Africa	3	2	1
Bantu	Central & Southern Africa	1		
Barbari	India, North Africa	2	1	
Bari	North Africa	2	1	
Beetal	North Africa	2	1	
Bengal	North Africa, India	1		
Boer	Central & Southern Africa	1	2	
British Alpine	West Europe	2	1	
British Saanen	West Europe	2	1	
British Toggenburg	West Europe	2	1	
Chamois Coloured	West Europe	2	1	
Chaper	North Africa	1		
Cheghu	India	2		1
Criollo	Middle America-Tropical, South America-Tropical	1		
Damani	North Africa	2	1	
Damascus	North Africa	2	1	
Dera Din Panah	North Africa	3	1	2
Dole	West Europe	2	1	
Don	USSR	3	2	1
Dutch Toggenburg	West Europe	2	1	
Dutch White	West Europe	2	1	
French Alpine	West Europe	2	1	
Gaddi	India	2		1
German Improved Fawn	West Europe, East Europe	2	1	
German Improved White	West Europe, East Europe	2	1	
Granada	West Europe	2	1	
Grisons Striped	West Europe	2	1	
Gujarati	India	2	1	3
Himalayan	North Africa, India	2		1
Improved North Russian	USSR	2	1	
Jamnapari	India	2	1	

Appendix Table 1 (cont'd)

Name	Origin	Purpose		
		Meat	Milk	Fleece
Kaghani	North Africa	2		1
Kamori	North Africa	2	1	3
Kashmiri	India	2		1
Katjang	South & Southeast Asia (except India)	1		
Kirgiz	USSR	2	3	1
Leri	North Africa	1	2	3
Ma	China, Mongolia	1	2	
Malaga	West Europe	2	1	
Mingrelian	USSR	2	1	
Murcian	West Europe	2	1	
North Russian	USSR	2	1	
Nubian	North Africa	2	1	
Osmanabad	India	1	2	
Philippine	South & Southeast Asia (except India)	1		
Poitou	West Europe	2	1	
Red Bosnian	East Europe	2	1	
Red Sokoto	Central & Southern Africa	2	1	
Saanen	West Europe	2	1	
Salt Range	North Africa	3	1	2
Sirli	North Africa	2		1
Sirohi	India	2	1	
Small East Africa	Central & Southern Africa	1		
Somali (Galla)	Central & Southern Africa	1		
Soviet Mohair	USSR	2		1
Surti	India	2	1	
Syrian Mountain	North Africa	1	2	3
Tanyang	China, Mongolia	1		
Telemark	West Europe	2	1	
Thori	North Africa	1	2	
Toggenburg	West Europe	2	1	
Valais Blackneck	West Europe	1	2	
Verzasca	West Europe	2	1	
West African Dwarf	Central & Southern Africa	1		
West African Long-Legged	North Africa	2	1	
Zaraibi	North Africa	2	1	

Source: Mason (1969).

Appendix Table 2. Sheep Breed Types Classified According to Region of Origin, Coat Type, Tail Type, and Purpose

Name	Origin	Type[a]		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Abyssinian	Central & Southern Africa	H	FT	1	2		
Algarve Churro	West Europe	CW	MT	1		2	
Algerian Arab	North Africa Mid East	CW	MT	1		2	
Altai	USSR	FW	MT	2		1	
Altamura	West Europe	CW	MT	2	1	3	
Amasya Herik	North Africa Mid East	CW	SFT	2	3	1	
American Merino	North America	FW	MT	2		1	
American Rambouillet	North America	FW	MT	2		1	
American Tunis	North America	CW	FT	1			
Apulian Merino	West Europe	FW-MW	MT	2	3	1	
Arabi	North Africa Mid East	CW	FT	1		2	
Aragon	West Europe	MW	MT	1		2	
Argentine Merino	South America Temperate	FW	MT	2		1	
Arles Merino	West Europe	FW	MT	2	3	1	
Askanian	USSR	FW	MT	2		1	
Aure-Campan	West Europe	MW	MT	1		2	
Ausimi	North Africa Mid East	CW	FT	2		1	
Australian Merino	Oceania	FW	MT	2		1	
Avranchin	West Europe	LW	MT	1		2	
Awassi	North Africa Mid East	CW	FT	1	2	3	
Azerbaijan Mountain Merino	USSR	FW	MT	2		1	
Azov Tsigai	USSR	MW	MT	2		1	
Badano	West Europe	CW	MT	1	3	2	
Balbas	USSR	CW	FT	1	2	3	
Balkhi	North Africa Mid East	CW	FR	3	2	1	
Baluchi	North Africa Mid East	CW	FT	1	2	3	
Barbados Blackbelly	Middle America Tropical	H	MT	1			
Bardoka	East Europe	CW	MT	2	1	3	
Barki	North Africa Mid East	CW	FT	2	3	1	
Basque-Bearn	West Europe	CW	MT	2	1	3	
Bellary	India	CW	MT	2		1	
Beni Ahsen	North Africa Mid East	CW-MW	MT	2		1	
Beni Guil	North Africa Mid East	CW	MT	1		2	
Berber	North Africa Mid East	CW	MT	1		2	
Bergamo	West Europe	CW	MT	1		2	
Bhadarwah	India	CW	ST	3		1	2
Bhakarwal	India	CW	FT	2		1	
Bibrik	North Africa Mid East	CW	FT	2		1	
Biella	West Europe	CW	MT	1	3	2	
Bikaneri	India	CW	MT	2		1	
Bizet	West Europe	MW	LT	1		2	
Blackhead Persian	Central & Southern Africa	H	FR	1			
Black Merino	West Europe	FW	MT	3	2	1	
Black Welsh Mountain	West Europe	MW	MT	2		1	

[a]See legend at end of table.

Appendix Table 2 (cont'd)

Name	Origin	Type		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Blanc du Massif Central	West Europe	MW	MT	1	3	2	
Bluefaced Leicester	West Europe	LW	MT	2		1	
Bluefaced Maine	West Europe	LW	MT	1		2	
Border Leicester	West Europe	LW	MT	2		1	
Bosnian Mountain	East Europe	CW	MT	2	1	3	
Boulonnais	West Europe	LW	MT	1		2	
Bozakh	USSR	CW	FT	1	2	3	
Braganca Galician	West Europe	CW	MT	1		2	
Brazilian Woolless	South America Tropical	H	MT	1	2		
Buryat	USSR	CW	SFT	1		2	
Calabrian	West Europe	CW	MT	3	2	1	
Companian Barbary	West Europe	CW-MW	SFT	2	1	3	
Campanica	West Europe	MW	MT	1	3	2	
Canadian Corriedale	North America	MW	MT	2		1	
Castilian	West Europe	MW	MT	1	2	3	
Caucasian	USSR	FW	MT	2		1	
Central Pyrenean	West Europe	MW	MT	1		2	
Chanothar	India	CW	MT	3	2	1	
Charmoise	West Europe	SW	MT	1		2	
Cher Berrichon	West Europe	MW	MT	1		2	
Cherkasy	USSR	CW	LT	1		2	
Cheviot	West Europe	MW	MT	1		2	
Chios	North Africa Mid East	CW-MW	LFT	2	1	3	
Churro do Campo	West Europe	CW	MT	1		2	
Chushka	USSR	Fur	LT	3	2		1
Clun Forest	West Europe	SW	MT	2		1	
Columbia	North America	MW	MT	2		1	
Comiso	West Europe	CW	MT	3	1	2	
Common Albanian	East Europe	CW	MT	3	1	2	
Corriedale	Oceania	MW	MT	2		1	
Corsican	West Europe	CW	MT	2	1	3	
Contentin	West Europe	LW	MT	1		2	
Cyprus Fat-Tailed	North Africa Mid East	CW	FT	3	1	2	
Dagestan Mountain	USSR	MW	MT	1		2	
Daglic	North Africa Mid East	CW	SFT	2	3	1	
Dala	West Europe	W	MT	2		1	
Dales-Bred	West Europe	CW	MT	2		1	
Dalmatian-Karst	East Europe	CW	MT	1	3	2	
Damani	North Africa Mid East	CW	ST	3	1	2	
Danube Merino	East Europe	FW	MT	3	2	1	
Dartmoor	West Europe	LW	MT	1		2	
Darvaz	USSR	CW	SFT	2		1	
Deccani	India	CW	ST	2		1	
Degeres	USSR	W	FR, SFT	1			
Derbyshire Gritstone	West Europe	MW	MT	2		1	
Devon Closewool	West Europe	SW	MT	2		1	
Devon Longwoolled	West Europe	LW	MT	2		1	
D'Man	North Africa Mid East	CW	LT	1			
Dorper	Central & Southern Africa	H-CW	MT	1			
Dorset Down	West Europe	SW	MT	2		1	
Dorset Horn	West Europe	SW	MT	2		1	
Doukkala	North Africa Mid East	CW	MT	2		1	

Appendix Table 2 (cont'd)

Name	Origin	Type		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Dubrovnik	East Europe	MW	MT	3	2	1	
East Friesian	West Europe						
	East Europe	MW	MT	2	1		
Edilbaev	USSR	CW	FR	1		2	
Entre Minho e Douro	West Europe	MW	MT	2		1	
Estonian Dark-headed	USSR	SW	MT	1		2	
Exmoor Horn	West Europe	MW	MT	2		1	
Finnish Landrace	West Europe	W	ST	2		1	
Frabosa	West Europe	CW	MT	2	1	3	
French Alpine	West Europe	MW	MT	1		2	
French Black-headed	West Europe	SW	MT	1		2	
Fulani	Central & Southern Africa	H	MT	1			
Galway	West Europe	LW	MT	1		2	
Garfagnana	West Europe	W	MT	2	1	3	
Georgian Finewool Fat-tailed	USSR	FW	FT	1		2	
Georgian Semi-finewool	USSR	MW	FT	1		2	
German Black-headed Mutton	West Europe	SW	MT	1		2	
German Heath	West Europe	CW	ST	2		1	
German Mutton Merino	West Europe						
	East Europe	FW	MT	1		2	
German White-headed Mutton	West Europe	W	MT	1		2	
Gorki	USSR	SW	MT	1		2	
Greek Zackel	West Europe	CW	MT	2	1	3	
Grozny	USSR	FW	MT	2		1	
Gujarati	India	CW	MT	3	2	1	
Gunib	USSR	CW	FT	2		1	
Gurez	India	CW	ST	3	2	1	
Hampshire Down	West Europe	SW	MT	2		1	
Han-Yang	China, Mongolia	MW-CW	FT	2		1	
Harnai	North Africa Mid East	CW	FT	2		1	
Hashtnagri	North Africa Mid East	CW	FT	2	3	1	
Hassan	India	CW	MT	2		1	
Hejazi	North Africa Mid East	H	SFT	1			
Herdwick	West Europe	CW	MT	2		1	
Hissar	USSR	CW	FR	1		2	
Hissar Dale	USSR	SW	MT	2		1	
Hungarian Combing Wool Merino	East Europe	FW	MT	3	2	1	
Hungarian Mutton Merino	East Europe	FW	MT	1		2	
Hu-Yang	China, Mongolia	CW	SFT	3		1	2
Icelandic	West Europe	W	ST	3	2	1	
Ile-de-France	West Europe	MW	MT	1		2	
Indre Berrichon	West Europe	SW	MT	1		2	
Iraq Kurdi	North Africa Mid East	CW	FT	1	3	2	
Island Pramenka	East Europe	CW-MW	MT	2	3	1	
Istrian Milk	East Europe	CW	MT	2	1	3	
Jaidara	USSR	CW	FR	2		1	
Jalauni	India	CW	MT	2		1	

Appendix Table 2 (cont'd)

Name	Origin	Type		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Kaghani	North Africa Mid East	CW	ST	3	1	2	
Karabakh	USSR	CW	FT	1	2	3	
Karachaev	USSR	CW	LFT	2	3	1	
Karakachan	East Europe	CW	MT	2	1	3	
Karakul	USSR	fur	FT	3	2		1
Karayaka	North Africa Mid East	CW	LT	2	3	1	
Karnah	North Africa Mid East	SW	ST	2		1	
Karnobat	East Europe	W	MT	3	1	2	
Kazakh Arkhar-Merino	USSR	FW	MT	1		2	
Kazakh Fat-rumped	USSR China, Mongolia	CW	FR	2		1	
Kazakh Finewool	USSR	FW	MT	1		2	
Kent or Romney Marsh	West Europe	LW	MT	2		1	
Kerry Hill	West Europe	SW	MT	2		1	
Khurasani	North Africa Mid East	CW	FT	1	3	2	
Kirgiz Fat-rumped	USSR	CW	FR	2		1	
Kirgiz Finewool	USSR	FW	MT	2		1	
Kivircik	North Africa Mid East West Europe	CW-MW	MT	1	2	3	
Kosovo	East Europe	CW	MT	1		2	
Krasnoyarsk	USSR	FW	MT	2		1	
Krivovir	East Europe	CW	MT	1	3	2	
Kuche	China, Mongolia	CW	ST, SFT	2		3	1
Kuchugury	USSR	CW	LFT	1		2	
Kuibyshev	USSR	LW	MT	1		2	
Kuka	North Africa Mid East	CW	ST	3	2	1	
Lacaune	West Europe	MW	MT	2	1	3	
Lacho	West Europe	CW	MT	3	1	2	
Lamon	West Europe	CW	MT	2		1	
Langhe	West Europe	CW	MT	2	1	3	
Latvian Darkheaded	USSR	SW	MT	1		2	
Lecce	West Europe	CW	MT	3	1	2	
Leicester	West Europe	LW	MT	2		1	
Leine	West Europe	W	MT	2		1	
Lezgian	USSR	CW	LFT	1		2	
Libyan Barbary	North Africa Mid East	CW	FT	1	3	2	
Lika	East Europe	CW	MT	2	1	3	
Limousin	West Europe	MW	MT	1	3	2	
Lincoln Longwool	West Europe	LW	MT	2		1	
Lipe	East Europe	CW	MT	2	1	3	
Liski	USSR	LW	MT	1		2	
Lithuanian Blackheaded	USSR	SW	MT	1		2	
Llanwenog	West Europe	SW	MT	1		2	
Lohi	North Africa Mid East	CW	ST	2	3	1	
Lonk	West Europe	CW	MT	2		1	
Lot Causses	West Europe	CW	MT	1		2	
Lourdes	West Europe	MW	MT	1		2	
Lowicz	East Europe	LW	MT	2		1	
Macina	Central & Southern Africa	CW	LT	2		1	
Malich	USSR	fur	FT	3	2		1
Mancha	West Europe	MW	MT	3	1	2	

Appendix Table 2 (cont'd)

Name	Origin	Type		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Mandya	India	H	ST	1			
Manech	West Europe	CW	MT	2	1	3	
Masai	Central & Southern Africa	H	SFT-FR	1			
Massa	West Europe	CW	MT	2	1	3	
Maure	North Africa, Mid East	H	MT	1			
Mazekh	USSR	CW	FT	1	2	3	
Mikhnov	USSR	CW	LT	1		2	
Miranda Galician	West Europe	CW	MT	1		2	
Mondego	West Europe	CW	MT	1	2	3	
Mongolian	China, Mongolia	CW	FT	2	3	1	
Mytilene	West Europe	CW	LFT	2	1	3	
Navajo	North America	CW	MT	2		1	
Nejdi	North Africa Mid East	CW	LFT	2		1	
Nellore	India	H	ST	1			
New Zealand Romney Marsh	Oceania	LW	MT	2		1	
North Caucasus Mutton-Wool	USSR	MW	MT	1		2	
North Country Cheviot	West Europe	MW	MT	1		2	
Northern Sudanese	North Africa Mid East	H	LT	2	1		
Old Norwegian	West Europe	W	ST	2		1	
Oparino	USSR	W	MT	1		2	
Ovce Polje	East Europe	CW	MT	1	3	2	
Oxford Down	West Europe	SW	MT	2		1	
Pag Island	East Europe	MW	ST	3	2	1	
Pagliarola	West Europe	CW-MW	MT	3	2	1	
Palas Merino	East Europe	FW	MT	2		1	
Panama	North America	MW	MT	2		1	
Pelibuey (West African)	Middle America Tropical	H	MT	1			
Pelo do Boi	South America Tropical	H	MT	1			
Pirot	East Europe	CW	MT	1		2	
Piva	East Europe	CW	MT	1	3	2	
Pleven Blackhead	East Europe	CW	MT	3	1	2	
Polish Heath	East Europe	CW	ST	3	1		2
Polish Merino	East Europe	FW	MT	2		1	
Polish Zackel	East Europe	CW	MT	4	2	1	3
Polwarth	Oceania	MW	MT	2		1	
Portuguese Merino	West Europe	FW	MT	3	2	1	
Prealpes du Sud	West Europe	SW	MT	1		2	
Precoce	West Europe	FW	MT	2		1	
Priangan (Garut)	South, Southeast Asia	CW	ST	1			
Racka	East Europe	CW	LT	2	1	3	
Radnor	West Europe	SW	MT	1		2	
Rahmani	North Africa Mid East	CW	FT	2		1	
Rakhshani	North Africa Mid East	CW	FT	3	2	1	
Rambouillet	West Europe	FW	MT	2		1	
Red Karaman	North Africa Mid East	CW	MT	2	3	1	
Reshetilovka	USSR	CW	LT	1			
Rhon	West Europe East Europe	W	MT	2		1	
Rila Monastery	East Europe	W	MT	3	1	2	
Romanov	USSR	CW	ST	3		2	1

Appendix Table 2 (cont'd)

Name	Origin	Type		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Rough Fell	West Europe	CW	MT	2		1	
Russian Long-tailed	USSR	CW	LT	1		2	
Russian Northern Short-tailed	USSR	CW	ST	3		2	1
Ryeland	West Europe	SW	MT	2		1	
Rygja	West Europe	SW	MT	2		1	
Saloia	West Europe	MW	MT	3	1	2	
Salsk Finewool	USSR	FW	MT	2		1	
Saraja	USSR	CW	FR	2		1	
Sardinian	West Europe	CW	MT	2	1	3	
Sar Planina	East Europe	CW	MT	1	3	2	
Savoy	West Europe	CW	MT	2	1	3	
Scottish Blackface	West Europe	CW	MT	2		1	
Segura	West Europe	MW	MT	1		2	
Serra da Estrela	West Europe	MW	MT	3	1	2	
Shetland	West Europe	MW	ST	2		1	
Shkodra	East Europe	CW	MT	3	2	1	
Shropshire	West Europe	SW	MT	2		1	
Shumen	East Europe	CW	MT	1			
Sicilian	West Europe	CW	MT	2	1	3	
Sicilian Barbary	West Europe	CW,MW	LFT	2	3	1	
Sinkiang Finewool	China, Mongolia	FW	MT	2		1	
Sjenica	East Europe	CW	MT	1	2	3	
Skopelos	West Europe	MW	MT	2	1	3	
Sokolka	USSR	fur	LT	3	2		1
Solcava	East Europe	CW-MW	MT	1	3		2
Sologne	West Europe	SW	MT	1		2	
Somali	Central & Southern Africa	H	FR	1			
Sopravissana	West Europe	FW-MW	MT	3	2	1	
South African Merino	Central & Southern Africa	FW	MT	2		1	
South Devon	West Europe	LW	MT	2		1	
Southdown	West Europe	SW	MT	2		1	
South Ural	USSR	FW	MT	2		1	
South Wales Mountain	West Europe	W	MT	2		1	
Soviet Merino	USSR	FW	MT	2		1	
Spanish Churro	West Europe	CW	MT	2	1	3	
Spanish Merino	West Europe	FW	MT	2		1	
Stavropol	USSR	FW	MT	2		1	
Steinschaf	West Europe	CW	MT	1		2	
Stogos	East Europe	CW	MT	1	3	2	
Suffolk	West Europe	SW	MT	2		1	
Sumava	East Europe	CW	LT	2		1	
Svishtov	East Europe	CW	LT	2		1	
Svrljig	East Europe	CW	MT	1	2	3	
Swaledale	West Europe	CW	MT	2		1	
Swedish Landrace	West Europe	W	ST	2		1	
Swiss Black-Brown Mountain	West Europe	SW	MT	2		1	
Swiss Brownheaded Mutton	West Europe	SW	MT	1		2	
Swiss White Alpine	West Europe	SW	MT	1		2	
Swiss White Mountain	West Europe	SW	MT	1		2	
Tadle	North Africa Mid East	CW	MT	1		2	
Tadmit	North Africa Mid Est	MW	MT	1		2	
Tajik	USSR	W	FR	2		1	
Talavera	West Europe	NW	MT	3	1	2	

Appendix Table 2 (cont'd)

Name	Origin	Type		Purpose			
		Coat	Tail	Meat	Milk	Wool	Pelt
Tanganyika Long-tailed	Central & Southern Africa	H	LFT, SFT or LT	1			
Tan-yang	China, Mongolia	CW	SFT	2		1	3
Targhee	North America	MW	MT	2		1	
Teeswater	West Europe	LW	MT	2		1	
Telengit	USSR	CW	SFT	1		2	
Texel	West Europe	LW	ST	1		2	
Thal	North Africa Mid East	CW	MT	2		1	
Thibar	North Africa Mid East	MW	MT	2		1	
Thones-Marthod	West Europe	CW	MT	1		2	
Tibetan	China, Mongolia	CW	ST	2		1	
Tirahi	North Africa Mid East	CW	FT	2		1	
Transbaikal Finewool	USSR	FW	MT	2		1	
Tsigai	East Europe	MW-CW	MT	3	2	1	
Tuareg	Central & Southern Africa	H	MT	1			
Tuj	North Africa Mid East	CW	SFT	1	3	2	
Tung-yang	China, Mongolia	CW-MW	FT	1		2	
Tunisian Barbary	North Africa Mid East	CW	FT	1		2	
Turcana	East Europe	CW	LT	3	1	2	
Turkmen Fat-rumped	USSR	CW	MT	2		1	
Tushin	USSR	CW	LFT,SFT	2	3	1	
Tyrol Mountain	West Europe	CW	MT	2		1	
Valachian	East Europe	CW	LT	2	1	3	
Valais Blacknose	West Europe	CW	MT	2		1	
Varese	West Europe	CW	MT	1		2	
Velay Black	West Europe	MW	LT	1		2	
Voloshian	USSR	CW	LT-LFT	1		2	
Vyatka	USSR	FW	MT	1		2	
Waziri	North Africa Mid East	CW	FT	2		1	
Welsh Mountain	West Europe	W	MT	2		1	
Wensleydale	West Europe	LW	MT	2		1	
West African Dwarf (Forest)	Central & Southern Africa	H	MT	1			
White Dorper	Central & Southern Africa	H	MT	1			
White Face Dartmoor	West Europe	LW	MT	1		2	
White Karaman	North Africa Mid East	CW	MT	1	2	3	
White Klementina	East Europe	W	MT	3	2	1	
White South Bulgarian	East Europe	W	MT	3	2	1	
Wicklow Mountain	West Europe	SW	MT	1			
Wiltshire Horn	West Europe	H	MT	1			
Zante	West Europe	CW	MT	1	3	2	
Zemmour	North Africa Mid East	CW	MT	1		2	
Zeta Yellow	East Europe	CW	MT	2	1	3	

Legend: Coat Type: H-hairy; W-wooled; FW-finewooled; SW-shortwooled; MW-medium wooled; LW-longwooled; CW-coarsewooled.

Tail type: ST-short tail; MT-medium length, thin tail; LT-long thin tail; FR-fat rump; LFT-long fat tial; SFT-short fat tail; FT-fat tail.

Appendix Table 3. Farmgate Prices of Cattle and Small Ruminants in Africa for 1962, 1966, and 1970 (price per kg live weight,local currency)

Country	Species	1962	1966	1970
Angola	Cattle	5.0	6.75	4.25
	Goats	5.0	3.45	4.43
	Cattle/goats	1.0	1.96	0.96
Cameroon[1]	Cattle	-	0.06	0.064
	Small ruminants	-	0.043	0.053
	Cattle/small ruminants	-	1.4	1.21
Chad[1]	Cattle	20.0	22.2	32.0
	Sheep	22.0	26.7	33.3
	Goats	22.0	23.0	32.0
	Cattle/sheep	0.91	0.83	0.97
	Cattle/goats	0.91	0.97	1.00
Ghana	Cattle	0.40	0.63	0.75
	Small ruminants	0.40	0.69	0.75
	Cattle/small ruminants	1.00	0.91	1.00
Ivory Coast[1]	Cattle	ɔ4.0	ɔ4.0	ɔ2.0
	Small ruminants	58.0	58.0	57.0
	Cattle/small ruminants	0.93	0.93	0.91
Kenya[2]	Cattle	0.82	0.92	1.00
	Sheep	0.90	0.90	1.11
	Goats	0.87	1.00	1.33
	Cattle/sheep	0.91	1.02	0.90
	Cattle/goats	0.94	0.90	0.75
Mali[1]	Cattle	55.0	72.0	98.0
	Sheep	63.3	83.3	120.0
	Goats	55.0	72.0	108.0
	Cattle/sheep	0.87	0.86	0.82
	Cattle/goats	1.0	1.0	0.91
Niger[1]	Cattle	44.0	ɔ6.0	ɔ6.0
	Sheep	67.0	57.0	57.0
	Goats	39.6	60.0	63.6
	Cattle/sheep	0.66	0.98	0.98
	Cattle/goats	1.11	0.93	0.88
Rwanda[1]	Cattle	9.2	13.2	18.0
	Sheep	5.0	8.0	9.3
	Goats	6.0	8.0	9.96
	Cattle/sheep	1.84	1.65	1.94
	Cattle/goats	1.53	1.65	1.81

Appendix Table 3 (cont'd)

Country	Species	1962	1966	1970
Senegal[1]	Cattle	56.0	64.0	64.0
	Sheep	66.7	83.3	83.3
	Goats	66.7	83.3	83.3
	Cattle/small ruminants	0.84	0.77	0.77
Somalia[1]	Cattle	0.5	0.46	0.76
	Sheep	1.1	1.5	1.43
	Goats	1.0	1.39	1.56
	Cattle/sheep	0.45	0.31	0.53
	Cattle/goats	0.50	0.33	0.49
Togo[1]	Cattle	61.0	61.0	61.0
	Sheep	50.0	60.0	60.0
	Goats	52.0	52.0	52.0
	Cattle/sheep	1.22	1.02	1.02
	Cattle/goats	1.17	1.17	1.17
Upper Volta	Cattle	90.0	75.0	95.0
	Sheep	60.0	161.0	120.0
	Goats	50.0	108.0	100.0
	Cattle/sheep	1.5	0.47	0.79
	Cattle/goats	1.8	0.69	0.96
Zaire	Cattle	0.107	0.17	0.18
	Sheep	0.163	0.217	0.22
	Cattle/sheep	0.66	0.78	0.82
Zambia[1]	Cattle	0.15	0.22	0.32
	Sheep	0.22	0.22	0.27
	Cattle/sheep	0.68	1.00	1.19
Unweighted ratio of prices of cattle/small ruminants, Africa		1.02	0.98	0.99

Source: FAO 1975.

Notes

[1] Prices quoted on a per-head basis; converted to price per kg live weight on the basis of cattle at 250 kg, sheep at 30 kg and goats at 25 kg.

[2] Prices quoted on a per-head basis; converted to price per kg live weight on the basis of cattle at 300 kg, sheep at 45 kg and goats at 30 kg.

Appendix Table 4. Farmgate Prices of Cattle and Small Ruminants in Latin America and the Caribbean for 1962, 1966, and 1970 (price per kg live weight, local currency*)

Country	Species	1962	1966	1970
Argentina	Cattle	.13	.50	.98
	Small ruminants	.09	.34	.60
	Cattle/small ruminants	1.44	1.47	1.63
Brazil	Cattle	.046	.345	.66
	Sheep	.066	.414	.69
	Goats	.029	.367	.71
	Cattle/sheep	.70	.83	.96
	Cattle/goats	1.60	.94	.93
Chile	Cattle	30.0	132.0	412.0
	Small ruminants	30.0	153.0	339.0
	Cattle/small ruminants	1.0	0.86	1.22
Colombia	Cattle	2.0	3.9	4.75
	Sheep	2.3	4.9	6.7
	Cattle/sheep	0.87	0.80	0.71
Guyana	Cattle	0.76	.89	.98
	Sheep	1.29	1.40	1.55
	Cattle/sheep	0.59	0.64	0.63
Paraguay	Cattle	11.8	14.1	14.3
	Small ruminants	12.9	17.7	20.3
	Cattle/small ruminants	0.91	0.80	0.70
Uruguay	Cattle	1.36	9.16	28.9
	Sheep	.835	7.50	28.0
	Cattle/sheep	1.63	1.22	1.03
Unweighted ratio of price of cattle/ small ruminants, Latin America		1.10	0.95	0.98

* For prices quoted on a per-head basis, cattle were converted at 400 kg live weight per head, sheep at 35 kg live weight per head and goats at 30 kg live weight per head.

Source: FAO 1975.

Appendix Table 5. Farmgate Prices of Cattle and Small Ruminants in Asia for 1962, 1966, and 1970 (price per kg live weights, local currency*)

Country	Species	1962	1966	1970
Burma	Cattle	2.3	2.9	3.3
	Small ruminants	1.0	1.5	1.7
	Cattle/small ruminants	2.3	1.9	1.9
Malaysia:Sabah	Cattle	1.40	1.45	1.53
	Goats	0.80	0.84	0.88
	Cattle/goats	1.75	1.73	1.74
Pakistan	Beef	1.47	1.74	2.14
	Mutton	3.08	3.62	4.55
	Beef/mutton	0.48	0.48	0.47

* Cattle converted from per-head basis at 300 kg live weight, sheep at 30 kg live weight and goats at 25 kg live weight.

Source: FAO 1975.

Appendix Table 6. Index Numbers of Prices Received by Farmers in Latin America

Country	Base Period	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Honduras	1972										
Crops			100		112	110	124	146	151	150	
Livestock & livestock products			100		138	104	119	131	169	219	242
Argentina	1976										
Crops				5	6	18	100	244	633	1,303	
Livestock & livestock products				7	8	14	100	289	640	1,976	
Bolivia	1975										
Crops					106	100	95	109	147	153	246
Livestock & livetsock products					96	100	92	89	99	104	150
Brazil	1977										
Crops					22	30	55	100	110	154	292
Livestock & livetock products					48	56	59	100	152	281	512
Colombia	1970										
Crops				201	256	346	401	678	597		
Livestock & livestock products				220	299	351	445	633	787		
Uruguay	1975										
Crops					57	100	125	169	307	487	940
Livestock & livetock products					79	100	151	251	441	1,029	829

Source: FAO Production Yearbook, 1980, Vol. 34.

Appendix Table 7. Index Numbers of Prices Received by Farmers in Africa

Country	Base Period	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Bostwana	1978										
Crops									100	111	122
Livestock & livestock products									100	112	137
Egypt	1962/63-1964/65										
Crops				167	214	224	253				
Livestock & livestock products				138	155	175	210				
Rwanda	1974										
Crops					100	138	152	158	178	217	
Livestock & livetock products					100	138	147	154	181	226	
South Africa	1958/59-1960/61										
Crops		125	137	168	193	223	231	247			
Livestock & livestock products		139	195	227	240	262	280	280			
Zimbabwe	1964										
Crops					137	147	146	156	170	181	
Livestock & livestock products					155	169	172	180	180	213	

Source: FAO Production Yearbook, 1980, Vol. 34.

Appendix Table 8. Index Numbers of Prices Received by Farmers in Asia

Country	Base Period	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Korea	1975										
Crops		41	52	56	78	100	121	138	181	210	257
Livestock & livestock products				73	86	100	138	169	232	221	260
Philippines	1972										
Crops					169	169	200	200	194	221	234
Livestock & livestock products					167	192	237	238	236	304	344

Source: FAO Production Yearbook, 1980, Vol. 34.

Appendix Table 9. Latin America and Caribbean: Summary of Research, Development, Credit and Training Projects with Possible Sheep and Goat Components

Project Title	Institution	Project Type	Production System	Major Species	External Funding Source	Period of Operation
Central America and Caribbean						
Regional Small Farming System Project	CATIE, Costa Rica	R + T	Mixed	Pigs, poultry cattle, goats	USAID-ROCAP	1979-83
Blenheim Sheep Development Project	Government, of Trinidad & Tobago	R + D	Mixed	Hair sheep	None--local financing	1981-83
Goat Production Improvement Program	Haiti, Min. of Agric.	D + T	Mixed	Goats	Arkansas United Methodist Church	1982-85
Livestock & Agriculture Development	Government, of Mexico	C	Mixed & Animal	Cattle, swine poultry, sheep	IBRD	1969-74
Agriculture Credit Project	FONDO-Mexico	C	Animal	Beef & dairy cattle, swine, sheep	IBRD	1965-69
Southern Latin America						
Livestock, Fruit, Vineyard & Agro. Ind. Credit Project	Chile, Ministry of Agriculture	C + D	Mixed, crop, animal	Dairy, beef, sheep	IBRD	1977-81
Agriculture Development	Uruguay Min. Agric.	C + D	Mixed	Cattle, sheep	IBRD	1980-86
Livestock Dev. Projects I-IV	Uruguay Min. Agric.	D	Animal	Cattle, sheep	IBRD	1960-74
Ulla Ulla Development Project	Bolivia Min. Agric.	D	Animal	Alpaca, llama	IBRD, IDA	1978-83
Agriculture Credit Project	Bolivia	C	Mixed	Beef, cattle, sheep	IDA	1975-80
Integ. Rural Dev. Project	Colombia Min. Agric.	C + D	Mixed	Cattle, swine, poultry, rabbits, sheep	IBRD	1977-82
Agriculture Credit Project	Ecuador Min. Agric.	C	Animal	Cattle, sheep, goats	IBRD	1978-82
3rd Livestock Development	Bolivia Min. Agric.	C + D	Animal	Cattle, sheep	IDA	1971-80
Livestock Dev., I & II	Colombia Min. Agric.	C + D	Animal	Cattle, sheep	IBRD	1966-75
Puno Rural Dev.	Peru Min. Agric.	D	Mixed	Cattle, poultry, Swine, alpaca, sheep	IBRD	1981-85
Ag. Credit Projects	Argentina, Min. Agric.	C	Animal	Cattle, sheep	IBRD	1979-83
Small Ruminant CRSP	Peru - INIPA	R + T	Mixed & Animal	Sheep, goats	USAID	1980-86
Small Ruminant CRSP	Brazil - EMBRAPA	R + T	Mixed	Sheep, goats	USAID	1980-86
Nat'l Goat Res. Center	EMBRAPA - Brazil	R + T	Mixed	Sheep, goats	IICA-IBRD	1978-present

Notes:
R = Research
T = Training
D = Development
C = Credit

Appendix Table 10. Mid-East and North Africa: Summary of Research, Development, Credit, and Training Projects with Possible Sheep and Goat Components

Project Title	Country-Institution	Project Type	Production System	Major Species	External Funding Source	Period of Operation
North Africa						
Souss Groundwater Project	Morocco	R + D	Mixed	Sheep, cattle	IBRD	1975-82
Madjerda/Nebhana Irrig.	Tunisia Min. Agric.	D + T	Mixed	Cattle, sheep	IBRD	1982-88
Meat Industry Development	Algeria-ONAB	D	Animal	Sheep	IBRD	1982-84
Agric. Credit	Morocco-CNAC	C	Mixed	Cattle, sheep	IBRD	1977-81
2nd Agric. Credit	Morocco	C	Mixed	Beef cattle, sheep	IBRD	1972-75
Luokkos Rural Development Project	Morocco Min. Agric.	D	Mixed	Cattle, sheep, goats	IBRD	1981-87
Middle Atlas Agric. Development	Morocco Min. Agric.	D	Mixed	Horses, cattle, sheep goats	IBRD	1982-88
N. W. Rural Development Project	Morocco	C + R & D + T	Mixed	Cattle, sheep	IBRD, Germany	?
1st Livestock Development Project	Syria Min. Agric.	C + D	Animal	Dairy cattle, sheep	IBRD	1978-82
Small Ruminant CRSP	Morocco Hassan II Univ.	R + T	Animal, mixed	Sheep, goats	U.S.AID	1982-86
Prolific Sheep Center (SR-CRSP)	Morocco Hassan II Min. Agric.	R + T	Animal	Sheep	U.S.AID	?
Nuclear Techniques for Sheep & Goats	Africa-Middle East Region	R	Animal	Sheep, goats	I.A.E.A. (Vienna)	?
Livestock Development Project	Afghanistan-Herat Livestock Dev. Crop.	R + D	Animal	Sheep	IDA	1974-81
2nd Livestock Dev. Project	Afghanistan-Sheep Imp. Center	R + D	Animal	Sheep	IDA	1976-82
Agric. & Rural Dev. Project	Afghanistan Min. Agric.	R, D, C	Animal	Cattle, poultry, sheep	UNDP-IDA-IFAD	1979-84
3rd Abbi Agric. Credit Project	Iran-Agric. Dev. Bank	C	Mixed	Poultry, cattle, sheep	IBRD	1975-79
Intensive Sheep Meat Production and Marketing	Iran Min. Agric.	D + T	Animal	Sheep	UNDP/FAO	1973-76
2nd Livestock Development	Turkey	D + C	Mixed	Cattle, sheep	IDA	1973-80
5th Livestock Development	Turkey	D + C	Mixed	Poultry, cattle, sheep	IBRD	1980-87
4th Livestock Development	Turkey	C	Mixed	Cattle, sheep	IBRD	1978-85
Livestock Credit & Processing	Yemen Arab Republic-Nat'l Livestock Dev. Corp.	D	Animal	Poultry, cattle, sheep, goats	IDA-Kuwait Dev. Fund--Holland	1977-84 1977-84
Erzurum Rural Development	Turkey Min. Agric.	D + C	Mixed	Cattle, sheep, goats	IBRD-IFAD	1982-87

R = Research Project D = Development Project
T = Training Project C = Credit Project

Appendix Table 11. Sub-Saharan Africa: Summary of Research, Development, Credit, and Training Projects with Possible Sheep and Goat Components

Project Title	Institution	Project Type	Production System	Major Species	External Funding Source	Period of Operation
Livestock Marketing	Sudan Min. Agric.	D	Animal	Sheep, goats, cattle camels	IDA-ODM	1979-84
Sheep & Goat Production	Gov't of Ghana	T + D	Mixed	Sheep, goats	UNDP/FAO	1978-82
Livestock Marketing in Central Zone	Niger Gov't	R	Animal	Cattle, camels, sheep, goats	U.S.AID	1982
West Volta Livestock Project	Upper Volta Min. Rural Development	R	Animal	Cattle, sheep, goats	French Government	1979-81
Livestock Project	Mali Min. Agric.	D	Animal	Cattle, sheep, goats, camels	IDA	1975-82
Rangeland Development	Ethiopia Min. Agric.	D	Animal	Cattle, sheep, goats, camels	IDA-ADF	1976-83
Bay Region Agric. Development	Somalia	D + T	Animal, mixed	Cattle, sheep, goats	IDA-ADF-U.S.AID-IFAD	1980-87
Narok Agric. Development	Kenya Min. Agric.	D + T	Mixed	Cattle, sheep, goats	IDA-CIDA	1979-84
Livestock Development Project	Mauritania	D	Animal	Cattle, sheep, goats	IDA	1972-76
Livestock Development Project	Botswana	D	Animal	Cattle, Karakul sheep	IDA-SIDA	1973-80
Central Rangelands Development	Somalia	D + T	Animal	Cattle, camels, sheep, goats	IDA-IFAD-U.S.AID-ODM-WFP	1980-86
Improvement of Small Ruminant Production in the Humid Zone	ILCA-IITA Nigeria Gov't	R + T	Mixed	Sheep, goats	CGIAR-Ford Foundation	1977-present
Sheep & Goat Development Project	Kenya Min. Livestock Development	D + T	Animal	Sheep, goats	UNDP/FAO	1975-present
Small Ruminant CRSP	Kenya Min. Livestock Development	R + T	Mixed	Dairy Goats	U.S.AID	1980-86

R = Research Project D = Development Project
T = Training Project C = Credit Project

Appendix Table 12. South and Southeast Asia: Summary of Research, Development, Credit, and Training Projects with Possible Sheep and Goat Components

Project Title	Country-Institution	Project Type	Production System	Major Species	External Funding Sources	Period of Operation
South & West Asia						
All-India Coord. Research Project on Sheep Breeding	India-Central Sheep & Wool Research Inst.	R + T	Animal	Sheep	None	1974-present
Sheep & Goat Research & Dev. Project	India-Central Sheep & Wool Research Inst.	R, T, D	Mixed, animal	Sheep, goats	None	1962-present
Drought Prone Areas	Indai Min. Agric. & Irrigation	D + T	Mixed	Dairy cattle, sheep	IDA	1975-81
National Sheep & Yak Dev. Project	Bhutan Min. Agric.	D + T	Animal	Yaks, sheep	UNDP/FAO	1974-78
Sheep, Goat & Wool Dev. Project	Nepal Min. Agric.	D + T	Mixed	Sheep, goats	UNDP/FAO	1974-80
Rainfed Agricultural Development	Philippines Min. Agric.	D + T	Mixed	Cattle, swine, goats	IBRD	1980-81
Small Ruminant CRSP	Indonesia-AARD	R + T	Mixed	Sheep, goats	U.S.AID	1980-86
Animal Research & Development Inst.	Indonesia-AARD	R + T	Mixed, animal	Cattle, buffalo, sheep, goats, poultry	Australia-ADAB	1973-present
Central Goat Research Institute	India-ICAR	R + T	Mixed, animal	Goats	None known	1978-present
All-India Coord. Goat Project	India-ICAR	R, T, D	Mixed, animal	Goats	None known	1972-present
Hill Country Dairy Goat Dev. Program	Sri Lanka	D	Mixed	Goats	None known	1978-present
Dairy Goat Dev. Program	Philippines Bureau Animal Inst.	D	Mixed	Goats	None known	1977-present
Goat Development Program	Fiji Min. Agric.	D + T	Mixed	Goats	UNDP/FAO	1976-80

R = Research Project D = Development Project
T = Training Project C = Credit Project

Appendix Table 13. Europe and North America: Summary of Research, Development, Credit, and Trainng Projects with Possible Sheep and Goat Components

Project Title	Country-Institution	Project Type	Production System	Major Species	Exeternal Funding Sources	Period of Operation
Nucleus Breeding Units Milk Recording Schemes	Cyprus Min. Agric. & Natural Resources	R + D	Mixed	Sheep, goats	United Nations	1976-86
Mixed Farming Project	Cyprus Min. Agric. & Natural Resrouces	C + D	Mixed	Sheep, goats	WFP	1967-present
Smallholder Livestock Project	Cyprus Min. Agric. & Natural Resources	C + D	Mixed	Sheep, goats	None	1982-present
Bosanska Krajina Agr. & Agro-Ind. Project	Yugoslavia-	D	Mixed	Swine, poultry, cattle sheep, goats	IBRD	1979-83
Macedonia III Agric. Dev. Project	Yugoslavia-	D	Mixed	Swine, poultry, bees cattle, sheep, goats	IBRD	1982-87
2nd & 3rd Agric. Credit Project	Yugoslavia-	C + D	Mixed	Swine, poultry, cattle, sheep, goats	IBRD	1978-85
Morava Reg. Development II	Yugoslavia-	C + D	Mixed	Swine, poultry, cattle, sheep, goats	IBRD	1981-86
Moldava Agric. Credit	Romania-	C + D	Mixed	Dairy cattle, sheep	IBRD	1982-86
Tras-os-Montes Rural Development	Portugal-	D	Mixed	Cattle, sheep, goats	IBRD	1982-88
Agricultural and Fisheries Credit	Portugal-	C	Mixed	Fish, cattle, sheep, goats	IBRD	1980-84

R = Research Project D = Development Project
T = Training Project C = Credit Project

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Highlights the importance of fisheries to the economies of developing countries and recommends that the World Bank provide assistance to those countries that have the fishery resources and are willing to develop them further.

Sector Policy Paper. December 1982.

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World Bank Staff Working Paper No. 393. June 1980. 39 pages (including appendix, references).

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Examines the significance of forests in economic development and concludes that the World Bank should greatly increase its role in forestry development, both as a lender and adviser to governments.

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Stock No. WP-0500. $5.00.

Agricultural Research and Productivity

Robert E. Evenson and Yoav Kislev

Examines the role of scientific research and technological change in increasing agricultural productivity.

Yale University Press, 302 Temple Street, New Haven, Connecticut 06520, U.S.A. 1975. xi + 204 pages (including 10 appendixes, references, index).

LC 74-15210. ISBN 0-300-01815-0, $15.00 hardcover; ISBN 0-300-01877-0, $3.95 paperback.

Spanish: Investigación agrícola y productividad. *Editorial Tecnos, 1976.*

ISBN 84-309-0641-X, 420 pesetas.

Agroindustrial Project Analysis

James E. Austin

Provides and illustrates a framework for analyzing and designing agroindustrial projects.

EDI Series in Economic Development. The Johns Hopkins University Press, 1981. 224 pages (including appendixes, bibliography, and index).

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French: L'Analyse des projets agro-industriels. Economica, 1982.

ISBN 2-7178-0480-3, 49 francs.

Spanish: Análisis de proyectos agroindustriales. *Editorial Tecnos, 1981.*

ISBN 84-309-0882-X, 600 pesetas.

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The Johns Hopkins University Press, 1983. 632 pages.

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World Bank Staff Working Paper No. 528. July 1982. v + 69 pages (including references).

ISBN 0-8213-0051-2. $3.00.

Casos y Ejercicios Sobre Proyectos Agrícolas

Edited by Orlando T. Espadas

Three case studies prepared in conjunction with the EDI's Agricultural Projects Courses in Spanish and intended primarily for teachers of project analysis.

World Bank (EDI), March 1974; revised January 1975. 480 pages (Available from ILS, 1715 Connecticut Avenue, N.W., Washington, D.C. 20009, U.S.A.)

$5.00 paperback.

The Design of Organizations for Rural Development Projects—a Progress Report

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World Bank Staff Working Paper No. 375. March 1980. 48 pages. English and French.

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The Design of Rural Development: Lessons from Africa

Uma Lele

Analyzes new ways of designing rural development projects to reach large numbers of low-income subsistence populations. The paperback reprinting in 1979 contains a new chapter by the author updating her findings.

The Johns Hopkins University Press, 1975; 3rd printing, 1979. 260 pages (including glossary, appendix, maps, bibliography, index).

ISBN 0-8018-1769-2, $9.95 paperback.

French: Le développement rural: l'expérience Africaine. *Economica, 1977.*
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The Johns Hopkins University Press. 1982. 145 pages. French and Spanish forthcoming.

LC 82-7126. ISBN 0-8018-2910-0, $8.50 (£6.50) paperback.

Monitoring Rural Development in East Asia

Guido Deboeck and Ronald Ng

World Bank Staff Working Paper No. 439. October 1980. 91 pages (including annexes).

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Rural Development

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Sector Policy Paper, February 1975, 89 pages (including 14 annexes). English, French, Spanish, and Arabic.

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Rural Projects Through Urban Eyes: An Interpretation of the World Bank's New-Style Rural Development Projects

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This paper describes the Bank's new-style rural development projects, including some of the things that happen in the political environment of a project when governments, assisted by the Bank, redirect their public-sector services and subsidies to the rural poor.

World Bank Staff Working Paper No. 532. 1982. 100 pages.

ISBN 0-8213-0028-8. $3.00.

Sociocultural Aspects of Developing Small-Scale Fisheries: Delivering Services to the Poor

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World Bank Staff Working Paper No. 490. October 1981. iii + 61 pages (including references).

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A System of Monitoring and Evaluating Agricultural Extension Projects
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Michael M. Cernea

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In the ten years since its publication, the first edition has been accepted widely as a standard reference and text. The methodology reflects the best of contemporary practice in government agencies and international development institutions concerned with investing in agriculture and is accessible to a broad readership of agricultural planners, engineers, and analysts.

This revision adds a wealth of recent project data; expanded treatment of farm budgets and the efficiency prices used to calculate the effects of an investment on national income; a glossary of technical terms; expanded appendixes on preparing an agricultural project report and using discounting tables; and an expanded, completely annotated bibliography.

EDI Series in Economic Development.

The Johns Hopkins University Press. July 1982. 528 pages (including appendixes and glossary/index).

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