THE ROLE OF SHEEP AND GOATS
IN
AGRICULTURAL DEVELOPMENT

A STATE OF THE ARTS STUDY

By

WINROCK INTERNATIONAL LIVESTOCK RESEARCH AND TRAINING CENTER

Route 3

Morrilton, Arkansas

Co-sponsored By

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

TECHNICAL ASSISTANCE/AGRICULTURE

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PREFACE

Winrock International Livestock Research and Training Center is a non-profit, publicly supported institution concerned with improving the role of livestock in the service of man. Particular attention is paid to ruminants and their place in agricultural systems suited to limited resource producers.

The approximately 1.5 billion sheep and goats of the world are a major resource for feeding and clothing mankind. The current role of sheep and goats in developing countries ranges from a very minor level of production in some of the countries in the wet tropics to being the principal source of animal protein in certain North African and Middle East nations. The lack of understanding of the roles of sheep and goats has generally resulted in their being ignored as a part of the sustenance and development cycle for small farmers and pastoralists.

In recognition of the need for better understanding of the contributions of sheep and goats, this state-of-the-arts study was initiated by Winrock International with partial support from a grant by the U. S. Agency for International Development, Technical Assistance/Agriculture. We are indebted to the scientists, educators, administrators, public officials, producers and others who shared experiences, publications and other background information.

In a sense, the absence of major development efforts dealing

with sheep and goats provides an unique opportunity - the opportunity and challenge to begin the development process with these species in a systematic and integrated approach at the appropriate entry levels and with appropriate implementation techniques. It is the sincere desire of the institutions responsible for this study that this report will provide the stimulus for attainment of the necessary understanding, communication and coordination required to determine the proper role for sheep and goats in future agricultural development efforts.

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TABLE OF CONTENTS

OVERVIEW

OVERVIEW

BACKGROUND

This study is part of a research project sponsored jointly by Winrock International Livestock Research and Training Center and the United States Agency for International Development. The principal objective of this study is to assess the appropriate role of sheep and goats in agricultural development, with emphasis on the tropical, warm regions of the world between 30^{o} N and 30^{o} S of the equator. The specific objectives of this study include: (1) documentation of production coefficients for sheep and goat systems, (2) identification of constraints and potentials for production and marketing systems, (3) assessment of research, training and development programs involving sheep and goats, (4) characterization of prevailing attitudes of policy makers and planners toward sheep and goats, and (5) suggestion of projects and locations for sheep and goat improvement projects from which important social and economic benefits are likely to result.

To accomplish these objectives, a workshop was held at the Winrock International Livestock Research and Training Center in November, 1976 to assist the research team in planning and sharpening the focus of the study. Leading authorities from around the world representing major research, education and development institutions participated in this workshop. Proceedings of this workshop are published separately and are available upon request.

The developing world was divided into four regions that, although not necessarily representing all areas with development needs, do include most tropical and subtropical environments. The four regions are: (1) Latin America; (2) Africa; (3) Southeast Asia and the Asian Subcontinent; and (4) the Middle East. Teams from Winrock International staff were assigned responsibilities for each region. Consultants with expertise in specific regions were also retained for assistance on this project. Within each region, the assigned team was responsible for accumulating existing regional input/output data; describing existing production and marketing systems; identifying regional and in-country institutions, organizations and scientists involved in sheep and goat production; reviewing available literature sources; and visiting selected countries within each region. Countries visited include:

Latin America	Africa	Southeast Asia and Asian Subcontinent
Mexico	Egypt	Philippines
Costa Rica	Ethiopia	Indonesia
Colombia	Kenya	Malaysia
Paraguay	Tanzania	India
Brazil	Nigeria	Afghanistan
Trinidad-Tobago	Cameroon	
Barbados		

In addition, Winrock team members have studied sheep and goat production

systems in the United Kingdom, France, Spain, Italy, Greece, Bulgaria, Venezuela and Iran in conjunction with other projects. Administrators and scientists involved in sheep and goat research and development programs were also visited in France and at the Food and Agriculture Organization of the United Nations in Italy.

Much of the data essential for definitive conclusions and recommendations do not exist. As a result, many conclusions and recommendations must be based on subjective evaluation, experience and intuition. The extent to which documents produced by this study are effective must be measured by their stimulation of needed objective research and creative development programs to improve the contribution of sheep and goats in the service of mankind.

WORLD AND REGIONAL PRODUCTION, CONSUMPTION AND TRADE

The current role of sheep and goats in developing countries ranges from a very minor role in some of the countries in the wet tropics to being the principal source of animal protein in certain North African and Middle Eastern nations. Production systems vary from nomadic desert range production where survival is the major objective to highly efficient, large scale intensive meat and milk production units in other regions. Variations in breeds or types of sheep and goats are as widely different as the environmental and social conditions under which they are managed.

Sheep and goats are generally viewed in much of the developed world as animals requiring improved management and increased investments in facilities, labor and health care. In general, just the opposite view is held in the developing world. Hardy breeds or types have been developed that permit use of sheep, and especially goats, on lands that will not support other domestic species such as cattle. In addition, a significant portion of the sheep and goat population in the developing world exist as scavengers, often observed on the streets of villages, towns and city metropolitan areas.

The 1974 world human and livestock numbers, land area, and relative percentages in the four developing regions are presented in Table 1. Although this study is specifically concerned with sheep and goats, mixed crop-livestock and/or multispecies production systems are the rule rather than the exception in the developing world. These interrelationships are discussed throughout the report.

Table 1. 1974 World Human and Livestock Numbers and World Land Area, and Relative Percentages in the Developing Regions.[1]

Item	World Total	Latin America[2]	Africa[3]	Southeast Asia and Asian Subcontinent[4]	Middle East[5]
	(000)	%	%	%	%
Land area, hectares	13,399,313	15.4	22.4	7.0	5.0
Humans	3,904,898	8.0	9.8	27.7	3.0
Cattle	1,178,867	21.7	11.3	21.5	1.9
Sheep	1,032,667	12.0	11.2	7.4	10.0
Goats	397,916	10.3	28.0	26.8	12.0
Buffalo	130,311	0.1	1.6	72.0	3.0
Camels	13,256	-	71.0	17.0	9.0
Horses, mules, asses	120,764	34.2	13.3	5.3	6.3

[1]FAO Production yearbook. 1974.

[2]The Latin America region includes all countries in Central and South America and the Caribbean except Pureto Rico and U. S. Virgin Islands.

[3]The African region includes all countries in Africa except Rhodesia, the Republic of South Africa and Southwest Africa.

[4]For the purposes of this study Southeast Asia includes Phillipines, Indonesia, Malaysia, Thailand, Laos, Cambodia, Vietnam and Burma, and the Asian Subcontinent includes India, Pakistan, Afghanistan, Nepal and Bangladesh.

[5]For the purposes of this study the Middle East includes Iran, Turkey, Israel and the Arab nations of Near East Asia (Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen Arab Republic and Yemen Peoples Democratic Republic.

The developing regions discussed in this report contain approximately 50 percent of the world's people and land area. Population density, however, varies from approximately 7 percent of the world's land area in Southeast Asia and the Asian Subcontinent supporting 27.7 percent of the world's human population to only 10 percent of the world's people in Africa living on over 22 percent of the world's land. These figures are deceiving, because over half of Africa is essentially desert or tropical forest and is essentially uninhabited by man. In general, however, agricultural land in the developing world which is arable or capable of supporting domestic livestock already supports a human population at or above the land's capability to provide adequate food at current technology levels.

The four developing regions also contain approximately 56 percent of the world's cattle, 41 percent of the sheep and 78 percent of the goats. Cattle are clearly the dominant livestock species in Latin America and the savannah zones of Africa, although sheep and goats are important as followers of cattle in the more arid savannahs. India, with almost 20 percent of the world's cattle would appear to be highly dependent on cattle; however, a major portion of these are sacred animals with limited value for meat production. In terms of the ratio of livestock to people, the sheep and goats of North Africa and the Middle East are the most significant statistics; however, livestock are the principal source of income and sustenance to pastoral societies

throughout the desert and arid savannah regions of the world.

The productivity of sheep and goats on a world and regional basis are presented in Table 2. In terms of productivity, the goats of India and the sheep and goats of North Africa and the Middle East exceed world averages for meat and milk production, thus reflecting their importance and level of management within the regions. The same is true for wool production in southern South America. Productivity, however, must also be viewed in terms of the production environment. A major portion of the sheep and goats of the developing world are expected to produce where other species would not survive.

There is also growing evidence throughout the developing world that many of the indigenous breeds will, under adequate nutrition and management conditions, perform at levels normally expected only from so-called exotic breeds from developed countries. Growing evidence indicates that many local breeds are resistant to local disease problems and are better adapted to local climatic and feed conditions.

The 1970 FAO data on production, consumption and net trade and 1980 projections for sheep and goat meat are presented in Table 3. The 1980 FAO projections indicate production increases in all regions of the world except North America and the United Kingdom. The largest production increases are projected for Oceania, Africa, the Near East, Asia and the Far East and the USSR and Western Europe regions. Wool and mohair production are not projected to increase at a rate equivalent to projected meat production increases, due primarily to competition from synthetic

Table 2. Productivity of Sheep and Goats in 1974; World Averages and Averages for the Developing Regions.[1]

	World	Latin America	Africa	Southeast Asia and Asian Subcontinent	Middle East
	kg/head/year				
Sheep					
Meat	5.2	2.6	3.7	3.4	5.4
Milk	7.0	0.2	5.6	6.2	16.3
Wool	2.5	2.4	0.6	1.1	1.2
Goats					
Meat	3.6	2.2	2.8	3.9	3.5
Milk	17.6	8.8	12.2	16.7	28.6

[1] FAO production yearbook. 1974.

fiber prices. While this was clearly the case in the first half of the decade, increased prices of petroleum used for synthetic fiber production may result in increased prices for wool. On the basis of this study, there is evidence that increases in meat production from sheep and goats may exceed the projected levels for North and East Africa and for the Middle East. This is due primarily to increases in demand for sheep and goat meat and increased investment in sheep and goat development schemes in the OPEC nations of North Africa and the Middle East. Depressing effects of drought and low cattle prices have also been a factor in East Africa for

Table 3. 1970 FAO Data on Production, Consumption and Net Trade and 1980 Projections for Sheep and Goat Meat.[1,2,3]

Region	1970			1980		
	Prod.	Consumption	Trade	Prod.	Consumption	Trade
	(000 Metric tons)					
Economic class I						
North America	260	340	80	212	383	171
European Economic Community	171	224	53	193	298	105
United Kingdom	230	590	360	202	658	456
Other Western Europe	400	423	23	463	550	87
Oceania	1335	755	-580	1735	853	-882
Other Developed	221	356	135	323	532	209
Economic Class II						
Africa	662	642	-20	958	956	-2
Latin America/Caribbean	476	422	-54	643	651	8
South America	407	349	-58	531	535	4
Near East	874	914	40	1147	1465	318
Asia and Far East	552	566	14	837	910	73
Economic Class III						
USSR/Eastern Europe	1277	1265	-12	1690	1717	27
Asian Centrally Planned	751	712	-39	969	1008	39
World Totals	7203	7200	-3	9362	9969	607

[1]FAO. 1972. Agricultural Commodity Projections: 1970-1980. Rome.

[2]Production data are in terms of carcass weight excluding offal and slaughter fats.

[3]Trade data represent the estimated carcass weight equivalent of meat (fresh, chilled, frozen, processed) and of live animals. Exports indicated by - sign.

the producer shift from cattle to sheep and goats.

On the basis of projected levels of production and consumption demands, world demand would exceed production by approximately 600,000 metric tons, or the production from 30-40 million sheep and goats by 1980. On the basis of updated consumption demand projections for the Middle East (see Middle East section of study), consumption demand by 1980 will have increased by 100,000 to 300,000 metric tons above those levels projected in Table 3. Either numbers and/or offtake will have to increase dramatically in the near future or projected demand will not be met. These data clearly indicate a favorable future for prices for sheep and goat meat in those areas near the expanding markets.

Other points of interest in these data are the suggestion that the Latin America and South America regions are shifting from net exporters to net importers of sheep and goat meat. The only developing regions with any apparent potential to capture a portion of the new market demand represented by the Middle East appear to be North and East Africa.

WORLD SHEEP AND GOAT PRODUCTION SYSTEMS

Sheep and goat production systems are determined by social and economic factors, tradition and, most importantly, by available resources. Pastoralists and their animals, as well as city dwellers with their scavenger sheep and goats, have adapted remarkably well to their environment. Few outsiders fully understand the tribal codes and traditions that pastoral societies have developed to protect their territorial grazing rights and animal use privileges.

For this study, the tropical ecozones were divided into four range types - desert shrub, woodland shrub, tropical savannahs and tropical forests. Production systems, however, are similar in the desert shrub, woodland shrub and the more arid sections of the tropical savannahs. The following section attempts to summarize the production systems found around the world in these range areas.

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.

In general, sheep and goats are the dominant livestock species on these ranges. Under the extreme dry conditions of the desert regions of North and East Africa, the Middle East, the Indian Subcontinent and Southwest Asia, the camel may be the dominant livestock species. Where sheep and goats are the primary food production enterprise, the camel is often the primary mode of transportation for herders. Few cattle are found on ranges receiving less than 200 mm annual rainfall, or in the woodland shrub ranges.

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 since cattle could not survive and produce on these lands.

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 encroaching on former nomad grazing lands, education and industrialization that is attracting younger nomads to urban jobs are all contributing to the decline. 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. It is estimated, for example, that the sheep and goat flocks of East Africa have an excess of 10 million males. Education and marketing programs are needed to encourage sale of surplus males. This practice should both reduce grazing pressures on the overgrazed desert shrub ranges and increase offtake and flock productivity in those that remain due to the resulting higher proportion of reproducing females in the flock and improved grazing conditions.

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 most 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. Even though the nutrient quality of desert forage tends to be good, the amount of forage is in short supply. Thus, undernutrition is a major problem leading to high mortality and low productivity.

Many of the world's unique genetic resources are found in the desert and woodland shrub ranges. These breeds are very hardy and have adapted in size and shape to their environment. Some breeds of particular interest include: the Awassi, Karamon, Balouchie and Nejdi sheep breeds of the Middle East; the Fulani, Red Masai and Blackhead Persian (Somali Blackhead) sheep breeds of Africa; and the hair sheep-Pelo de Boi, Tabasco and Barbados Black Belly-of Latin America. Desert milk goats generally trace their origins to the Nubian of the Middle East or Indian breeds such as Jamunapari. Meat goats of interest should

include the various dwarf breeds around the world - East African Dwarf, West African Dwarf, the Maridi in West Africa and the Barbari of India. The "Spanish" or criollo goats of Southwestern U.S. and Latin America also merit further study.

The major problems on desert shrub ranges are related to improved land utilization and land use control. Range improvement without grazing control is an exercise in futility; producers will simply increase numbers to take advantage of available feed resources. Unless strict control is possible, then cooperation from all graziers is essential. This is a difficult goal to achieve. Development of supplemental feed resources without grazing control usually produces the same results. Livestock water is often the major constraint to efficient rangeland use, yet livestock water development without concurrent grazing controls has only created new problems. Further, any improvement in the production environment without intensive education and marketing programs will only result in increased numbers but little improvement in productivity.

TROPICAL SAVANNAH RANGES

The tropical savannahs are generally considered the major range type for livestock in the world. 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. However, production of sheep and goats on the South American tropical savannahs does have potential, if local and/or export demand should develop.

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-around grazing and water for economically viable units. Cattle are the principal livestock species although sheep and goats are increasing in popularity among commercial ranch units in Africa. 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 importance or potential 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 to 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.

Many breed resources appear to have high potential in the tropical savannahs. The breeds previously mentioned in the desert and woodland shrub section are generally the most important breeds in the arid savannah zones. Where wool marketing has been developed, large flocks of wool sheep such as Corriedales and Merinos may be seen. The Dorper breed of sheep, developed in South Africa and now spread throughout Kenya, clearly appears to be a hardy and productive breed with tremendous potential in medium and high potential zones. Dorpers have a high reproduction rate, rapid growth rates and produce excellent carcasses. Under improved conditions, three lamb crops in two years appear to be possible. The hair sheep in Latin America mentioned earlier, also show potential for meat and hide production. The Boer goat, developed in South Africa, also appears to be a meat goat with tremendous potential (this breed is being evaluated in several East African countries). Specialized meat production systems using strictly Boer goats in high potential areas, and Boer males as terminal sires in medium potential areas, appear to offer tremendous increases in productivity.

There also appears to be tremendous potential for the dairy goat among small holder producers in high potential areas. Interest among both smallholder producers and research and development institutions on the role of the dairy goat was widespread throughout all of the developing regions visited. The appropriate role of the dairy goat in smallholder mixed crop-livestock production systems clearly deserves high research priority. The breeds widely used include the Jamunapari, Nubian, Saanen, Alpine, Toggenburg, Spanish Granadina, and numerous local breeds that are generally derived from crosses of one or more of the above breeds on native goats.

The major constraints to sheep and goat production on arid savannahs are generally the same as those discussed for the desert and woodland shrub ranges. In the medium and high potential savannahs, diseases or parasites may be more of a problem. A critical problem is the inadequate knowledge from which appropriate production programs can be developed and implemented. Many opportunities are apparent for developing appropriate production systems; however, they should be adequately tested prior to making recommendations for implementation and investment.

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. Large tropical forest areas of Africa with high potential 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. The apparent resistance of the African Dwarf breeds of goats to trypanosomiasis clearly merits further investigation. Also, these breeds of goats and breeds of sheep such as the Red Masai in Africa, the Tabasco sheep of the Yucatan Peninsula in Mexico, the Barbados Black Belly in Central America and

other local breeds in Asia appear to be able to produce successfully in areas of normally high internal parasite infestation. Whether or not resistance to internal parasites, grazing habits or other factors account for this ability is an interesting question that merits further study. These breeds are also generally characterized by little or no wool or hair production and year around breeding capability when nutrition and management are adequate.

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 2-10 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 byproducts. Development of an organized production and marketing program along the lines of Indian milk marketing schemes merits further study.

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.

GENERAL RECOMMENDATIONS

The development of efficient livestock production systems that will benefit the producer and meet increasing food needs must be closely tied to efficient land utilization and conservation of natural resources. The small ruminant can be an important component in future development programs that will meet these various requirements. Recommendations to facilitate their reaching this potential follow:

Improved Communications. An effective communications network among institutions, planners, scientists and educators working with and interested in sheep and goats in tropical developing countries is needed. One institution should assume leadership for this major international effort. Regional institutions such as ILCA in Africa and ICARDI in the Middle East should assume primary responsibility for regional leadership.

The broader international effort should focus on developing a world wide library of research and development publications appropriate to sheep and goats in developing countries. Coordination of regional efforts and information transfers would also be an important role. Serious consideration should be given to initiating an international publication devoted to sheep and goat research and development work. An international meeting to review the findings of this study and develop specific recommendations for future programs could be a first step in the broader international communications effort.

Appropriate regional leadership in this communications effort should focus on improved intraregional communications. It was discovered on trips related to this study that workers in adjoining countries within a region are often not aware of each other's programs with sheep and goats. A workshop or conference within each of the four developing regions would be an appropriate first step. This conference could (1) review and formulate recommendations based on this report, (2) present the work of other institutions and scientists within the region, and (3) permit government officers, planners and scientists to share ideas and jointly work on solutions to common problems. Follow-up to this should be a specific planning conference that would (1) establish priority needs for small ruminant development, (2) recommend specific research, education and development projects for support on a regional basis, and (3) identify specific support required in terms of financial support, technical assistance and government policies.

Improved Data Base. A key requirement for adequate planning and development of future programs is knowledge of current production levels, resource inputs and outputs, producer perception of problems, market potentials, and other technical data. Few countries in the developing world have the adequate resource inventory and analysis base required for formulating long-term research and development programs.

Increased Emphasis on Sheep and Goat Programs. Few countries in the developing world currently support sheep and goat programs at a level equal to their current importance or future potential. The same is true for those institutions providing external development assistance. For example, approximately 10 countries in Africa receive more than 40 percent of their meat supply from sheep and goats, with another 10 countries at between 20 and 40 percent. In spite of this, no country provides as much as 20 percent of its livestock program support for sheep and goat activities.

Strengthen Components Required For Proper Development. Successful development efforts require (1) effective planning and analysis at the policy level, (2) efficient and equitable marketing systems from producer to consumer, (3) adequate credit for development, and (4) appropriate technology provided by effective support services such as extension education and veterinary services.

Probably, the major deficiency in most developing countries is inadequate and/or inequitable marketing systems. Most sheep and goats are produced in areas remote to ultimate consumers. Producers are generally unaware of price and supply and demand required for market negotiations and, as a result, are generally prey for traders and others that take advantage of their ignorance. Government policies such as meat price controls, export bans, import subsidies and artificially high feed price supports are disincentives to fair and equitable market returns for sheep and goat products.

The supply of credit to producers in adequate amounts and at equitable cost is essential for development. Credit is often not available for sheep and goat programs, although producer desires and appropriate development plans both indicate the need for sheep and goats. This is currently true for the commercial ranch scheme development programs in East Africa, although producers want to purchase sheep and goats.

Support services such as research, demonstration and extension education programs, training programs for extension personnel and technicians, veterinary services and other government support services for sheep and goats are either non-existent or inadequate in most tropical developing countries. These services should be linked together with equitable marketing and credit programs.

SPECIFIC RECOMMENDATIONS

Improved Land Resources Management. A special advantage of ruminants is the ability to exploit land and feed resources that cannot be efficiently utilized by other means. An important component of the role of ruminants, though not often recognized or understood, is soil and water conservation. The role of man is to match animal resources to permit optimal exploitation and conservation of natural resources.

Animals are often blamed for problems created by man. Overstocking of goats on arid range lands by man has resulted in severe range degradation. At the same time, goats are known to be more efficient users of bush and desert shrubs than other livestock species and are often used for biological brush control. The proper role of both sheep and goats along with cattle and other species in management of land resources urgently needs clarification and exploitation. There is little doubt that the proper role will embrace the concepts of multispecies production systems and multiple use concepts of land management.

The ultimate hope for conservation of productive land resources for future generations lies in education and enforcement of proper land use. Decisions must not be made on an either/or basis (i.e., cattle or sheep or goats), but rather as to combinations which optimize land use. The major challenge is to change the mentality of man in this process - all the way from planners and policy makers to smallholder producers.

Develop Production Systems For Smallholders. The number of smallholder agricultural producers exceeds 100 million. A significant portion of these own livestock, either as a primary or a secondary enterprise. Development planners and researchers have generally viewed smallholders as one-dimensional crop producers, rather than as integrated producers of both crops and livestock. Increasing interest in small ruminants which fit smallholder production systems is apparent throughout the developing world. The following specific comments relate to components that should be considered in developing integrated small ruminant production systems for small farmers.

1. Simplicity. The low level of education and available resource inputs to the average smallholder rule out sophisticated production schemes. Inputs must be low cost, must require few external inputs to the system and must give careful consideration to the appropriate technology for the system. One research leader in India, for example, issued an appeal for the development of a confinement production system for 3 to 5 dairy goats, plus their offspring, keeping in mind that a significant portion of the producers would be landless peasants.

2. Local Resources. Emphasis should be on utilizing noncompetitive feedstuffs such as bush, crop residues, and grasses or weeds harvested from fields and nonagricultural lands. Supplemental feeding should be limited to relatively small portions of readily available and economical protein and energy concentrates.

3. Local Breeds. The authors of this study were impressed with the hardiness and adaptability of many local breeds throughout the world. When better management, nutrition and disease control are provided, these breeds generally respond with dramatic increases in productivity. They also have the advantage of being readily available and already accepted by local producers. Unless a local market and local shearers already exist, wool should be avoided in tropical smallholder systems. Both harvesting and marketing of wool can be a serious problem in some areas.

4. Health Programs. Much progress can be made in improving animal performance through simple sanitation and animal health control programs. Use of vaccines and antibiotics is expensive and requires trained personnel.

5. Marketing. Probably, the most serious problem confronting the smallholder is effective marketing. Cooperative marketing schemes and development of local markets are needed. New products may be necessary to attract consumers in some markets, such as the development of cheeses, candies or other products from goat's milk where consumers are not accustomed to drinking fresh milk. New methods of product preservation are needed to serve remote areas.

Increased Emphasis on Training. Few countries have training programs for professionals interested in sheep or goat research, extension or production. In addition, opportunities for advanced training for these people are rare, and practical experience as a part of the training program

is even more unusual. The number of qualified professionals within a country rarely approaches the number required to manage an effective research and training program, much less the number of field personnel required for program execution.

A special appeal is made for the development of practical training programs with the ultimate target audience of the smallholder producer. This will likely require the development of imaginative and new approaches to training, heavy reliance on paraprofessionals and local leaders as trainers of target producers, renewed emphasis on field demonstration of desired results to break down producer suspicion toward external changes, and a willingness to accept smallholder producer inputs concerning his desires and needs when the training process is being planned and developed.

Specific Projects - In addition to the specific recommendations already discussed, several projects were identified by the Winrock International team members during the regional visits. Since these projects appear in some detail in the regional reports, only the general titles are presented below:

- Development of small ruminant production systems for smallholder integrated crop-livestock units in high potential zones.
- Characterization of genetic resources, including production potential, disease and parasite resistance and market acceptability.

- Establishment of a dairy goat operation and management training center.
- Use of goats for biological control of brush.
- Establishment of training networks and demonstration units for smallholders and development of the necessary support services for technology implementation.
- Incorporation of small ruminants in reforestation programs.

INTRODUCTION

INTRODUCTION

Rationale:

With the exception of oil and mineral rich countries, the economy of the developing world is still based primarily on agriculture. McDowell (1972) defines the tropical or warm regions of the world as being between 30^{o} N and 30^{o} S of the equator which includes a major portion of the developing countries that are even more dependent on agriculture for economic and social survival.

The tropical regions contain approximately 50 percent of the world's cattle, mules and asses; 75-80 percent of the world's goats, buffaloes and camels; and 30-35 percent of the world's sheep, swine and poultry. The contributions of livestock, and the different livestock species, vary among regions and countries according to social customs, tastes and preferences, policies, available land and feed resources, production constraints, and many other factors. There is an acknowledged lack of understanding of the appropriate use of land resources by livestock, their current and potential role in meeting human food needs as well as the economic well being of livestock producers, and the development programs that are both acceptable to the target population and appropriate to the challenge. These points are especially applicable to sheep and goats.

Planners and decision-makers have generally viewed agriculture

solely from the standpoint of increasing crop production on high potential lands rather than as an integrated system of food production. In fact, livestock, and particularly small ruminants, are considered by the smallholder as an important component of his total production system. Agriculture is generally viewed in terms of "commercial" production enterprises, when in fact a significant portion of the world's food supply comes from multi-enterprise small farm units. The livestock component of the smallholder farm unit has generally been ignored by those involved in the planning and development processes, while the smallholder insists that livestock be an integral part of the system.

Objectives:

The broad objective of this study is to identify the current and projected future role of sheep and goats in developing agricultural economies. This includes the identification of research, training and development programs that can have the maximum socio-economic benefits to the target population. To accomplish this broad objective, the following specific objectives received primary emphasis in the study:

I. To identify, within the developing regions, current production relationships for sheep and goats. This includes an inventory of existing production and marketing systems by region.

II. To identify current programs and commitments to sheep and goat research, education and development programs by region. This includes an inventory of institutions, scientists and organizations capable of impacting on future development efforts.

III. To identify those production and marketing systems within the developing regions that are likely to optimize input/output relationships and social benefits to the target population. The transferability to other areas of observed management practices, genetic resources, nutrition and health programs was also evaluated.

IV. To recommend specific criteria for future sheep and goat research, education and development projects for donor institutions, international centers and selected in-country research and development institutions.

Procedure:

The first phase included a planning workshop held at Winrock Conference Center in November, 1976. Twenty-five international leaders in sheep and goat research and development programs were selected to participate in this workshop on the basis of their experience in developing areas, understanding of production problems and opportunities, professional accomplishments and geographical balance with

respect to developing regions. The purpose of this workshop was to (1) critique the terms of reference for this study, (2) identify priority areas and problems to be evaluated by region, and (3) identify technical expertise that could assist the team in specific problem or subject matter areas. The proceedings of this workshop have been published.

For this study, the developing world was then divided into four regions. Although these four regions do not necessarily represent all areas of the world with development needs and opportunities for using sheep and goats in the development process, they do represent common tropical and subtropical production environments. The four designated regions are: (1) South and Central America, including the Caribbean; (2) Africa; (3) Southeast Asia and the Asian Sub-Continent including India, Afghanistan, Pakistan and Bangladesh; and (4) the Middle East. The Winrock International staff was then divided into teams with responsibilities for each region.

Within each region, the assigned team was responsible for accumulating existing regional input/output data, identifying existing production and marketing systems, and inventorying regional and in-country institutions, organizations and scientists involved in sheep and goat production, review of available literature sources, and direct visits to selected countries within each region. Countries visited include:

South and Central America	Africa	Southeast Asia and Asian Sub-Continent
Mexico	Egypt	Philippines
Costa Rica	Ethiopia	Indonesia
Colombia	Kenya	Malaysia
Paraguay	Tanzania	India
Brazil	Nigeria	Afghanistan
Trinidad-Tobago	Cameroon	
Barbados		

In addition, Winrock scientists have visited sheep production systems in United Kingdom, Bulgaria, Greece, Italy, France, Spain and Iran. Administrators and scientists involved in sheep and goat research and development programs were also visited in France and at the Food and Agriculture Organization of the United Nations in Italy.

The following reports are summaries of these efforts. The production systems, constraints to production and the potential role of sheep and goat production are viewed within ecozones and on a regional basis. The ecozones and range types within ecozones in the tropics and subtropics are broadly defined in a section of this report that precedes the regional reports. The Winrock International staff readily acknowledges that visits to additional countries and institutions would have been desirable. However, within the constraints of this initial study, every effort was made to visit major areas that would help in defining the principal production systems and practices, socio-economic and technical constraints, and opportunities for future program efforts.

THE SYSTEMS APPROACH

This was by definition a "state-of-the-arts" study. This implies that the understanding of the problem and its resolution is generally rudimentary. Ideally, recommended solutions can be based on substantial data and experience; however, these may not be available for a state-of-the-arts study.

The systems approach to problem solution permits the identification of both the known and unknown components required in the solution. This state-of-the-arts study should, therefore, on the basis of a systematic analysis of the known and the recognition of unknown components, provide objective judgments on problem definition, current knowledge levels, perceived interests and commitments, suitability of alternative technologies, and recommended programs for implementation.

Although the phases of analysis in systems research have often been stated, it is appropriate to re-state them in the context of this study.

1. The first step is the formulation and search phase, in which parameters are established, or the problem is defined and the existing data base determined. In this study, the first step was to assess the land and feed resource base, existing sheep and goat populations and their productivity, and current production and marketing systems.

2. The second step is the analytical phase, in which alternative actions or program decisions are analyzed. This required an analysis of needs and potential solutions to technical and social constraints including consideration of the appropriate policy decisions and support mechanisms required to facilitate development of efficient sheep and goat production systems.

3. The third step is the interpretation or judgmental phase required to develop specific plans or projects that will permit verification and project implementation. Selected research projects are recommended to remove technical constraints or to develop management practices that will minimize their impact. In other cases, genetic resources, feed resources or management practices effective in one region are recommended for testing in other regions with similar ecosystems. If the technical base, government policies, economic climate and support services are sufficient in an area, then specific development projects are suggested.

4. The fourth step is the implementation phase. This includes identification of specific locations, institutions and personnel necessary to implement a project as well as the necessary financial, political and physical support services. Specific plans and procedures are then suggested for the implementation phase.

5. The final step is the re-assessment or program review and evaluation phase. Specific mechanisms must be provided in all projects for periodic review and evaluation and adjustments made as needed on the basis of results or experience to that point.

These steps in the systems approach provided a rational procedure for this state-of-the-arts study. In a broad sense, these identify the steps to follow in determining the role of sheep and goats within a region. The appropriate entry point for improving sheep and goat production systems within the specific target area depends on which of these stages has been reached. In some countries, for example, the available resources, animal populations and production systems are not known - here, the entry point is quickly identified as the first step in the systems approach. In other cases, the parameters of the production system have been established, analyses are largely complete and interpreted, and the institutions and scientists are basically in place for implementation of specific projects - or the fourth phase.

DESCRIPTION OF THE TROPICAL ECOZONES

For the purposes of this report a detailed and complete description of the ecozones that exist in the tropical countries of the tropics and sub-tropics would be impractical. An attempt has been made, however, to characterize the major ecological areas based upon the important climatic and ecological details observed while traveling and from the literature reviewed. A simple overall structure was developed that allows the major focus to be on general concepts which can be applicable to those areas as a whole.

Most authors describe five climatic zones in the tropical and sub-tropical areas of the world. These zones are the parched zone, the arid zone, the semi-arid zone, the sub-humid zone, and the humid zone. It was felt that these five zones could be reduced to three zones and still adequately describe the major climatic differences applicable for description of livestock production systems. These broad climatic zones are described as follows:

A. Arid Zone

This zone typically receives less than 500 mm of annual precipitation and encompasses those parts of the desert or parched zone (less than 250 mm precipitation) that are used in some kind of livestock grazing system.

Precipitation is generally too low or erratic to support forestry or permanent cultivation, except in localized situations or with the aid of irrigation. Droughts are common and to be expected, soils are potentially unstable and protective plant cover is sparse.

B. Semi-Arid Zone

This zone typically receives between 500-1200 mm of annual precipitation. It is further characterized in that it generally has a single rainfall season and the dry season may extend from three to eight months. Crops can be grown in these ecological areas provided the soils are permeable and fertile. Native vegetation varies widely in this zone, ranging from thro'ed shrubland to true savannah to tropical woodlands.

C. Sub-Humid Zone

This zone receives greater than 1200 mm of precipitation per year and includes that portion of the humid zone or wet tropics having potential to be used by livestock. If a dry season exists in this zone, it will last less than three months.

Many of these lands have been cleared of forest with crops being produced on the arable soils. In areas of Africa, the high potential livestock and crop areas that are not cleared and put into crop or livestock production are usually infested with the tsetse fly.

MAJOR RANGE TYPES IN TROPICAL ECOZONES

Since existing ecosytems are a reflection of many abiotic and biotic conditions, these ecosystems tend to overlap each other when they are categorized using a finite set of classification factors. Using Stoddart, Smith, and Box (1975) and Billings (1966) as a guide, four broad groupings of range types were selected as being the most common found in the developing countries of the world. Figure 1 shows

the approximate distribution and overlap, using the precipitation and climate types defined earlier.

Table 1 shows the distribution and some characteristics of each of the four range types chosen to represent the tropics. A verbal synopsis follows:

A. Desert Shrub

This area generally receives less than 250 mm of precipitation annually and is subject to extreme drouth periods that may last several years in some cases. The precipitation is generally irregular, and the vegetation is typically sparse with shrubs less than a meter in height. Most of the problems in utilizing these areas are associated with low humidity and sources of water; the moisture shortage is critical for both livestock and for plant growth. The use of these areas is generally only accomplished during times when favorable moisture conditions exist. The forage, though not abundant, is nutritious and livestock diseases are uncommon. The range areas displaying these characteristics are found in large areas in North Africa, Southwest Asia, East and Southwest Africa, the Middle East and the Indian sub-continent. In addition, large areas in Argentina and Mexico can be classified as the desert shrub types.

B. Woodland Shrub

This area typically has between 250 and 750 mm of precipitation per year. It has several dominant subclasses within it, one of which is the sclerophyll vegetation that dominates the area surrounding the Mediterranean Sea and the Chapparel areas of California.

This area is unique in that most of the rainfall comes in the cool season. The vegetation is typically shrub with very thick leaves, and in general it can be said that this type is best suited for use by sheep and goats.

Another subclass of the woodland shrub lands are the so-called thorned forests or thorned woodlands. These particular areas are generally adjacent to the savannah types of the less favorable sites. In Africa, those areas in the higher rainfall zones may be difficult to use during the wet season because of the tsetse fly.

C. Tropical Savannahs

These areas are typified by precipitation that ranges between 250 mm and 1500 mm per year. The great range in this precipitation zone also indicates quite a range in the vegetation types. However, the savannahs are typified by grass which has a tree overstory with the overstory being somewhat open in that it has a canopy cover of less than 40%. This particular type is one of the major grazing types in the world. One unique point is that this type does not occur in the United States. Although there is great disagreement among ecologists as to the exact description and identity of the savannahs, most agree that large areas of Africa, Asia, and South America should be classified as a part of the savannah type.

D. The Tropical Forest

These are generally areas which have greater than 1200 mm of precipitation per year and are characterized as having no prolonged dry season during the year. Many of these areas have been cleared of forest and are cultivated for crop production. Those areas of Africa with high potential for livestock and crop production that are not being utilized are usually infested with the tsetse fly. Central America along the Atlantic coast, the Amazon Basin coast, the Congo Basin, and the Philippines are areas which typify this particular area.

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FIGURE 1. DISTRIBUTION OF THE MAJOR RANGE TYPES IN THE TROPICS COMPARED TO PRECIPITATION AND CLIMATE TYPES

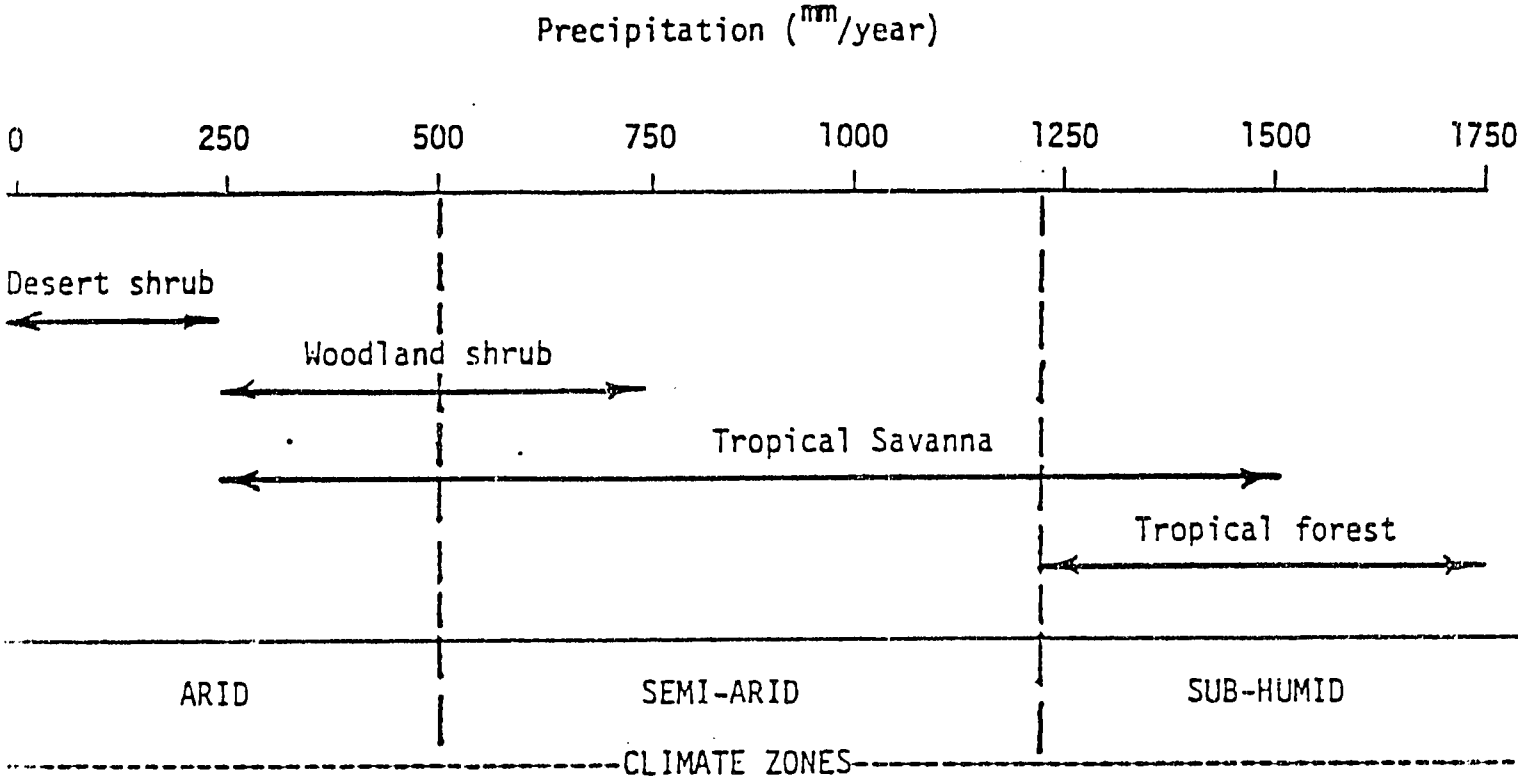

TABLE 1. WORLD DISTRIBUTION AND CHARACTERISTICS OF THE FOUR MAJOR TROPICAL RANGE TYPES

Range Type	Principal Locations	Precipitation Range (cm/year)	Temperature Range Daily max./min.C°	Soils	Selected Major Range Plants	
					Browse	Grass
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 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	Larrea Acacia Salvadora Gymnosporia	Aristida
Woodland 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 red soils; considerable variation	Acacia Hakea Eucalyptus Terminalia	Sorghum Themeda Danthonia Stipa Poa Eragrostis Cenchrus
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 thunderstorms Almost no rain in cool season Long dry period during low sun	Considerable annual variation; no really 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	Acacia Combretum	Andropogon Imperata Hyparrhenia Panicum Aristida Heteropogon
Tropical Forest	Central America (Atlantic coast) Amazon Basin Brazilian coast West African coast Congo Basin Malaysia East Indies Philippines New Guinea N.E. Australia Pacific Islands	1200-10000 Equatorial type: frequent torential thunderstorms Tradewind type: steady, almost daily rains No dry period	Little annual variation Max. 29-35 Min. 18-27 No cold period	Mainly reddish laterites		Pennisetum Digitaria Cynodon Paspalum

Adapted from Billings (1966)

LATIN AMERICA

SHEEP AND GOAT PRODUCTION IN LATIN AMERICA

The Latin American region, as defined in this study, includes all the countries in Central and South America and the Caribbean with the exceptions of Puerto Rico and the U. S. Virgin Islands. The target areas for the study were the arid and semi-arid tropical areas where hair sheep and goats are more numerous and well suited to the environment and the socio-economic conditions. Less emphasis was placed on the sub-humid and humid tropics where few sheep and goats are found. Little attention was given to wool sheep since the majority are found in the temperate zones near or south of the 30° S paralle and in the cool tropical alpine and subalpine areas.

- Latin America has a total land area of 2,061 million hectares representing about 15 percent of the world total. Approximately 596 million hectares (29% of the total) are considered as agricultural area - arable land and land under permanent crops (6.2%) and permanent meadows and pastures (22.8%). Forests, woodlands and other lands make up the rest.

The human popula ion in 1974 was estimated at 314 million or 8 percent of the world population. The present high rate of population increase (over 3%) is exerting further pressure on the agricultural sector and is likely to aggravate the existing deep-rooted socio-economic problems. About 42 percent of the population

was considered to be agricultural based in 1970. The past two decades have shown an ever increasing population shift from rural to urban areas. This migration trend is creating serious over-crowding problems in cities and high unemployment rates. If modern agricultural technology is not introduced at a faster pace, the agricultural sector will be hard pressed to meet internal urban demand, consequently, scarce foreign exchange will be used for importation of foodstuffs as is the case in the Caribbean.

The estimated 1974 Latin American livestock population and its percentages of the world total are shown in Table 1. Cattle is not only the most important livestock industry within the Region but also is an important economic resource to the Region. Latin America has 22% of the world cattle population with only 15% of the total area and 8% of the population. Sheep and goats are of lesser importance than cattle representing 12 and 10%, respectively, of the world totals.

Regionally, cattle numbers increased 37% from the base year 1961-65 to 1974 while goats showed an increase of only 8%. Sheep numbers, on the other hand, dropped 3% during the same period. Argentina and Uruguay were the primary contributors to the decline of the Region's sheep population; each reducing its national flock by approximately 5.5 million head. Although the regional trend showed increased goat numbers, Peru, with the fourth largest goat population in the base year 1961-65, reduced its stocks 50% (from 3.9 to 1.9 million) by 1974.

Table 1. Human and Animal Populations In Latin America and Their Percentage of World Totals

Item	Number		Percent Change	Percent Of World Total	Livestock Per Human
	1961-65	1974			
	1000's	1000's	%	%	No.
Human Population	229,921	313,992	36.6	8.0	-
Cattle	186,322	255,738	37.3	21.7	0.81
Sheep	128,340	124,381	-3.1	12.0	0.40
Goats	37,883	40,925	8.0	10.3	0.13
Horses, Mules, Asses	38,001	41,264	8.3	34.2	0.13

Source: FAO Production Yearbook, 1974

The majority of goats are distributed in the arid and semi-arid regions of Latin America, principally in Northern Mexico, Northeastern Brazil and the Chaco area of Argentina. These three countries account for over 75% of the regional goat population. Lesser numbers are found in the semi-arid and arid areas of Chile and Peru, the Northeastern coast of Colombia (Guajira), the North Central area of Venezuela (states of Falcon and Lara) and throughout the Caribbean.

Both wool and hair sheep are found in Latin America. Approximately 85% of the sheep are found in southern South America (Argentina, Brazil, Chile, Peru and Uruguay). It is not possible at this time to accurately estimate the proportion of hair to wool sheep in the region because of lack of adequate data. However, it is well recognized that wool sheep are concentrated in the temperate zones of Argentina, Uruguay, Chile and Southern Brazil. Taking the sheep populations of these countries and the estimated 13 million wool sheep in Southern Brazil, it can be assumed that at least 65% of the sheep population is wool sheep and are located outside the tropics. The remaining 35% of the sheep (about 44 million) include both hair and wool sheep with the wool sheep being distributed primarily throughout the Andes Mountains of South America at various altitudes (usually in those areas classified as "cooler climates") and the Mexican and Central American altiplano. Hair sheep, on the other hand, are distributed throughout the warm to hot tropical climates. Large numbers exist in Northeast Brazil and the Yucatan

Peninsula of Mexico. Fewer numbers are found throughout the Caribbean, Colombia and Venezuela.

As previously stated, the numbers of hair sheep in the Region are not adequately documented. However, observations made during this trip lead to the conclusion that the importance and potential of hair sheep as a source of meat and skins in the Latin American tropics has been widely underestimated.

Table 2 presents total production and productivity per head for sheep and goat meat, milk, skins and wool in the Latin American region as compared to world totals. Average production per head of sheep meat and goat meat and milk in the Region is about one-half of the world average. Sheep are not normally milked in Latin America, thus the average production per head is quite low. However, wool production per head in the region compares favorably with the world average. Although the developed countries contribute substantially to the higher world average production per head, the much lower averages for Latin America indicate potential for improvement in sheep and goat productivity.

The tropical ecozones and their general characteristic range types have been discussed in an earlier section of this report. Following, a description of livestock production systems, the production constraints and the potential role of sheep and goats are discussed within each of the range types (desert shrub, woodland shrub, tropical savannahs and tropical forests) as they apply to Latin America.

Table 2. Annual Productivity of Sheep and Goats in Latin America and the World.

Area	No. Animals	Percent Slaughtered	Meat Per Head	Milk Per Head	Wool Per Head
	000's	%	Kg.	Kg.	Kg.
Sheep					
Latin America	124,381	16.5	2.6	0.1	2.4
World	1,032,667	34.4	5.2	7.0	2.5
Goats					
Latin America	40,925	8.0	2.2	8.8	-
World	397,917	32.4	3.6	17.6	-

Source: FAO Production Yearbook, 1974.

DESERT AND WOODLAND SHRUB RANGE

The desert and woodland shrub ranges are discussed together since they share similar small ruminant production systems, constraints and potential for development although there are variations in the types of vegetation, amount and frequency of rainfall and topography. Furthermore, the majority of goats and hair sheep in Latin America are found within these range types.

The desert shrub range is characterized by low annual precipitation (generally less than 250 mm), sparse vegetation and frequent droughts. Large areas in Northern Mexico, Argentina and Pacific coastal areas of Chile and Peru fall under this category. The woodland shrub range receives more annual precipitation than the desert shrub range (250 to 750 mm) and its vegetation varies from typical shrub with thick leaves to thorned forests to thorned woodlands. Areas in Northeast Brazil, Argentina, Northeast Colombia, Northcentral Venezuela and the Yucatan Peninsula in Mexico can be generally classified as woodland shrub range.

Livestock Production Systems

Extensive livestock production systems are by far the most widely used in the desert and woodland shrub ranges of Latin America (de Andrade and Eduardo, 1976: Ministerio de Agricultura - Colombia 1974; Garcia, et al, - ; Banco Nacional Agropecuario, 1971). Loose herding without fences is common, with or without herders to watch

and care for the animals.

Desert Shrub Range - Goats are more important in this area because of the type of vegetation, feed shortage, and limited water supply. Other ruminants such as cattle and sheep generally do very poorly under these environmental conditions are not found in large numbers. Transhumance exists in some areas of Latin America (Northern Mexico, Peru) but it does not involve appreciable numbers of the population.

Intensive small ruminant production systems are rarely found in the desert shrub zone. Exceptions are pockets where irrigation has been developed and small ruminants play an important role in the community and surrounding area. For example, in Northern Mexico in the region of La Comarca Lagunera several goat dairies are being successfully operated in totally confined systems (Banco Nacional Agropecuario, 1971). Semi-confined goat dairy operations where does are allowed to graze adjacent irrigated pastures were also evident.

Small ruminants under extensive grazing conditions are usually owned by poor landless peasants whose family income is derived primarily from the animals. The average number of animals owned per family under these conditions is difficult to generalize because of the many variables existing within the entire Latin American region. In Northern Mexico, for example, the number of goats per owner varies between 50 and 400 with the average being around 100 (Juarez, 1976).

Around villages and rural-fringe areas where the major portion of the family income is not derived from small ruminants the average number owned is probably less than 10 goats.

Woodland Shrub Range - Cattle, sheep and goats alone or in various combinations are found in this range type, however, the cattle observed did not appear to be in as good condition as hair sheep and goats.

An example of the woodland shrub type area is an 860,000 km^2 area located in Northeast Brazil called the "Drought Polygon" (a major study on sheep and goat production in this area has been carried out by de Andrade and Eduardo, 1976, under the sponsorship of the Banco do Nordeste do Brasil). This is a semi-arid zone receiving between 400 to 800 mm of precipitation per year. The zone is characteristic in that the rainy season is of short duration - about 3 months (January, February and March). Goats and sheep (mostly hair sheep) are kept primarily for meat production and hides.

Generally, sheep and goats in Northeast Brazil are raised in extensive systems with no fences between properties. Herd health, sanitation programs, and nutrient supplementation are uncommon. Herds are gathered once or twice a year for purposes of counting, selection for market and castration. There are usually no facilities for penning with the exception of small corrals where some goats are kept for milk production for the home. There is apparently no commercial milk production.

Forage in the "Drought Polygon" is quantitatively and qualitatively insufficient for either high stocking rates or high levels of individual productivity. This area suffers from periodic droughts. Even during normal rainfall years, the irregularity of rainfall limits pasture growth, which is mostly made up of annual forages. The annual grasses and legumes rapidly dry and disappear after the rainy season. As forage become scarce, sheep and goats will consume the green leaves of shrubs as well as some fallen flowers. Before the rains, the diet consists mainly of desert-like bush and whatever dried grasses and legumes are left over in addition to fallen leaves of larger trees.

The lack of an adequate diet throughout the year leads to substantial fluctuations in body weight, slow maturing, longer postpartum anestrous, insufficient milk production and older age at market. Energy and protein supplementation are rarely practiced, but cottonseed meal, leaves from sisal, trees and palms are occasionally used as supplements. Salt and other mineral supplements are infrequently provided although mineral deficiencies (e.g., phosphorus) are known to exist in the Northeast soils.

Sheep and goats occupy important niches within the desert and woodland ranges of Latin America. Some of these are:

- Arid grazing lands - goats survive primarily on desert bush. Their ability to graze for extended periods without water and their breeding instinct are important attributes under these conditions. Degraded lands may be further damaged by overstocking and poor range management, thus

creating a serious conservation problem. This is the case in parts of Northern Mexico and the dry Pacific coastal areas in South America.

- Heavy shrub lands - Browsing goats perform relatively well compared to cattle and sheep. In these areas there is potential for biological control of bush and pasture productivity improvement via management and grazing. An example is the "Drought Polygon" area of Northeast Brazil.
- Seasonal high rainfall - The soil is usually very poor, shallow and rocky with low range productivity. This is typical of the Yucatan Peninsula (Mexico) and some Caribbean islands. Hair sheep have adapted to these conditions fairly well. In addition, sheepmeat is usually preferred to goatmeat and perhaps; sheep have less potential for damaging trees and local cash crops, such as sisal plants. Hair sheep are better adapted to high rainfall environment than wool sheep.
- Mixed species grazing - Examples of this system are found in the Paraguayan and Argentinian Chaco areas. Although the numbers of sheep and goats following cattle are not large, mixed species grazing provides a more efficient feed resource utilization.

On large ranches small ruminants provide meat for the workers while the cattle provide income. To a degree, the same holds true for the smallholder who has both - a few head of cattle and a few sheep or goats.

- Mixed crop-livestock - In villages and rural fringe areas where irrigation water is available (La Comarca Lagunera in Mexico, for example) small ruminants harvest crop residues, crop interstices and roadsides, which would otherwise be wasted. Small ruminants produce some or most of the family animal protein under these circumstances.

Goats are raised primarily for meat in the desert and woodland shrub range types. Under extenstive systems of production, slaughter animals are harvested periodically, usually between 12 and 14 months of age at a live weight of 20 to 30 kg (de Andrade and Eduardo, 1976). Northern Mexico is an exception where the dairy goat kids are sold for slaughter at about 30 to 40 days weighing somewhere between 6 and 10 kg liveweight. Hides are an important source of income to the producer and/or processor where hide processing factories and export markets are well developed, such as in Northeast Brazil.

Milk production from goats is of secondary importance to meat in the desert and woodland shrub environments. Milk is normally used for raising kids and for home consumption if does are milked at all.

This is typical in Northeast Brazil, North Central Venezuela and rural fringe areas where goats are owned by smallholders. La Comarca Lagunera (Northern Mexico) is an exception where totally confined, partially confined and some loose goat herds are maintained for commercial milk production. Meat and hides are secondary products of these dairy operations.

Meat is the primary product from hair sheep with skins being a secondary product. Sheep meat is mostly consumed during festive occasions (Christmas, New Year's, birthdays, baptisms, etc.), except in many of the Caribbean Islands, especially those with a British colonial history and/or populations where there is a traditional preference for lamb. In Jamaica goat meat is favored. Sheep and goats supply 58% of all meat consumed in Guyana (Devendra, 1975).

Several breeds of "native", improved and exotic sheep are found throughout the desert and woodland shrub areas of Latin America. Productivity varies considerably but there is potential for improvement in both meat and milk production. Table 3 shows that exotic and/or improved breeds of goats are significantly more productive when fed well than the unimproved Criollo breed. However, it is also true that in most cases the genetic potential of the local breeds under optimal management conditions is not known.

The local or "Criollo" goats found throughout Northern Mexico Northeastern Colombia and North Central Venezuela are probably descendants of similar Spanish stock brought in by the Spaniards during

Table 3. Productivity of Goat Breeds - Types.

PRODUCTION PARAMETER	NORTH MEXICO		NORTHEAST BRAZIL		NORTH CENTRAL VENEZUELA
	CRIOLLO[1]	EXOTIC[2]	CRIOLLO[3]	BUHJ[4]	CRIOLLO[5]
Mature Weight, Kg.					
Males	45	70	35-40	70-80	40-45
Females	35	50	30	40-50	30-35
Slaughter: Weight, Kg.	6-9	10	25-35	30-40	20-25
Age, Months	1-1.2	1	12-14	8-12	
Lactation: Length, Months	5-6	6-10	-	-	6-7
Yield/Day, Kg.	0.5-0.8	1-2	-	-	0.2-0.3
Reproduction					
% Kidded,	-	-	-	-	-
Litter Size (Mature)	1.6	1.8	-	-	-
Breeding Season	All Year	Sept-Feb.	-	-	-
Mortality Rate: %					
Pre-wean	-	18	50%	-	High
Post-wean	-	14	-	-	-
Mature	-	8	-	-	-

Sources:

[1,3] Observations and responses to questions by local producers

[2] Production statistics summarized at the Centro de Cria Tlahuallilo

[4,5] Publications: de Andrade and Eduardo, 1976; Garcia, et. al.____; Castillo, et. al.____.

the conquest. These goats, through natural selection, have evolved into a relatively small, nondescript breed type. They are well adapted to their environment because of their hardiness and resistance to disease, but productivity under the prevailing environmental conditions is low. The local "Criollo" goat of Northeast Brazil has similar characteristics to those found in Mexico, Colombia and Venezuela.

Some genetic resources of special interest in Northern Mexico include improved exotic breeds such as Nubian, Alpine, Saanen and Toggenburg presently producing from 1 to 2 kg of milk per day. Also, the Granadina, a Spanisn breed, is now recognized for its milking ability and prolificacy. The large, upstanding Buhj breed of Brazil seems to have considerable potential for increasing size of crosses with local breeds. Mature males weight up to 100 kg. Other Brazilian breeds of interest include the Moxoto, Marota and Caninde (de Andrade and Eduardo, 1976).

Table 4 shows some production characteristics of various hair sheep breeds. Genetic resources of particular interest include the Tabasco or Pelibuey (oxen hair) sheep found in the Eastern coast and Yucatan areas of Mexico. They are short fine haired, thin tailed sheep with short, semi-erect ears. Both sexes are polled. Colors include white, tan, red and occasionally black. Color patterns include solid, spotted, dark tan bodies with lighter bellies and light tan bodies with black bellies. Some individuals carrying varying amounts of wool are apparent consequences of earlier crosses with

Table 4. Comparative Productivity of Sheep Breeds.

PRODUCTION PARAMETER	MEXICO[1] Pelibuey	NORTHEAST BRAZIL[2] Santa Ines	BARBADOS[3] Black Belly
Mature Weight, Kg.			
Males	70-80	60-70	65-90
Females	30-40	40-60	40-60
Slaughter: Weight, Kg.	25-30	20-30	40
Age, Months		10-14	-
Lactation: Length, Months	3-4	-	-
Yield/Day, Kg.	0.5	-	-
Reproduction			
% Ewes Lambed	90	-	-
Litter Size (Mature)	1.3	1.5	2-3
Breeding Season	Year-round	Year-round	Year-round
Mortality Rate: %			
Pre-wean	10	Up to 50%	-
Post-wean	-		-
Mature	-	-	-

Sources:

1 Bermiecos, et. al., 1975. (data refers to flocks under experimental conditions).

2 de Andrade c Eduardo, 1976; Observations and responses to questions by local producers.

3 Patterson, H. C. 1976. The Barbados Black Belly Sheep, Ministry of Agriculture Science & Technology. Barbados

wool breeds; even though some speculation has been presented that wool has resulted from recurrent mutations.

The reported reproduction coefficients (Valencia, et. al., 1975) and observed fleshing condition of the Tabasco sheep indicate that they are well adapted to heat, humidity and relatively high seasonal rainfall of their tropical environment. Primiparity occurs at 15 to 18 months of age with breeding throughout the year. Usually, Tabasco sheep are expected to lamb 3 times in 2 years with the average litter size being 1.3 lambs. Mature weight of males is about 70 kg. Commercial milking is uncommon; some experimental milking trials have yielded 500 ml of milk per day.

Pelo de Boi (oxen-hair) is the predominant breed of hair sheep in Northeast Brazil. These sheep are very similar in appearance and production characteristics to the Tabasco sheep of the Yucatan Peninsula in Mexico. Other breeds commonly found are the Rabolargo, Deslanada and Morada Nova. Crosses between the Bergamacio (an Italian coarse wool breed) and Pelo de Boi are giving rise to a more precocious and productive "breed" known as the Santa Ines. These sheep often yield a 20 kg carcass at 12 months of age compared to 12 to 14 kg for other breeds (de Andrade and Eduardo, 1976).

The Barbados Black Belly sheep of Barbados is one of the best known hair sheep located in the Western Hemisphere. Its potential as a genetic resource is well recognized. Apparently of African origin, its characteristics include body color ranging from tan to dark red with black bellies and black on head and legs, coarse hair neck and

chest of rams, and both sexes are polled with short, semi-erect ears.

The prolificacy of the mature, well nourished Black Belly ewe under intensive conditions is high - twins and triplets are common; quadruplets and quintuplets occur occasionally (Patterson, 1975). Ewes breed year-round with primiparity at 15 to 18 months with two litters per year being recorded infrequently. Adequate nutrition and health management is required for realization of this genetic potential for prolificacy. Common slaughter weight is 40 kg with a 50 to 55 percent carcass yield. Meat is the major product from the Black Belly.

Export demand for Black Belly breeding stock is strong because of the attributes of the breed. The Government therefore, has imposed strict controls on animal exports in order to increase the local herd.

The Blackhead Persian (Somali Blackhead) sheep presents another genetic resource of interest as a meat producer breed. It has been imported to Brazil, some Caribbean Islands, some parts of Colombia and other areas. The breed appears to be well adapted to the tropical environment. Although there are some variations in the shades of color, the characteristic white body, fat rump and black head are predominant. The breed is smaller than the Black Belly and commonly produce single lambs. Paradoxically, these single lambs are sometimes cited as an advantage because of higher survivability, higher growth rate to weaning and reduced lactation stress in ewes.

Constraints to Production

This section lists the primary constraints affecting small ruminant production in the desert and woodland shrub areas of Latin America. The constraints are discussed under general headings but are not necessarily listed in order of importance.

Socio-Political Constraints

1. Traditionally, throughout Latin America there is lower preference for goat meat and milk compared to cattle meat and milk. Lamb meat, however, is preferred in the British West Indies.
2. There is often little political interest in small ruminant production because of limited potential for earning foreign exchange.
3. Generally, there is a negative attitude on the part of development agencies toward goats because of their reputation for range degradation, deforestation and erosion induction. In Venezuela, for example, there was a goat eradication campaign during the 1960's (Garcia, et. al.).
4. Sheep and goat herders are usually held in low esteem. The common image of goat meat is the poor man's survival food rather than a delicacy for the well-to-do. In Mexico, for example, this image has been changed partly because kid barbeque or "cabrito" has gained considerable acceptance as a delicacy in restaurants. Also, "cajeta" and candy made from goat's milk are sweets enjoyed by large segments of the population.

5. Predation, especially theft, is relatively easy because of the small size of the animals.

Economic and Marketing Constraints

1. The demand for sheep and goat products for the Region as a whole is poorly documented. Demand and market analyses and consumption patterns need to be established in order to determine production needs.
2. The relative unavailability of credit from government agencies, banks and development agencies for small ruminant production as compared to cattle production is a serious constraint. Exceptions to this were seen under some circumstances in Northern Mexico and Northeastern Brazil.
3. Marketing infrastructure is generally poorly developed, but often poorest for sheep and goats. Market centers and channels for cattle do exist and are increasing in number but this is not the case for small ruminants. Throughout the Region, small ruminants are regarded as the "savings bank" of the smallholder and are sold to provide cash for immediate needs. Prices are negotiated on a one to one basis (buyer-seller) since there is rarely an established competitive marketing system. Furthermore, the lack of grading services and marketing information precludes setting of commensurate price differentials for different qualities. Returns are often so low that producers are not motivated to invest time, effort or cash into improvements.

4. Seasonal fluctuations in supply of milk and slaughter animals have an adverse effect on price stability. These fluctuations are primarily a consequence of rainfall patterns and feed availability. Means of storing feed and/or animal products during the peak of the production season for use during the off season are needed.

Resource Inventory

1. Knowledge of sheep and goat numbers, productivity and economic contributions of small ruminants to the family, community or the nation is limited. Therefore, planning decisions relating to small ruminants are often based on subjective assessments, personal biases and faulty conventional wisdom. The only way to provide needed objective facts is through resource (animal, human, land, feed and water) inventories and marketing studies.
2. Often, where the value of the small ruminants is obvious and expansion is recommended, the major constraint becomes the availability of sufficient numbers of improved breeding stock, for example, the case of Barbados Black Belly sheep mentioned earlier.

Technical Constraints

1. Lack of adequate nutrition and sanitation are two major constraints to biological productivity of small ruminants throughout Latin America. Technology is currently available to resolve these problems, however, this technology is expensive. Marginal returns in most smallholder operations may not justify the investment in areas where market channels for small ruminant products are poorly developed.

2. Feed availability is usually in short supply year-round in arid areas and seasonally in wet/dry areas during the dry season (in wet/dry areas feed quality may be higher during the dry season). This results in slower growth rate, periodic body weight losses, low reproduction rate and low milk production. The financial values of the animals and their products are often too low to justify improving nutrition (through supplementation or otherwise) if this means greater financial costs. Poor nutrition may be primarily due to poor management of the feed resources (e.g. overgrazing).

3. Overgrazing has led to range degradation, especially by goats, in the arid areas. The desire on the part of the producer to have more animals (for loss insurance and prestige) as opposed to more productivity is facilitated by the high prolificacy of small ruminants which can overrun available feed resources before the producers (or planners) realize the effects. Livestock water development and techniques to control small ruminants are needed in most arid areas to allow more equal spread of grazing pressure.

4. Internal parasitism is widespread, particularly in the humid and sub-humid regions. Herd health technical assistance from veterinarians is usually not available or too expensive for the small producer. Not readily available diagnostic laboratories and information on herd health programs to small producers set the stage for serious losses from disease.

5. Little effort has been placed in developing improved meat and milk producing lines adapted to local environments. The "Criollo" breeds have evolved with little attention from man. Adapted terminal sire lines with emphasis on size and growth rate to slaughter and terminal dam lines with emphasis on fertility and milk yield, especially for dairy production systems would be useful.
6. Product harvesting, processing and preservation technology need improvement in order to stabilize markets. Hide curing techniques, for example, need to be improved at the point of slaughter to prevent damage to skins and reduction in value.
7. There is an apparent lack of qualified, interested personnel and programs to provide technical assistance to producers in all areas of small ruminant production. Teaching and training programs at all levels of production, particularly for the small holder, must be developed and implemented if productivity is to be increased. The smallholder, small ruminant production system is a low risk, low investment, low production and low return system. These factors limit productivity increases, but any changes must be considered in the light of the smallholder's special needs.

Potential Role of Sheep and Goats

Opinions of planners and policy makers are shifting toward support of the smallholder and the improvement of their productivity and well-being. Some policy emphasis has been placed on small ruminants since they fit well into most smallholder production systems.

Also, the recent world wide decrease in beef profitability and apparent increase in sheep and goat profitability has caused many individuals and institutions to review small ruminant production systems more favorably.

Emphasis on sheep and goats varies between countries and government institutions. However, the general impression is that where sheep and goats are of any socio-economic importance, in particular to the smallholder, government institutions are beginning to promote programs for small ruminant production. Examples of some of these programs in the desert and woodland range regions include: (1) the Tlahualilo Goat Breeding Center near Torreon, Mexico; (2) the National Goat Research Center at Sobral in the state of Ceara, Brazil; (3) the establishment of goat and sheep experimental farms in the state of Pernambuco, Brazil; (4) the establishment of hair sheep experiment stations in the Yucatan Peninsula (Mexico) by the National Livestock Research Institute and; (5) the Loma de Leon Goat Research and Production Center in Barquisimeto, Venezuela. These programs are expected to increase production and productivity of sheep and goats, however, some are new and are in need of expert guidance and technical assistance.

Sheep and goats are the primary source of animal protein and income for the desert and woodland range inhabitants. Any regional small ruminant program to eliminate one or more of the constraints mentioned earlier has the potential of considerably increasing production, productivity and smallholder socio-economic well being.

Because of the advantages of small ruminants (small, prolific, low investment, etc.) they fit special niches in developing agricultures including mixed crop-livestock smallholdings where they optimize feed, land, labor and resource utilization.

Production and productivity need to be increased in the desert and woodland shrub areas where small ruminant products are in demand. Kid meat (cabrito) in Northern Mexico, for example, is in short supply. The dairy goat industry has a potential for expansion since Northern Mexico is the supplier of most of the cheese and the nation's popular sweets (cajeta and candy) manufactured with goat's milk. Juarez (1976)estimates that in the Tlahualilo herds meat and milk production can be further increased by about 48% by increases in milking persistence, reducing reproductive failures and increasing replacement rates. De Andrade and Eduardo (1976) estimate that a shortage of some 9,000 tons of sheep and goat meat will occur in Northeast Brazil by 1980 if present production practices are not improved. This area is noted for the poor nutritional status of its human population; in 1971 the urban population had a caloric and protein deficit of 42 and 47%, respectively (Anonymous - Dirigente Rural, 1977). There is indeeed, a dire need for accelerated small ruminant development programs in this area.

Small ruminants are a major resource which will reward the investment of additional aid, effort, money and attention. Thoughtful development of management and marketing systems to take advantage of the special attributes of the small ruminants is needed if their potential is to be realized.

TROPICAL SAVANNA AND FOREST RANGES

Tropical savannas are found in the Pacific Coast of Central America, the Orinoco River basin, south of the Amazon River basin, Eastern Colombia and Western Venezuela. The amount of rainfall in these areas is varied (250 to 1500 mm annually) and several species of grasses are found. Throughout Latin America the tropical savannas have been traditionally used for extensive cattle ranching in the absence of alternative uses. In many areas, agriculturally marginal lands (thin soils with precipitation between 500 and 1000 mm) are being converted to crop lands sometimes resulting in erosion problems because of inadequate farming technology.

Tropical forests are found throughout Central America (Atlantic Coast), the Amazon basin and sections of the Brazilian coast. These areas are of little importance for grazing under their natural states because of the scarce herbaceous vegetation and the prevailing hot and wet conditions (1500 to 10,000 mm precipitation). The tropical forest areas that have been cleared are: (1) placed under plantation-type enterprises (cocoa, rubber, bananas, etc.); (2) after the lumber is harvested, improved pastures are established for cattle ranching or; (3) farmed by smallholders for 2 or 3 years and then planted to pasture or abandoned. Smallholder uncontrolled agricultural practices (slash and burn process), however, have often resulted in erosion and other damages to tropical forests after the land is abandoned.

Livestock Production Systems

Sheep and goats are not found in large numbers in the tropical savannahs. This can be explained in part by the land tenure system (large, private landholdings); the traditional preference for cattle raising; unknown demand; and the largely undeveloped market and infrastructure to merchandise sheep and goat products in many of these remote areas. In the drier Colombian savannahs, for example, small flocks of hair sheep are occasionally kept in cattle ranches as a convenience source meat.

Where small ruminants are kept in the tropical forests they are in association with smallholders. The production system is primarily extensive. Loose animals feed on roadsides, ditches and crop residues during the day and are penned at night. A more intensive system, tethering, is also practiced, particularly in the Caribbean. This system efficiently utilizes feed resources and prevents animals from damaging crops and gardens. Tethering is particularly suitable to situations where small ruminant production is not a full time operation and where the available land does not permit large scale production (Devendra, 1977).

The tropical, lower montane dry forest includes rolling uplands reduced to natural grasslands after centuries of woodcutting, seasonal grain cultivation and cattle and sheep grazing (Holdridge, 1967). These areas located in the Andes Mountains (for example, the states of Cundinamarca and Boyaca in Colombia) have been traditionally the

suppliers of wool for use in crafts, blankets, ponchos, etc. The production systems are varied but the most widely used are the extensive and tethering systems. In Colombia, for example, small flocks of sheep are seen grazing on roadsides, ditches, etc., as well as tethered sheep on small family plots. The majority of the sheep are kept by smallholders in a mixed crop-livestock system. The average size of the flock ranges from 5 to 10 head commonly in landholdings varying from 1 to 10 hectares (Ministerio de Agricultura - 1974). Sheep supplement the family income as a readily available source of cash in times of greatest need. Wool is the primary product; it is usually spun by the women and sold at local markets. Lamb and/or mutton is a secondary product and is popular during holidays and festive occasions.

The native or 'Criollo" sheep predominate in the tropical lower montane dry, forest areas. Over 70% of the Colombian national flock is made up of "criollo" sheep (Morales, 1977 - personal communication). The reported average mature body weight and wool production of these sheep under experimental conditions is 32.8 kg and 2.1 kg, respectively (Instituto Colombiano Agropecuario, 197?). Wool from "criollo" sheep are used in crafts and carpet making because of its low quality. Exotic sheep introduced to Colombia (probably less than 2% of the population) include Romney Marsh, Black Face, Corriedale, Rambouillet, Cheviot and others. These sheep are presently at various degrees of adaptation to the local conditions.

Constraints to Production

Most of the constraints to production affecting the desert and woodland shrub listed earlier apply to the tropical savannahs and forests but the relative importance differs. The most critical constraints are listed below.

Socio-political Constraints.

1. The tropical savannahs have been traditionally extensive cattle raising areas. Furthermore, cattle meat and milk are preferred over sheep and goat meat and milk.
2. There is little interest and knowledge on the part of planners and livestock producers on the importance of small ruminants as a source of meat.
3. Theft is a serious constraint to small ruminant production. Often, the most desirable animals are stolen.

Eonomic and Marketing Constraints

The constraints discussed earlier for the desert and woodland shrub areas apply also to the savannah and forest areas and need not be repeated. However, the following constraints must be emphasized.

1. The marketing infrastructure is rudimentary.
2. The economic feasibility of raising hair sheep in the tropical savannahs is largely unknown although some advocate the suitability of these areas for commercial sheep rearing.

3. In areas where wool is produced there are no fixed wool quality standards or marketing systems to provide incentives for high quality products.

Resource Inventory.

1. Small ruminant production inventories are needed to facilitate development of effective public policy.
2. Communications and coordination amongst the public and private sectors in the development and implementation of livestock programs is limited and should be expanded.

Technical Constraints.

1. Parasitism and other major diseases are limiting factors to small ruminant production in the tropical savannah and forest areas. In higher rainfall areas, hair sheep appear to be susceptible to internal parasite infestation and to foot rot (although there are claims that some breeds are resistant to these afflictions). Health technical assistance is seldom available or is too expensive for the small producer.
2. Research is needed in the areas of forage production and crop residue and crop by-product utilization to establish effective nutrition programs.
3. Techniques in product harvesting, processing, preservation and transportation need improvement in order to maintain the quality of the product.
4. Flooding limits ability of small ruminants to graze; high rainfall leaches forage nutrients.

5. Teaching and training programs at all levels of production, particularly directed to the small producer, need to be developed and implemented.

Potential Role of Sheep and Goats

In general, the present potential for small ruminant production in the tropical savannahs and forest areas is largely unknown primarily because of the above mentioned constraints and the traditional preference for cattle ranching. Solutions to these problems require a great deal of thought and sufficient economic and production data, which in most instances do not exist.

The drier tropical savannahs, however, present an opportunity for development and adaptation of hair sheep production systems. Generally, hair sheep perform adequately in areas where rainfall does not exceed 800 mm, average temperature ranges between 25 and 30° C and altitude does not exceed 1000 m (Bautista, 1977). Vast areas in Colombia (the Tolima, Huila, Atlantic Coast) and Venezuela (Venezuelan Plains) meet the above requirements. Because of the proximity of these areas to the Caribbean, there is a potential for development of export programs for sheep meat. The Caribbean is deficient in sheep meat; in 1974, for example, imports of fresh sheep meat reach 6,354 tons valued at 8.7 million U. S. dollars (FAO Trade Yearbook, 1974). Such programs, however, would involve: (1) economic analyses of sheep production; (2) development of production systems at smallholder and commercial levels; (3) development of marketing systems and; (4) implementing national sanitation programs

(such as hoof and mouth disease control) so that fresh meat can be placed in the world market.

A major opportunity exists also in the integration of small ruminants, particularly sheep, with plantation crops. This system is presently practiced with cattle in some areas of Brazil and the Caribbean. It is believed that hair sheep will fit this system well, particularly in the Caribbean where sheep meat is a preferred food Kirby (1976) recommends the system of grazing sheep and cattle under immature low-density soft-wood plantations for Amazonia (Brazil). He indicates, however, that environmental and market conditions and cultural preferences favor beef cattle in this area.

Another major opportunity for small ruminant production is to increase integration with smallholder agriculture. Small ruminants under this system contribute to improved feed, land and labor utilization and supply the much needed animal protein to the human population. In the tropical lower montane dry forest areas where wool sheep are reared primarily by smallholders production is constrained by poor feeding practices, uncontrolled breeding and lack of a market infrastructure for commercialization of wool. Colombia, for example, must implement programs directed toward the elimination of the above constraints in order to increase internal wool production and reduce large imports. Colombia's total wool imports amounted to 15 million U. S. dollars in 1974 (FAO Trade Yearbook, 1974).

RECOMMENDATIONS

General Recommendations

Latin America has tremendous resources yet to be tapped. However, the rapidly expanding human population and increasing immigration from rural to urban locales has created a number of related problems. Some of these problems and the potential contribution of small ruminants in their solution are:

- Nutritional inadequacies for poor urban dwellers, especially children, and attendant health problems are widespread. Increasing availability of meat and milk would have obvious benefit. Dairy goat systems provide both and are adaptable to low input management (e.g., the African village goats). Diseases, such as brucellosis, which can have a major impact on human health are a serious problem of such systems.
- Land degradation due to overgrazing and/or faulty cultivation practices reduce both subsistence and commercial value to producer and, ultimately, reduce availability and increase cost of food for urban residents. Small ruminants do have a role to play in improved management of grazing and cultivated lands including utilization of crop residues. For

example, managed concentration of goats has been an effective means of brush and regrowth control. Loose herding, tethering and cut and carry feeding systems for small ruminants are methods of converting forage to desirable animal products which fit well where intensive labor requirements is not a constraint. Many countries are embarking on national reforestation programs in efforts to limit major ecological damage (erosion, water pollution). However, where population continues to increase and food and income shortages exists, successful reforestation requires continued food production. Grazing small ruminants (sheep, if goats damage seedlings and young trees) will help control competing plant species and provide food and income.

Land tenure and new land development policies need to take more cognizance of the smallholder's primary goal of survival and risk minimization. Small ruminants provide a low investment, low risk alternative food source while utilizing otherwise wasted feed resources. Their manure serves as fertilizer to improve crops.

Recognition of the potential contributions of small ruminants and encouragement of their increased utilization will be most effective if improved stocks are available. For example, hair sheep appear well adapted to many humid

tropical and sub-tropical ecosystems. Some types are noted for prolificacy; most are noted for their ability to survive in unfavorable environments without much attention. Potential does exist for improving turnoff through better nutritional and health management and selection for growth rate. However, development of these improved management techniques (including their economic evaluation), importation and characterization of improved genetic stocks and multiplication of improved stocks must be accomplished on a large scale before they can be made available to producers.

One of the more obvious needs throughout Latin America is for increased communications among planners, institutions and scientists interested in small ruminants. An effective way to bring this about is through international workshops that would allow discussions of problems and joint formulation of solutions to common problems. These workshops are also ideal vehicles for disseminating scientific work carried out at the various institutions throughout the Region.

The major program area needs for sheep and goat production in Latin America can be broadly categorized under the following subheadings:

Resource Survey and Analysis - In most cases there is little documented information available to planners and policy makers with regard to available small ruminant resources, levels of productivity, advantages and disadvantages specific to local production environments. If small

ruminants are considered at all in agricultural development plans, planners generally must rely on subjective opinions, sometimes biased by limited negative experiences or hearsay. For the most part, little is known about the potentials for improving smallholder productivity. In many regions, small ruminants and smallholders are a common combination, often involving the grazing of unfenced common lands, forests and non-agricultural lands (roadsides, urban areas). Contributions of small ruminants to subsistence of poor families are usually not adequately assessed. All these factors contribute to inadequate planning to raise the productivity of small ruminant production systems.

In some Latin American countries the production environment is well suited to sheep and goats; yet, these species are of trivial importance. Paraguay is such a country. The few sheep and goats in Paraguay produce for the home market with only a limited urban market available. Consumption of sheepmeat (0.5 kg/capita/year) is very low relative to beef (32.4 kg) or pork (16.3 kg). The active USAID supported smallholder agricultural development program in Paraguay concentrates on cattle, swine and poultry. One reason for the limited attention to sheep and goats in Paraguay is that while people are poor ($510 GNP/capita), there remains abundant land for agricultural development. Another reason is that there are no trained Paraguayan professionals with particular interest or knowledge of sheep and goats. For example, the National University lists a sheep

production course in its Annual Service curriculum. This course has not been taught because of lack of qualified instructors.

Opportunities do exist to expand sheep and goat production in Paraguay. The first step would be to develop a small base of professionals trained with special emphasis on sheep and goat production. These professionals would then have a vested interest in identifying opportunities and implementing programs involving sheep and goats. Their presence will be an increasingly valuable resource as the Paraguayan population increase, urban and export markets develop and the contributions of sheep and goats are more generally recognized.

Increased Emphasis on Sheep and Goat Programs - Programs to improve sheep and goat production in the Latin American tropics are relatively new. The Tlahualilo Goat Breeding Center (Mexico) and the Loma de Leon Goat Breeding and Production Center (Venezuela) were founded in the mid-1960's while the hair sheep experiment stations in the Yucatan Peninsula (Mexico), the National Goat Center in Ceara (Brazil) and the hair sheep breeding ranches in Pernambuco (Brazil) were established in early and mid-1970's. Although progress has been made at these institutions, there is need for in-country and external support (technical and financial) to accelerate sheep and goat programs.

Countries that have established training institutions and research facilities (Colombia, for example) must re-evaluate their national small ruminant programs in the light of the recent worldwide increase in the profitability of sheep, the animal protein and fiber requirements of the population, the socio-economic well being of the smallholder and the efficient utilization and conservation of resources.

Development of Organized Marketing Programs for Sheep and Goats. The lack of organized marketing systems for sheep and goats and their products in the Latin American tropics is widespread. Although the estimated Regional per capita consumption of lamb/mutton and goat meat is low compared to beef (Table 5), it is felt that an organized market structure would make sheep and goat products more accessible to the consumer and perhaps encourage transfers to deficiency areas. For example, the Yucatan Peninsula in Mexico has the potential for increased hair sheep production to supply Mexico City, however, present marketing practices preclude this opportunity.

Countries with traditionally large numbers of sheep and developed marketing infrastructure for exporting cattle (for example Argentina and Uruguay) should look into the economic feasibility of establishing marketing systems for the exportation of lamb and/or mutton to deficient areas such as the Caribbean. Other potential impo t markets include the U. S., Europe and Middle Eastern OPEC countries; however, competition for these markets from Australia and New Zealand wil be very strong.

Table 5. Per caput beef and veal and mutton and lamb consumption - base period 1964-66 average

Country	Kg/Yr./Caput		Country	Kg/Yr./Caput	
	Beef	Mutton/Lamb		Beef	Mutton/Lamb
Costa Rica	16.2	-	Argentina	68.1	6.2
El Salvador	6.7	-	Bolivia	8.3	4.4
Guatemala	7.7	-	Brazil	17.5	0.7
Honduras	5.2	-	Chile	17.2	2.9
Nicaragua	11.2	-	Colombia	20.6	0.2
Mexico	7.2	1.2	Ecuador	8.5	2.1
Panama	19.3	-	Guyana	5.6	0.1
Cuba	22.1	0.1	Paraguay	31.5	0.5
Dom. Rep.	7.5	-	Peru	8.3	3.6
Haiti	2.7	0.9	Surinam	4.1	-
Jamaica	8.2	1.5	Uruguay	79.6	18.4
Puerto Rica	10.6	-	Venezuela	18.0	0.2
Trinidad	4.5	0.8			

Source: FAO. 1971. Agricultural Commodity Projections - 1970-80.

Specific Recommendations

Specific programs that have been identified as having significant impact in sheep and goat production and productivity on a regional basis are in the general areas of: dairy goat operation and managment training; brush control; mixed crop-small ruminant systems for smallholder and use of small ruminants in reforestation programs These projects are described in some detail below.

Goat Dairy Operation and Management Training Center: Presently, there is very little expertise in Latin America on dairy goat production and management under extensive or intensive conditions. In view of the large numbers of smallholders that are involved in goat production throughout the Region, the establishment of a training program in dairy goat production and management training is recommended in an area where the dairy goat industry is developed.

The general objective of the program is to establish a dairy goat operations and management training center to: (1) train producers in adjacent areas; (2) train trainers from other areas within Latin America and; (3) provide experience and training to scientists from Latin America (or other countries in the world) involved in dairy goat production.

A suggested location for a training center oriented to modern commercial production is the Tlahualilo Goat Breeding Center (Centro de Cria de Caprina Tlahualilo) in Tlahualilo, Durango, Mexico. This center was established 10 years ago through financial assistance of the Rural Credit Bank (Banco de Credito Rural). Presently, it is a major dairy

goat development -demonstration project and a source of superior breedin stock for local producers. Some 2500 does of six breed types (Saanen, Toggenburg, Alpine, Nubian, Granadina, Criollo and Criollo crosses) are now being mechanically milked. This successful demonstration of improved dairy breeds under intensive, totally confined management systems has stimulated the development of similar (but smaller scale) goat dairy operations at 8 "ejidos" (cooperative producer associations associated with land redistribution programs in Mexico) and several private enterprises in the area. These operations appear to be financially successful, however, individually owned goat dairies are usually integrated with some other kind of agricultural activity - mainly cash crops.

The success of goat dairying in Northern Mexico is largely due to the availability of a strong, well established market structure and processing facilities for goat's milk and meat. Although some seasonal variation in production occurs, the processing and storage facilities are sufficient to provide somewhat constant flow of products.

Biological Control of Brush

The forage production potential of many of the world's rangelands are limited by the presence of heavy growth of brush. The presence of brush is often, but not necessarily, a consequence of long periods of overgrazing in which perennial native grasses have been replaced by annuals and heavy brush. Regardless of the cause, the cure practiced in developed countries of brush clearing and control by fire, herbicides and/or heavy equipment is often too expensive for use in developing

countries. Rising concerns about the adverse environmental effects of heavy use of herbicides cast further doubt on their potential users.

Brush clearing, when practiced in developing countries, usually is done by fire and/or machete. The newly cleared land may be cropped for a few years, but low soil fertility and unfavorable rainfall patterns in many tropical regions lead to establishment of pastures, often using introduced grasses and legumes. These improved pastures yield substantially higher animal offtake per hectare. The principal problem is that of undesirable competitive vegetation types, especially sprouting shrubs which can produce regrowth thicker than before clearing. Even where it is financially feasible initially to clear brush, the continuing costs of controlling regrowth may be financially infeasible, especially when the rising costs of hand labor is not matched by rising returns from animal products.

In such situations, the grazing patterns and preferences of small ruminants, especially goats, offer special opportunities for "biological control" of undesirable brush (Stoddart, Smith and Box, 1975). The reputation for browsing on brush and shrubs by goats is well established. To a lesser extent, sheep (especially, hair sheep) are noted for browsing.

The potentials for clearing dense brush stands (e.g., the "catinga" of Northeast Brazil) by controlled overgrazing with goats deserve additional study. Control by fencing or close herding will

be necessary to cause severe damage and destruction to the brush. Otherwise, goats well known for their selective grazing habits will pick and choose the better quality plant parts and, probably, do little lasting damage. This technique to be successful must emulate the unplanned, undesirable, but effective overstocking of goats in other parts of the world which has brought them the reputation of "destroyers of the forest". An obvious impact on the success of this approach is the type of growth of the brush or shrub. Trees and tree-like brush species with a high canopy may not be affected unless the goats eat the bark.

Control of regrowth by goats (and, perhaps, sheep) seems to have even more obvious potential. This practice has been successful in trials carried out in Tanzania (Staples, et. al., 1942; Hornby, et. al., 1942), the United States (Magee, 1975; Merrill, 1975; Stein, 1970; Taylor and Merrill, 1975) and elsewhere. Experimental plots of improved forage/legume pastures on cleared "catinga" on the EPACE station near Quixada, Ceara, Brazil exhibited clearly the beneficial effects of using goats to control brush regrowth. Systematic evaluation of alternative grazing systems using goats is needed. For example, is it best to graze cattle or sheep and goats simultaneously or to allow cattle or sheep first choice on the pasture followed by goats in order to increase the grazing pressure on undesirable species. Obviously, controlled management is the key.

Results of this type of experimentation should be readily transferable. However, it is a relatively sophisticated multidisciplinary research problem. Well qualified scientists and well controlled experimental environments are required to plan and execute research yielding unambiguous results. Obviously, the best research conditions will be those where the problem is already present. Two locations in Latin America which meet these requirements were observed - doubtless many other similarly qualified locations exist in Latin America and the rest of the world. These two locations are the previously mentioned station in Brazil and the INIP station "Las Margaritas" in the state of Puebla in Mexico.

Mixed Crop-Small Ruminant Production Systems for Smallholders

The typical smallholder operation is subsistence oriented, low investment, low risk, low production and low return. The emphasis is on low risk, accomplished by spreading investment of land and labor over several food crops. Small ruminants using either the tethering or cut and carry feeding techniques offer an opportunity for converting crop residues, weeds and grazing on nonarable land areas into animal products for family use and limited cash income. Cattle on the other hand require a substantially greater financial investment per head (with more serious potential losses if one dies) and often produce both milk and meat in volumes greater than needed for family use. This extra meat and milk could be sold, however, many smallholders are isolated and do not have ready access to commercial market

channels.

The potentials and problems of combining multiple cropping systems with small ruminants require careful evaluation before these systems should be carried out in conjunction with an institution that has the facilities and preferably on going research in multiple crop systems. A likely candidate for carrying out such a program is Centro Agronomico Tropical de Investigaction y Ensenanza (CATIE) at Turrialba, Costa Rica. CATIE was founded in 1973 by Costa Rica and the Institutio Interamericano de Cienicas Agricolas (IICA). CATIE is based in the facilities formerly occupied by IICA prior to moving to San Jose. Prior to 1973, these facilities housed the headquarters staff of IICA and the tropical agricultural research and training faculties. Training emphasized postgraduate (Master's level) study and research. Students came from most Latin American countries; many of them now occupy positions of influence in the academic and governmental programs throughout Latin America. Most of the livestock emphasis was (and continues to be) on cattle, both beef and dairy.

CATIE includes three major divisions - agronomy, forestry and livestock. Institutional research focus is on smallholder agriculture and on reforestation. The agronomy division has an active and successful research project on multiple cropping systems, involving beans, corn and cassava. The livestock division has developed a model demonstration cattle dairy for smallholders; other versions of this model are being established at two other locations in the Caribbean

coastal plain area of Costa Rica.

Incorporation of Small Ruminants in Reforestation Programs

A research program dealing with the incorporation of small ruminants in reforestation programs is recommended. This program is also suggested to be carried out in conjunction with CATIE because of their involvement in reforestation programs. Costa Rica and other mountainous countries throughout the developing world share a common environmental problem caused by the "slash and burn" techniques used to clear forests slopes for cropping. High rainfall and common cultivation practices combine to erode rapidly the thin soils. Two, three, rarely more, years of adequate crop yields and then the smallholder must clear new, more fertile lands. The remaining eroded slopes continue to pollute streams and contribute to ecological imbalances. Reclamation of damaged, eroded slopes by reforestation is difficult in itself; development and application of practical technology is a major thrust of the CATIE forestry division. However, longterm success of this program depends on resolution of a still more difficult problem - providing a means for the smallholder to support his family without continuing the cropping techniques which originally caused the problem.

Small ruminants in the reforested areas would provide both food and income, conceivably, they could be symbiotic by controlling regrowth of plant species, such as grass, weeds and shrubs, which compete with the seedlings and young trees for scarce nutrients. Small

ruminants would be less likely than cattle to cause soil compaction and physical damage to trees by stepping, leaning or rubbing on them. An obvious potential problem is damage to seedlings and young trees if small ruminants were to eat all or essential parts (e.g., bark) of the trees. Goats, in particular, have a reputation for causing such damage. Among the objectives of needed research are the following:

- o Taste and preference studies with small ruminants to see what parts, if any, of seedlings, young trees and mature trees they will eat, especially when alternative feed sources are available.
- o Comparison of controlled grazing techniques, such as tethering and cut and carry, with free herding to evaluate labor requirements and animal productivity.

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Castillo, J., O. Garcia y L. Figueroa. El Mestizo Toggenburg x Criollo. I Crecimiento de cabritos.

Castillo, J. Alimentacion del ganado caprino.

Castillo, J., O. Garcia, N. Osal y M. Arangu. El mestizo Alpino X Criollo I Crecimiento de cabritos.

Castillo, J., O. Garcia, A. Camacaro y M. Arangu. Estudio comparativo del crecimiento de cabritos 1/2 Nubian -- 1/2 Criollo y 3/4 Nubian - Criollo.

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AFRICA

SHEEP AND GOAT PRODUCTION IN AFRICA

Africa is a continent of tremendous contrasts - in its people and their life styles, in its natural resources and their uses, and in the types of agriculture and livestock production currently practiced. Although mineral and oil wealth, tourism and other industries are important to certain countries, agriculture and livestock production are the largest contributors to the gross national product of almost all countries in Africa, and provide the livelihood for a majority of the people.

The total land area in Africa is 3,000 million hectares with approximately 842 million hectares as permanent ranges and pastures. Due to increasing human population pressure, a large portion of the land resources of Africa are being severely abused. Medium and low potential lands are being settled and cultivated with little hope for success, and the results are increasing erosion due to the destruction of natural turf and forest cover. Pastoralists, due to both increasing population pressure and to being forced further into the lower potential lands, are severely over-grazing most of the range lands. At the same time, it is estimated that more than one-third of the continent is underutilized due to tsetse fly infestation and other disease problems that prevent inhabitation by human and animal populations. These are in many situations the lands with the highest production potential.

African ecosystems and range types encompass all of the major ecozones and range types outlined in the previous section. On a broad scale, these range from the Mediterranean zones of North Africa, the Sahara and the sub-Sahara desert zones of Central Africa, The vast tropical savannahs of east and south Africa, the high potential highland zones, and the humid tropics and tropical rain forests of Central Africa and the coast of West Africa. Broad descriptions are dangerous, because abrupt changes in elevation, mountain ranges and other factors often result in dramatic changes in the ecosystem within a short distance.

Table 1 presents the 1961-65 average and 1974 estimates of human and animal populations in Africa, and their relative percentages to 1974 world totals. The 1974 estimate of the human population of Africa was 384 million, which was approximately 10 percent of the world total. This represents an approximate 35 percent increase in ten years, which has far exceeded the continent's increase in food production from crops, livestock and poultry.

Table 1. Human and Animal Populations in Africa, and Their Percentage of World Totals

Item	Number		Percent	Percent of	Livestoc
	1961-65	1974	Change	World Total	Per Huma
	(000)	(000)	%	%	No.
Human Population	277,461	384,098	38.4	9.8	-
Cattle	116,294	133,380	14.7	11.3	.35
Sheep	96,685	115,252	19.2	11.2	.30
Goats	104,111	111,591	7.2	28.0	.29
Buffalo	1,559	2,150	37.9	1.6	.01
Camels	8,413	9,410	11.9	71.0	.02
Horses, Mules, Asses	15,270	16,078	5.3	13.3	.04

FAO Production Yearbook. 1974

Based on the 1974 estimates, cattle and sheep numbers in Africa are approximately 11 percent of world totals for each of the two species. Africa also contains approximately 28 percent of the world's goats. The change in numbers from the 1961-65 period to 1974 suggests that sheep are increasing in numbers most rapidly and goats are increasing at a much slower rate; however, visits to countries and with people that know the area suggest that recent drouths in the Sahel region and in the arid zones of East Africa have resulted in dramatic increases in goat numbers at the expense of declining cattle populations. A 1976 survey in Kenya indicates goat numbers are more than double the 1974 estimate of 3.6 million and most of these are in the arid zones. (E. W. Allonby, personal communication).

With the region, approximately 50% of the sheep and 32% of the goats are located in Northern and the Sahel regions of Africa, which are almost exclusively arid zones. Another 28% of the sheep and 27% of the goats are located in the four East Africa countries of Ethiopia, Somalia, Kenya and Tanzania. Nigeria, with 7,545,000 sheep (6.5%) and 22,390,000 goats (20.1%) is the other major small ruminant producing country. In general, almost all of the goats and a major portion of the sheep in the East African countries and Nigeria are located in the arid zones.

The productivity of Africa's sheep and goats is presented in Table 2. To distinguish between production systems, the data are presented for North Africa and the rest of Africa separately. The rest of Africa in this report excludes South Africa, Rhodesia and Southwest Africa. North Africa in this table includes Morocco, Algeria, Tunisia, Libya, Egypt and Sudan.

Table 2. Productivity of Sheep and Goats in Africa*

Area	No. Animals	% Slaughtered	Meat Per Head	Milk Per Head	Wool Per Head
Sheep					
North Africa	46,190	34.2	5.0	11.7	1.4
Rest of Africa	69,061	27.4	2.9	1.5	0.14
Goats					
North Africa	22,547	21.8	2.6	33.8	-
Rest of Africa	89,044	33.1	2.9	6.7	-

*FAO Production Yearbook. 1974.

Apparent differences in sheep and goat production systems for the two parts of Africa are quite evident from this table. The sheep in North Africa generally are more productive as shown by the higher annual percent slaughtered and the higher quantities (kg) of meat, milk and wool per head in the herd. Goats in North Africa are important also in the production of milk.

The Annual percentage of goats slaughtered is 50% higher in the rest of Africa when compared to North Africa. The quantity of meat produced is also slightly higher. It is interesting to note that the annual percentage slaughter for sheep and goats in Africa is about twice the turnoff rate for cattle.

Almost every conceivable type of livestock production system can be found in Africa. These range from desert nomadic systems including camels, goats and fat-tailed sheep; to water buffalo for milk production and work in Egypt; to livestock scavenging in the streets of large metropolitan centers; and to ultramodern dairies and meat production systems in the highlands. Under traditional production systems in low and medium potential areas, it can generally be concluded that little is known about current production systems and future potential. Many scientists and planners speculate on the potential benefits, for example, of tsetse fly eradication. Many other leaders, however, recognize that removal of the tsetse fly could be a sociological, ecological and economic disaster if we do not develop a better understanding of current production, producer attitudes and marketing systems and the potential for future changes.

DESERT SHRUB RANGE

Practically all of North Africa and the lowland regions of East and Southwest Africa are classified as desert shrub rangeland in that it receives less than 250 mm annual rainfall. Approximately one-third of the continent is in this range type (Abercrombie, 1974).

121

Grass cover in this zone is usually quite limited and highly variable due to low rainfall and high livestock stocking rates. Browse is the primary feed resource in most of this region.

Almost all of the people living in these regions are dependent on livestock for survival. Nomadic and transhumance production systems are necessary to utilize the scattered feed and water resources with rainfall and other water sources, dictating traditional grazing patterns. In some of these areas, seasonal tsetse fly migrations will further influence livestock migration patterns.

Livestock Production Systems

Cattle, camels, sheep and goats, alone or in different combinations, are found within various parts of these regions. Due to faster water turnover rates and limited ability to utilize browse, cattle are excluded from the drier areas of these regions. Where stock water sources are plentiful, cattle appear more frequently in the production systems. Many production units in this range type are multi-species systems with available water and feed and, to a lesser extent, tradition dictating the species mix.

The drier and sparsely covered areas are exclusively nomadic with camels, goats and fat-tailed or fat-rumped sheep as the livestock species. In North Africa, sheep are more important than goats while East African desert shrub ranges will contain more goats than sheep.

North African sheep are principally of the fat-tailed types with varying amounts of coarse wool (McLeroy, 1961). Sheep of the fat-rumped type (i.e. the Somali Blackhead breed) are also found in this region. These fat-tailed and fat-rumped breeds have the unique ability to store excess fat in the tail rump and brisket regions of the body during better seasons, and then live off of these body stores during leaner periods (Rakoczi, 1974). These sheep apparently have the ability to drink and retain more water and have slower body water turnover rates than other breeds of sheep. Many hair breeds of sheep that are not classified as fat-tailed or fat-rumped can be found in desert shrub range areas. The Red Masai breed of East Africa and the Fulani breed of West Africa are examples. Most of these sheep breeds probably evolved from three or four basic breed types, with the well over 100 breed types in the region taking the names of desert tribes or regions and the characteristics for which these tribes selected.

The goat breeds of the desert shrub regions range from the long-legged Nubian and Jamnupari types of North Africa and the Sahel to the relatively large Galla breed of East Africa as well as other dwarf breed types found in Southern and West Africa. The longer legs of some of these breeds is an apparent adaptation to the need to range further and reach higher into the bush for feed. The dwarf breeds, however, tend to be more popular with agriculturalist located in the more dense brush areas.

/2

DeHaas and Horst (1977) state that a major advantage of the goat on desert brush ranges is their reduced susceptibility to drouth. The goat's ability to survive and produce almost exclusively on a diet of browse, while sheep and cattle usually depend on forages, is an important attribute under these conditions in that during periods of extreme drought, browse may be growing on rainfall of 10-15 years previous to the drouth. The roots therefore tap deeper ground water sources and provide relatively more water through leaves than do other forages during drought periods. Browse species also provide a relative higher protein and energy level (Cook and Child, 1971).

The breeds of sheep and goats in the desert bush ranges can generally be characterized by relatively low or no wool or hair production, low growth rates, lower maturing and lower reproductive rates (0.7 to 1.2 offspring per female per year). They are impressive, however, in their ability to survive, reproduce at these levels and perform satisfactorily in the harsh desert environment. For example, southern Kenya tribesmen were selling thousands of cattle this past year that were clearly showing the effects of drouth while goats and Somali Blackhead sheep in the area all appeared to be in good condition.

Constraints to Production

The desert shrub ranges of Africa are a difficult environment for humans and animals. Within this environment, the major constraint is reaching the producers with development programs that will encourage improvements or removal of constraints (Abercrombie and

McLeroy, 1974). The constraints listed in this section are discussed under general headings as socio-political, economic and technological constraints. They are not necessarily listed in order of importance.

Socio-Political Constraints.

1. As stated above, the major constraint is that programs have not been developed that can effectively reach nomadic tribesmen, even in the primary areas of health and education. Frustrations, and political differences in many cases, have resulted in little or no government efforts to develop programs for this sector of the population.
2. At the same time, in many parts of Africa, nomadic tribesmen are unwilling to recognize geo-political boundaries and will fiercely resist efforts to change their way of life.
3. The lack of a land tenure system makes it practically impossible to encourage pastoralists to initiate range improvement practices, and greatly restricts government's ability to deliver support services.

Economic and Marketing Constraints.

Demand for sheep and goat products is generally not a problem in Africa. In most areas, demand exceeds supply. However, outside of major production areas the following economic problems are evident.

1. Marketing infrastructures for sheep and goats are non-existent (Harris, 1975). As a result, sheep and goats and their products

tend to be marketed directly from producer to buyer. Also, they are often the primary meat source for nomadic families and as a result are not for sale. The result is that, where external marketing is necessary, it is dominated by local traders and the prices received by producers are far below external market prices. This translates into no economic incentive for the producer to improve production or increase offtake rates.

2. Little or no credit system is available to nomadic producers desiring to improve small ruminant production. In Kenya, for example, both IBRD and USAID channel livestock loan money through the Agriculture Finance Corporation, and the terms of reference of their agreements permit only cattle loans. This restriction has frustrated tribesmen desiring loans for increasing or improving their sheep and goat production enterprises.

3. The "beef cattle mentality" has further extended into export marketing policies. Huge sums of money are being spent by many African governments to develop export markets for beef with a concurrent policy of retaining small ruminant meat supplies for local consumption. This seems strange in view of the readily accessible Middle East market for sheep and goat meat that pays from three to five times the price of the world market for the beef products available for export from

most of these countries. A re-evaluation of this policy could substantially increase export earnings and reduce internal meat costs to consumers.

4. Government policies have also tended to support crop prices and control livestock prices - which result in artificially high grain prices and artificially low meat prices. This is clearly a disincentive to improving production efficiency in the livestock sector.

Resource Inventory.

1. The small ruminant sector is poorly understood in terms of numbers, grazing potential, almost all production coefficients, etc.. In fact, most of the data used in this report are estimates at best. A detailed small ruminant sector survey is essential if effective programs are to be planned.

2. Complementary to the animal sector survey should be more indepth range land and water resource surveys. One of the opportunities for goats could be their use as a biological method of brush control, but just how many of the brush and browse species existing in this region will be eaten by goats is an unknown. The lack of water sources prohibits stabilization of land use in many areas, thus emphasizing the need for better hydrologic surveys.

Technological Constraints.

1. A major constraint is inadequate nutrition, which is compounded by a lack of understanding of optimum grazing patterns for desert forage and browse species. If utilization of these species was better understood, then multi-species grazing systems could be recommended for optimum range utilization.
2. In some areas, strategic supplementation of nutrients could be an important component of increasing production, but not until nutrient supplementation is better understood and a marketing system is developed that reflects true market value of the livestock.
3. Major genetic constraints relate primarily to an adequate supply of improved breeding stock adapted to the environment. As the quick solution efforts in this area have generally related to importing exotic breeds. These have generally failed due to their low adaptability to the local environment, low resistance to diseases, or lack of acceptance by local pastoralists. There is growing evidence which suggests that the best breeds may already be in the area. Large-scale selection programs within locally adapted breed populations offers tremendous potential for genetic improvement (Rumich and Semenye, 1975).
4. Although diseases are a problem, they are generally not a major problem in the desert shrub range areas (Allonby, 1975). These areas generally do not have adequate brush or tree canopy for the

tsetse fly. The low population density migratory production systems and low rainfall tend to minimize the internal parasite problems. Tick borne diseases are more of a problem with cattle and improved breeds of wool sheep than with hair sheep or goats. Although both species are highly susceptible to foot and mouth disease, both mortality and morbidity are lower than in cattle.

5. Support such as livestock extension services, veterinary service, medications, supplements and other supplies are basically not available to nomadic producers, except in a few limited disease control campaigns.

Potential Role of Sheep and Goats

If the technology and support services to improve production practices were developed, small ruminants could become the dominant meat producers in the desert shrub range areas of Africa. In fact, sheep and goats are already producing 46% of the meat and 31% of the milk in the countries of North America. Government of Kenya estimates indicate that small ruminants have increased from providing 20% of the national meat supply in the early 1960's to approximately 40% of the national meat supply in 1976.

The fact that these increases have occurred in spite of the relatively low inputs raises some serious questions about past programs, and strongly suggests that changes are needed in the immediate future

to bring the importance of small ruminants to this region into perspective. In Kenya, which has one of the best sheep and goat development programs in the developing countries of Africa south of the Sahara, the number of government scientists and extension officers working with sheep and goats is less than 10% of the number working with cattle. There are also many external research and development institutions in Kenya with probably over 100 SMY inputs to livestock programs, and to the best of our knowledge, only two FAO scientists from this total external input are specifically assigned to sheep and goat projects. In Ethiopia, with over 22 million sheep and 17 million goats, the only estimate obtained of government scientists working on small ruminant problems was "no more than five" (Tessema, 1975). The same situation exists in Tanzania, Nigeria, Cameroon and other countries visited in Africa.

According to Nestel et al. (1973), the most critical problems in the desert bush range areas are the development of delivery systems for services and technology to nomadic producers, land tenure systems and marketing incentives to increase offtake and encourage improved range management practices, and better sources of local, genetically superior, breeding stock. If these can be provided, meat production from these desert shrub ranges could easily be doubled without an increase in breeding herd numbers.

TROPICAL SAVANNAH AND WOODLAND SHRUB RANGES

The only areas of Africa that fit the woodland shrub range types are limited areas within or adjacent to the major tropical savannah ranges. Production systems and constraints are essentially the same for these two range types, and thus will be discussed jointly.

Three vast areas of Africa can generally be classed as tropical savannahs. These are the North Central region of Africa generally known as the Sahel zone, large and scattered areas of East Africa that range from arid lowlands to high potential highlands, and similar areas in South Central Africa. These areas generally have extended dry seasons ranging from three to eight months. In some cases, rainfall may have a bimodal distribution, with 70 to 80% generally occurring in a principal rainy season and the rest in a second and shorter rainy season. Savannah ranges have a wide range of precipitation, between 250 mm and 1500 mm annually, with the woodland shrub ranges generally being adjacent to the drier savannah ranges. Higher rainfall savannahs, 850 to 1500 mm annual rainfall, are generally adjacent to tropical forest ranges.

In terms of total meat production from cattle, wildlife species sheep and goats, the savannah ranges are clearly the most important ranges in Africa (Abercrombie, 1974). The variation in rainfall results in widely different production and range use systems. Savannah ranges receiving above 800 mm rainfall are rapidly being converted from livestock production to crop production, generally

in small farm units. In many areas, marginal lands with high rainfall but thin soils or steep slopes and marginal lands in terms of rainfall (500 mm to 800 mm annually) are being converted to crop lands. The encroachment of farming into these marginal lands is certain to cause severe erosion and ecological damage that will take centuries to repair. Evidence of these problems is clearly visible throughout the savannah ranges.

Livestock Production Systems

Production systems in the tropical savannah and woodland shrub ranges are normally nomadic or transhumant, and are multispecies systems involving cattle, sheep and goats (Fransen et al., 1970). Cattle are by far the most important livestock species in these areas, with sheep and goats as followers. Vast herds of wildlife can still be seen on the savannahs.

In many areas, wildlife dominate the grazing system and can be a major constraint to range improvement if uncontrolled. Some ranching schemes are being developed and evaluated in East and Southern Africa to practice planned harvesting of wildlife and domestic livestock species. When uncontrolled, migratory wildlife can eliminate several year's work in a very short period of time in terms of range land conservation and improvement programs. Many wildlife species are also carriers of ticks and other disease

vectors, which can cause serious problems for domestic livestock health management programs (Allonby, 1975).

Although cattle are the dominant livestock, sheep and goats are probably more important than existing data would indicate. Nigeria and Tanzania research scientists and government officers, after conducting recent limited sector surveys, estimate that small ruminant numbers are probably at least one-third higher than current statistics indicate (deLeeuw, 1976 and Farris, 1976). Kenya, after an in-depth sheep and goat survey in 1976, projects population at 7.4 million meat goats, 4.6 million hair sheep and 0.5 million wool sheep. This compares with the 1974 FAO estimates of 3.6 million goats and 3.2 million sheep. The FAO estimates of sheep and goat numbers have shown a general decline in numbers of both species over the last 10 years, which defies all logic. Government of Kenya data on skin sales, which is a relatively good indicator of what is happening, clearly substantiate an increase in numbers of goats and a shift from wool to hair sheep. The following data on sheep and goat skin sales in Kenya would emphasize this point:

	1970	1973	1976*
	(000)	(000)	(000)
Sheep Skins	663	937	1,200
Goat Skins	896	1,364	1,800
	1,559	2,301	3,000

* Unofficial estimates from the Ministry of Agriculture, March 1, 1977.

13

Data from the Kenya Sheep and Goat Development Project indicates offtake averages from 20 to 25%, which would confirm the 12.5 million head through the number of skins sold. The increase in numbers of sheep skins has been accompanied by a decline in wool sales.

The Kenya survey further confirms that most of the goats and a significant portion of the sheep are in the low rainfall areas:

Land Potential	Average Rainfall (mm)	Kenya Land Area (%)	Estimated No. Sheep and Goats (000)
Low	Under 600	76	7,500
Medium	600-850	10	3,000
High	Over 850	14	2,000

As the average rainfall decreases the ratio of goats to sheep and cattle increases. Almost all of the wool sheep remaining in Kenya are owned by European farmers or white Kenyans, and are in the medium to high potential areas. The following preliminary data from the Kenyan sector survey illustrate these points:

District	Average[1] Flock Size		Average[2] Offtake		Average % Males		Average Weight			
							Sheep		Goats	
	Sheep	Goats	Sheep	Goats	Sheep	Goats	Male	Female	Male	Female
	No.	No.	%	%	%	%	kg	kg	kg	kg
Wajir	22	32	14	36	15	15	41	39	57	43
Kajiado	64	87	9	21	25	23	32	28	35	28
Kitui	37	31	21	20	25	27	35	29	38	28
Kinangop	23	-	25	-	9	-	56	45	-	-

[1] Flock size is the number of mature stock in the flock at the time of the survey.

[2] Offtake in this survey was defined as a percent of the total population in a given year, rather than as a percent of mature stock.

The districts can briefly be defined as follows: The Wajir district is inhabited by the Somali Tribe, is desert brush range, with primarily Somali Blackhead sheep and Galla goats; the Kajiado district is inhabited by the Masai tribe, is desert bush to woodland shrub range, with primarily Red Masai sheep and East African Dwarf goats; the Kitui district is inhabited by the Wakamba, is woodland shrub to savannah range, with primarily Red Masai sheep and East African Dwarf goats; The Kinangop district is inhabited by the Kikuyu tribe, is high potential highland savannah range, with primarily Corriedale sheep and very few goats in the district.

The above data support the generalization that the low rainfall zones tend to contain fat-tailed or fat-rumped breeds of sheep, with the medium to high potential lands having native hair breeds and, to a lesser extent, introduced wool breeds. Goats tend to be the larger, long legged types in the low rainfall zones and smaller or dwarf types in the dense bush and medium potential zones. One other obvious point in these data is the excessive number of males kept in the breeding herd. An aggressive marketing program to reduce surplus males would both reduce stocking rates and increase production efficiency (Harris, 1975). Kenya, as an example, has an estimated one million surplus male goats. Ethiopia estimates that surplus male goats approach three million head. There are relatively few goats in the high potential zones, although there is universal interest in evaluating introduced dairy breeds for future use as milk producers for smallholder farmers in mixed crop-livestock farming systems.

As stated previously, almost all of the wool sheep in Africa south of the Sahara are owned by European farmers (white citizens) in large commercial units and by experiment stations. As the white farmers are bought out and local farmers, either in cooperatives or as smallholders, take over these farms the transition to hair sheep is rapid. Goats are a part of the unit if there is bush or browse, but goats are not often seen on open savannah ranges. The trend away from wool sheep is due primarily to the management difficulties created by wool for the native farmer - increased susceptibility to tick-borne diseases and internal parasites, the need for shearers

and shearing facilities, lack of good markets for small amounts of wool, etc. Most of the large commercial units (5,000 + head) market their wool direct to European buyers, which is not possible for individual smallholders. With the clear trend away from large commercial units, government research and development investments in programs for wool sheep are not advised.

Constraints to Production

The constraints to production are similar to those discussed in the desert bush range section, with some differences in emphasis.

Socio-Political Constraints:

1. The lower rainfall savannahs are populated by nomadic tribes, with the same problems as previously discussed.
2. In the medium to high rainfall savannah zones, smallholder mixed crop-livestock production systems are rapidly increasing. Crop production and livestock production are basically studied by researchers and considered by planners on an either/or basis rather than as integrated parts of the smallholder farm unit. In the few situations where they have been considered on an integrated basis, cattle are generally the livestock species considered rather than the small ruminants that may actually be more appropriate for the smallholder unit.

Economic and Marketing Constraints:

The economic and marketing constraints in the woodland shrub and savannah range areas are the same as those discussed in the desert bush range section.

Technical Constraints:

1. The technical constraints for the lower rainfall savannahs are essentially the same as those for the desert bush ranges.
2. In-depth studies of existing smallholder sheep and goat production systems in mixed crop-livestock farming systems are clearly needed (McConnell, 1975).
3. Comparative efficiencies of herding, tethering and small confinement sheep and goat management systems for small farms need to be evaluated.
4. More research is needed on genetic resources for optimum production efficiency in these systems. In sheep, the Dorper breed from South Africa, the Red Masai breed from East Africa and the Fulani breed all merit further evaluation. In goats, the dwarf breeds may not be large enough to please some but, in the case of the East and West African Dwarf breeds, production per female in the breeding herds is very impressive. The Boer goat from South Africa is the largest and fastest growing meat-type goat in Africa, but may be limited in use to higher potential areas. All of these factors need further investigation

(Rumich and Semenye, 1975).

5. The apparent tolerance of East African Dwarf goats to tsetse challenge and reduced problems with tick-borne diseases merits further study. The apparent resistance of Red Masai sheep to Hemonchosis (personal communication with Dr. E. W. Allonby, Veterinary Research Laboratory, Kabete, Kenya) is a potential major breakthrough that merits further basic research.
6. The relative value of waste nutrient resources (crop residues, by-product feeds, weeds, etc.) in smallholder systems need further research (deLeeuw, 1976; Okigbo, B. N., 1977; Personal communication, IITA, Ibadan, Nigeria).
7. Dairy goat production systems for smallholders in high potential areas need to be evaluated.

Potential Role of Sheep and Goats

The potential production of meat from the rapidly expanding sheep and goat populations in the low and medium potential savannah and woodland shrub ranges represents a major unexploited resource. However, the dramatic increase in sheep and goat numbers in medium and low potential areas during the past 10 years cannot be sustained without serious range lands deterioration unless major program changes are implemented. These must include:

1. Systematic range management/range lands development programs that include sheep and goat production systems.
2. Increased emphasis on sheep and goat research programs that are more equitable to the relative importance of the two species.

3. Development of effective marketing programs for the pastoral areas that will encourage increased offtake rates at fair market prices.

4. Improved education and training programs, veterinary services and other support services for the small ruminant sector.

In the high potential areas of the tropical savannahs, the greatest opportunities appear to be through the use of improved local genetic resources, surplus nutrients from crop residues and by-product feeds, and improved management practices in intensive production systems for smallholder farmers with integrated crop and livestock production units. Dairy goat production systems clearly deserve evaluation in these programs. The Dorper sheep and the Boer goat are breeds that appear to offer tremendous opportunities for genetic improvement in medium to high potential tropical production systems.

THE TROPICAL FOREST

The tropical forest areas of Africa are generally defined as the Congo basin and the West African Coast. Many of the tropical forest areas have been cleared and are high producing crop lands with plantation type agricultural enterprises. These include rubber, bananas, oil palm, plantain, coffee and other crops of this type. Smallholder agriculture is rapidly encroaching on the tropical forests. Where uncontrolled development is occurring, this is generally a "slash and burn" process that allows two or three years of cropping without major inputs of fertilizer, soil stabilizing crops and other improvement practices. Since these inputs are often not made, then severe erosion and other damages occur to the ecosystem as these areas are abandoned making minimal use of these lands for livestock production systems.

Livestock Production Systems

This ecozone, despite its tremendous livestock potential, has only token numbers of livestock when compared to the rest of Africa. Disease are the major constraint, with the tsetse fly and the resulting trypanosomiasis being the primary problem. Without the tsetse fly, however, such problems as tick-borne diseases, respiratory diseases, internal parasites and many others would be a severe challenge to livestock production.

In those areas that have been cleared and developed, cattle production is generally favored. Sheep are more numerous than goats

14.

with both species generally being held by small holders in herds of one to five head. The only exception to these generalizations would be along the edges of the rain forest areas where the tsetse fly might migrate into the forest zones away from the perimeters for brief periods of the year, and in areas where livestock may be kept in combination with plantation crops.

There is increasing interest in organized livestock production systems as a part of plantation crops such as oil palm and rubber. Results to date indicate that cattle and hair sheep can be valuable in controlling forage growth, with sheep providing some brush and weed control without affecting the plantation crops (Demiruren, 1974). Goats are more effective in brush control, but must be more carefully managed to avoid damage to the primary crops.

Where sheep and goats are kept by smallholders, they are considered as important to their total farm enterprise. Sheep and goats can also be seen in the metropolitan areas of this region as scavengers of refuse, graziers of areas around canals and ditches, etc. These are generally owned by landless people. Developing integrated crop-livestock production systems would be of major interest to smallholder farmers in the tropical forest areas.

The breeds of cattle, sheep and goats that are present in these areas are generally small in size, the quantity of product per animal is lower than in the other African ecozones. It is not understood at this time, however, whether the small size of these breeds is a favorable environmental adaptation or whether it is a result of poor management and selection practices. The breeds of sheep in

the area will generally have mature weights of 20 to 30 kg and are almost exclusively hair breeds. The goats will generally weigh from 15 to 30 kg at maturity. Very few goats or sheep are milked.

Constraints to Production

In addition to major animal health and disease constraints, the tropical forest range areas have the similar problems associated with underdevelopment that exist in the other areas of Africa. Since these have been previously discussed in the sections on the range areas of Africa, they will not be discussed in detail in this section. This does not mean, however, that they are not equally important to this area.

Socio-Political Constraints.

1. This area has the advantage that most of its agriculturalists are sedentary. However, planners have generally ignored livestock in the development process for small farmers in these areas.
2. Tribal differences often result in the exclusion of major groups of people from the planning and development process.

Economic and Marketing Constraints.

1. Essentially no economic analyses on sheep and goat production enterprises exist for this area, and would clearly be needed in the planning process.
2. The market potential for sheep and goat products in this area is essentially unknown and needs further study.

Resource Inventory.

1. Adequate sector surveys on livestock production, and especially sheep and goats, are needed for this area. Analyses of these and other economic data would be invaluable to planners.
2. Land and other production resource inventories should be an integral part of these sector surveys.

Technical Constraints.

1. As stated previously, trypanosomiasis and other major disease problems are probably the major constraint to livestock production in this area. Basic research on disease vector control and immunization is needed to resolve certain disease problems, but many such as most respiratory diseases, internal parasites and tick-borne diseases will only be controlled through improved production and management practices (Allonby, 1975).
2. More research is needed on pasture and forage crops, methods of harvesting and utilizing crop residues, and an inventory of by-product feed sources before effective nutrition programs can be developed for sheep and goats.
3. More research is needed on the production traits and performance characteristics of the breeds of sheep and goats in the area before the decision is made that exogenous breeds would be better than selection within indigenous breed populations.
4. As stated previously, integrated crop-livestock production systems for smallholder farm enterprises need to be developed.

Potential Role of Sheep and Goats

Major opportunities for sheep and goat production must await solutions to many of the disease, socio-economic and other technical constraints previously discussed. There are areas, however, which have immediate opportunities for improving sheep and goat production.

Tropical forest ranges are different from the other range areas in that the relative short dry periods that occur do not prevent the development of year-around intensive pasture grazing systems for sedentary producers. Many areas within the cleared regions are too steep or the soils are too thin for crop production and provide real opportunities for intensive pasture production systems. These are generally the same areas where combined crop-livestock production systems are appropriate.

The other major opportunity for immediate increases, particularly in sheep production, is in association with plantation crops such as oil palm and rubber. Offtake from livestock is in a sense bonus production from the land, while providing the benefits of manure for fertilizer and the control of undesirable grass, weed and brush growth.

14.

RECOMMENDATIONS

General Recommendations

Sheep and goat numbers and production systems in Africa have not been adequately documented. Although this is correct, it is generally agreed that sheep and goat numbers are expanding. Without planned development, these changes are not likely to have the desired benefits and may actually add to such problems as range lands deterioration.

The 1970 FAO World Census of Agriculture included two significant recommendations concerning small ruminants that are still relevant today. These were:

1. "Fund a meeting to develop a foundation for new international program which will have governments participate in planning objectives and standards for small ruminant development programs which would assist in improving conditions of life and economic growth.
2. In the past there has been limited developmental assistance to include small ruminants in development planning. A greater flow of structured developmental assistance is necessary. Its effective use depends upon improved planning, execution and an adequate number of trained and qualified technicians to develop fully integrated systems of improved husbandry for small ruminant livestock."

Although it is not certain today that the development of a new foundation is the best approach, the basic needs and recommendations made in 1970 are clearly applicable today.

Increased communication among planners, institutions and scientists working with and interested in sheep and goats in Africa is clearly needed. A workshop or conference in Africa that would (1) present the results of this report, (2) present the work of other institutions and scientists in Africa, and (3) permit scientists, government officers and planners in Africa to share ideas and jointly work on solutions to common problems should receive first priority. This would hopefully be jointly sponsored by institutions such as the appropriate division of the Organization for African Unity, International Livestock Center for Africa, International Bank for Reconstruction and Development, International Institute for Tropical Agriculture, Arab Development Bank, U. S. Agency for International Development, Winrock International Livestock Center, and other appropriate institutions. Follow-up to this first workshop or conference should be a specific planning conference that would (1) establish priority needs for small ruminant development in Africa, (2) recommend specific research, education and development projects for support on a regional basis, and (3) identify specific support required in terms of financial support, technical assistance and government policies.

The major program needs for sheep and goat production in Africa can almost be universally recommended to most countries. These are:

1. Resource Survey and Analysis. Several countries have a high level of interest in sheep and goat production, but know essentially nothing about production resource inputs and outputs for their existing populations. These countries should start with in-depth production sector resource surveys that would improve their understanding of resource inputs and outputs, current sheep and goat production systems, technical and social constraints, marketing systems, etc. These data will provide the needed base for future research and development planning in these countries.
2. Increased Emphasis on Sheep and Goat Programs. Approximately twenty countries of Africa receive more than 20% of their meat supply from sheep and goats. Ten of these countries are estimated to receive more than 40% of their meat supply from the two species. Milk, wool, hides and other products are also of major importance to many countries. In spite of these facts, we are aware of no country that provides as much as 20% of its livestock program support for sheep and goat activities. The amount is clearly less than 10% in most of these countries. Both in-country support and support from external development agencies should be changed to reflect the realities that currently exist in Africa in terms of the importance of sheep and goats.

3. Development of organized marketing programs for sheep and goats. The potential market for sheep and goats and their products appears to be excellent in Africa, and the export market, if organized, could certainly support any production that is surplus to internal needs. Organized marketing, at producer prices that accurately reflect product value, could encourage both increased offtake of surplus males to reduce grazing pressures in the pastoral areas and increase production efficiency in the remaining populations. The fact that producers are generally accustomed to selling sheep and goats at young ages in most areas suggests that pastoralists would respond to an organized marketing effort.

Specific Project Recommendations

The primary emphasis on recommendations is for the countries of Africa to (1) determine the current resources and needs in terms of sheep and goats, (2) work together through improved regional communications to develop specific regional and in-country projects that will impact on desired development efforts, and (3) place emphasis on sheep and goat development more in line with the importance of the two species. At the same time, certain countries are known to be at the point where they are prepared to implement specific development projects if adequately planned and supported.

An example of a country that is beyond the resource survey and analysis stage and is ready for a comprehensive research and development effort is Kenya. The cooperative Sheep and Goat Development Project, sponsored by the GOK Ministry of Agriculture and the FAO during its first five years, has comprehensively identified the production systems, production constraints and the opportunities for sheep and goat production within the various ecozones of Kenya. A complete review and planning effort for specific research, training and development projects in Kenya is strongly encouraged. The support services and infrastructure in Kenya, and the full spectrum of ecozones within the research stations, enhance the likelihood of success and the transference of technology to a major portion of the developing tropics.

The following recommended project is an example of the desired results of regional planning and cooperative efforts. These should be considered as preliminary suggestions.

Project Title: Developing Dairy Goat Production Systems for Smallholder Integrated Crop-Livestock Farm Units in High Potential Zones.

Cooperators: This would be a regional research project, with specific country projects contributing to the overall objectives. Regional cooperators should include:

- Organization for African Unity
- International Livestock Center for Africa

- International Institute for Tropical Agriculture
- Other appropriate international research and development agencies.

Countries known to be interested in dairy goats that should be invited to participate include Ethiopia, Kenya, Tanzania, Cameroons and Nigeria. Others may want to participate once informed of the project.

Objectives:

1. To develop dairy goat production systems for smallholder integrated crop-livestock farm units in high potential zones.
   a. Determine nutrient needs, and feed resources to meet these needs, for dairy goats. This should include improved pasture systems, supplemental nutrients from local feeds and by-products, crop residue and browse utilization, etc.
   b. Develop appropriate genetic resources through importation of exotic dairy goat breeds and through their crosses with local breeds.
   c. Develop disease prevention and health management programs for dairy goats.
   d. Develop marketing programs for goat's milk and milk products such as cheeses, candy products, yogurt, ice-cream, etc.
   e. Determine optimum resource inputs for the expected market value of outputs in order to maximize profit to smallholder producers.

15

2. Once appropriate production systems are determined, develop demonstration units and training programs for smallholder farmers.

Procedure: Specific procedures and responsibilities would be determined by the regional project group to optimize the inputs needed to accomplish the above objectives. Manpower needs, budgets and other needed support services would be developed at this point.

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15

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MIDDLE EAST

SHEEP AND GOAT PRODUCTION IN THE MIDDLE EAST

The Middle East region, as defined in this study, includes Iran, Turkey, Israel and the Arab nations of Near East Asia (Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen Arab Republic and Yemen Peoples Democratic Republic). This regional report differs from the other regional reports presented in this study in that some of the countries included in this region are north of the 30° N parallel and therefore outside of the initial terms of reference for this study. The reasons for their inclusion are: (1) they are part of the developing regions of the world; (2) this is a major sheep and goat producing region with a consumer preference for these meats; and (3) Due to the potential regional increase in income earnings, there is an increasing demand for sheep and goat meats. Demand is expected to exceed production. This trend will result in this region becoming a major market for meat from small ruminants. This opportunity complements anticipated production increases in the North and East Africa region by providing a market outlet.

A major portion of the people of the region are still dependent on agriculture and livestock production for their livelihood, although the relative economic importance of agriculture is rapidly dimishing due to income from oil. The major exception to this generalization is the

non-Arab nation of Turkey, which has little oil and mineral income but has approximately one-third of the region's people and more than one-third of the region's livestock.

Official statistics on land use in the area are incomplete, with an accurate assessment of the region's rangelands clearly needed. Data (FAO Production Yearbook, 1974) indicate that from 5 to 7 percent of the land is cultivated, approximately 15 percent is classed as permanent meadows and pastures, approximately 10 percent forests, and the remaining 65 to 70 percent of the land area is listed under "waste and other uses". This large "waste and other uses" category includes vast desert regions and several mountain ranges, all of which are seasonally grazed when weather conditions and stock water permit. Range conditions vary from overgrazing to the point of desertification in many settled and traditional grazing areas, to underutilization in other areas where stock water or other factors may limit grazing use, to true desert that is not habitable by man or beast.

Table 1 presents the 1961-65 average and 1974 human and animal populations for the region, and their percentages relative to 1974 world totals. The human population has increased approximately one-third in the last 10 years, with essentially all of the increase occurring in urban and settled agricultural areas.

Sheep numbers have increased substantially in the region during the last 10 years (32.4 percent) while goat numbers have declined and

Table 1. Human and Animal Populations in the Middle East, and Their Percentage of World Totals.

	Number		Percent Change	Percent of World Total	Livestock Per Human
	1961-65	1974			
	(000)	(000)	%	%	No.
Humans	88,534	116,901	32.0	3.0	-
Cattle	22,027	22,846	3.7	1.9	.20
Sheep	78,557	104,031	32.4	10.0	.89
Goats	53,164	47,449	-10.7	12.0	.41
Camels	1,051	1,168	11.1	9.0	.01
Horses, Mules, Asses	7,874	7,510	-4.6	6.3	.06

FAO Production Yearbook. 1974.

cattle numbers have remained stable. Essentially all of the decline in goat numbers can be accounted for by campaigns to remove goats from overgrazed areas in Turkey and Iran. These two countries still contain approximately 70 percent of the region's goat population.

Sheep and goats are clearly the most important livestock to the region, with 1.3 sheep and goats for every human in the region and approximately seven times as many sheep and goats as cattle. The Middle East and North African regions are the only developing regions of the world where the number of sheep and goats exceeds the number of people.

The productivity of the Middle East's sheep and goats is presented in Table 2. Although productivity may be considered low when compared to temperate developed countries, the region's productivity compares favorably with other developing regions, particularly when the harsh environment of the region is considered. As might be expected, the productivity of sheep and goats in the region is similar to that presented for North Africa in the Africa section of this report.

Table 2. Productivity of Sheep and Goats in the Middle East in 1974[1]

Species	No. Animals (000)	% Slaughtered %	Meat Per Head kg/year	Milk Per Head kg/year	Wool Per Head kg/year
Sheep	104,031	33.2	5.4	16.3	1.2
Goats [2]	47,449	24.8	3.5	28.6	—

[1] FAO Production Yearbook. 1974.

[2] Although not shown in this table, mohair is an important product from Angora goats in Turkey. Most of the world's Angora goats are located in Turkey, South Africa and Texas in the United States.

The principal range types in the region are desert shrub and temperate mountains and foothills, with rainfall over much of the area averaging less than 100 mm per annum. The Near East Regional Study (1972) further characterized the climate as erratic rainfall patterns and high temperatures and winds that result in high moisture evaporation rates. The soils are characterized generally as light soils with low organic matter and a tendency to salinization when irrigated. In spite of these conditions, the study estimates that 80 percent

of the population is dependent on agriculture for its livelihood. Farming is still largely for local subsistence, with little integration of crop production and animal husbandry.

There is little doubt that income from oil is dramatically changing the economy of the region, but it is not as yet clear what the benefits of this wealth will be for the farming and pastoral sectors of the population. The demand for food, and particularly products such as sheep and goat meat, is increasing. The extent to which the agricultural sector will benefit by increases in prices paid for production will depend largely on government policy. The following section attempts to analyze the limited data available as well as information obtained from direct contacts within the region on projections for consumption demand production and trade in sheep and goat meat in 1980 and 1985.

Projection of Consumption Demand, Production and Trade in Sheep and Goat Meat

Several public institutions and private firms have attempted to project future demand, production and trade deficits for meat in the Middle East since 1973. This analysis relies heavily on data recently published by the World Bank (Young and Tyler, 1977) and unpublished material available to the authors of this report.

The economic importance of oil income to the OPEC countries in the Middle East and the subsequent effect of this income on demand for meat within the region is staggering. The IBRD Economic and Social Data Division in 1974 projected that the GNP of the region in 1967-69 U. S. dollars would grow from the 1973 level of 50 billion dollars to approximately 100 billion dollars in 1980 and approximately 160 billion dollars in 1985. These figures are their "medium income growth" projections, and are clearly conservative in view of recent income data for selected countries in the region. For example, the IBRD projects the GNP of Saudi Arabia to be $16.3 billion in 1985, while updated estimates of current oil production at 10 million barrels per day indicates oil income alone will exceed 30 billion dollars in 1977. Most major private banks are now projecting the GNP of the region to exceed 150 billion by 1980 and 200 billion by 1985. At any rate, the GNP of the region is projected to grow at a rate of 9 to 15 percent annually, depending on whose figures are accepted, while most sources agree on a regional population growth rate of approximately 2.8 percent annually. This means that the GNP per capita for the region is expected to grow from the approximately $430 per capita in 1973 to between $1,000 and $1,500 per capita in 1985, which represents a dramatic increase in disposable income to the region. Unequal distribution of oil income is likely; thus, medium income may be substantially below average income. Consequently, meat consumption may not reach levels projected from average income.

A detailed analysis of all of the components affecting demand for meat within the region are beyond the scope of this study. Thus, this study will restrict itself to summarizing other demand projections with supplementary comments and analyses, rather than a detailed analysis and projection study.

Certainly one important component of any demand projection for meat is consumer tastes and preferences, and how these may be affected by income level. Detailed household surveys have not been conducted for all countries in the region, but have been conducted in Iran. Since Iran represents about 30 percent of the region's human population and is both a Moslem nation and a member of OPEC, tastes and preferences in Iran should be representative of the countries of the region that are expected to dramatically increase per capita meat consumption. Table 3 presents data on expenditures in 1971 for food and meat by urban households as affected by income level. Although data are available on rural households, only urban households are used since most of the growth in demand and population is expected to be in the urban sector.

Results from the 16,000 urban households survey (Table 3) indicate that the average monthly expenditures for meat for all income groups were 9.3 percent of the total monthly expenditures. Lamb and goat meat represented a relatively stable proportion of meat expenditures at near 80 percent for all income levels. Of major interest were the changes that occurred in expenditures for beef and veal and for chicken. Proportionately, expenditures for beef and veal declined while expenditures for poultry increased with increasing income level.

Table 3. Expenditures for Food and Meat by Iranian Households of Different Income Levels in 1971 [1]

Monthly Expenditure (Iranian Rials)	Percent of Total Monthly Expenditure		Percent of Meat Expenditure			
	Food	Meat	Lamb & Goat	Beef & Veal	Chicken	Fish
	%	%	%	%	%	%
Less than 2,000	61.4	6.2	71.2	20.6	0.4	3.8
5,000 to 7,499	57.7	10.7	82.8	10.2	1.3	3.7
10,000 to 14,999	50.4	10.3	82.2	6.3	5.9	3.4
15,000 to 19,999	43.4	9.0	81.7	4.0	6.2	5.4
20,000 to 29,999	38.8	8.3	78.1	3.4	11.5	4.3
Over 30,000	25.1	5.3	74.1	2.8	17.7	3.0
Average All Groups	46.9	9.3	80.6	7.3	5.7	4.0

[1] Household Expenditure Survey: Urban Households, 1971. Iranian Statistical Center, Tehran.

The FAO in 1970 estimated that 60 percent of the red meat consumed in Iran was lamb, mutton and goat, while Table 3 shows 80 percent of meat expenditures for lamb, mutton and goat. Mutton prices are generally 30 to 50 percent higher than beef and veal prices. Traditionally, in the Middle East, beef is regarded as a meat for lower income groups, although this may change to some extent as higher quality beef is introduced. Regardless of changes in beef and poultry consumption, there is every reason to believe that lamb, mutton and goat will be the dominant meats in Middle Eastern diets. Tradition, religious customs and other factors all point in this direction. The only constraints that could potentially alter the market share for lamb, mutton and goat meat would be availability and price. It is questionable whether the supply of these meats can be obtained at reasonable prices to meet the demand projections presented in Table 4.

The projected consumption demand for lamb, mutton and goat meat presented in Table 4 represent ranges in estimates from unpublished data compiled by IBRD, FAO, internal government sources in the Middle East, and from various private sources. Production projections are based on historical trends in sheep and goat numbers and offtake rates. The potential trade deficit represents the difference in projected demand and production. To place these consumption demand data in perspective actual consumption of lamb, mutton and goat meat in the region in 1970 was estimated by FAO at 725,000 metric tons, which was approximately 60 percent of the red meat consumed in the region.

161

Table 4. Ranges in Estimates from Various Sources for Projected Consumption Demand, Production and Potential Trade Deficit for Sheep and Goat Meat in the Middle East for 1980 and 1985 in Thousands of Metric Tons.[1]

	Projected Consumption Demand (000 MT)[3]	Projected Production[2] (000 MT)	Potential Trade Deficit (000 MT)
1980			
Iran	472-492	291	181-201
Iraq	150-207	113	37-94
Saudi Arabia	80-91	22	58-69
Turkey	324-376	215	109-161
Rest of Region	180-187	162	18-35
Region Total	1,206-1,353	803	403-560
1985			
Iran	606-950	344	262-606
Iraq	237-404	143	94-261
Saudi Arabia	120-156	24	96-132
Turkey	449-538	225	224-313
Rest of Region	180-202	176	4-26
Region Total	1592-2250	912	680-1338

1,2 Estimates are from Young and Tyler (1977) and unpublished data compiled by IBRD, FAO, government sources in the Middle East and, in some cases, from private sources.

3 To place these projections into perspective, assuming a carcass weight of 20 kg, one thousand metric tons is equivalent to 50,000 live sheep.

These estimates of consumption demand should be tempered somewhat by the question of whether or not a country such as Turkey can afford to import such massive amounts of meat. Also, most estimates are generally based on projected beef and mutton price increases over 1970 value of approximately 30 percent by 1980 and 45-50 percent by 1985. Lamb and mutton prices are already more than double 1970 prices in cities such as Tehran and Jeddah. This is in spite of substantial government subsidies to importers to offset sheep prices and transportation costs. The government of Saudi Arabia, for example, subsidizes imports at the level of 30 percent of animal cost and 50 percent of transportation cost.

Even assuming that Turkey can only afford limited imports, the potential trade deficits could range from 15 to 20 million sheep by 1980 to well over 30 million sheep by 1985. This represents a huge new market outlet for sheep and goat meat. One other important characteristic of this market is that the demand for live animals is greater than the demand for meat imports. The in-country and even in-home slaughter of sheep has strong traditional and religious roots, which will continue to be an important factor. The other problem is the lack of storage, handling and processing facilities and internal transportation capabilities required to handle such massive amounts of fresh or frozen meat. Again, tradition and social customs are strong factors affecting the marketing system for meat at the present time.

Currently, Australia and New Zealand are the dominant factors in supplying both live sheep and mutton to the Middle East. According to sources within the Commercial Ministry of the government of Australia, that country projects live sheep and carcass sales to the Middle East at over 7 million head by 1980. East Africa, including Sudan, have

traditionally exported substantial numbers of sheep and goats to the Middle East, but government policies and production goals will have to change for this region to become a major factor in the Middle East market.

The other question is the ability of the region to increase production of sheep and goat meat. Although subsidies are available in certain countries to encourage increased production, these do not appear to be competitive with subsidies currently provided for dairying, crop production or sheep and goat imports. This question will be discussed further in the following section.

In summary, the potential market in the Middle East for sheep and goats is staggering. The major questions as yet unanswered are the internal and external capabilities of supplying this market, and at what price the market will continue to exist. The size of the market is also obviously dependent on government policy within the region (import subsidies or controls, etc.) and the ability of OPEC to maintain or increase current oil prices and volume.

LIVESTOCK PRODUCTION SYSTEMS

The lands grazed either regularly or periodically by livestock can be classed as true desert, arid savannahs, steppes and mountains. In addition, a limited number of livestock may be kept under zero grazing conditions near villages or in irrigated crop production areas. According to the Near East Regional Study (FAO, 1972), approximately 70 percent of the sheep and goat population of the region are estimated to be managed under nomadic or transhumant migratory systems. The remainder would largely be managed under sedentary grazing systems on communal village grazing lands and, in some areas, crop interstices and residues.

Estimates for various countries in the region are that from 60 percent to as high as 90 percent of the feed for livestock comes from permanent meadows and pastures. Changing patterns of land use, with some of the better grazing lands switching to marginal crop production, along with increased human and animal populations, are resulting in severe overgrazing on much of the traditional grazing lands. At the same time, lack of livestock water and other factors are actually resulting in underutilization of some range areas [Arid Lands Agricultural Development Program (ALAD), 1972].

Nomadic and Transhumant Production Systems

True nomadism is characteristic of certain Bedouin tribes in Saudi Arabia, Syria and Iraq and other tribes in Iran. The nomads

are increasingly restricted to true desert and marginal rangelands receiving less than 100 mm annual rainfall. In some areas, traditional arrangements allowing crop residue grazing during winter months still exists.

Although true nomads have no base, they generally have a traditional and exclusive use right over specific lands that have evolved as tribal territories. Nomadic systems almost exclusively involve camels, goats and sheep, in varying ratios to each other depending on the harshness of the environment. The camel is probably the most important animal to the true nomad, providing transportation, fiber, milk and, in extreme conditions, meat for sustenance. Traditionally, nomads sell very few animals or products, allowing numbers to expand during good times. Winter death losses of 20 percent are common during normal years.

Numbers of nomads are declining because of difficulties faced in trying to survive on less land, government pressures to settle, and job opportunities near cities brought about by industrial development associated with petroleum development. Government efforts to establish tribal boundaries, codify tribal laws, educate younger nomads and other factors are encourage nomads to settle. At the same time, vast desert areas of the region can probably only be used for food and fiber production if nomadic systems continue.

Transhumance, or the occupation of specific grazing lands along established grazing routes between winter and summer grazing areas, is the most important livestock production system in the region. The Near East Regional Study (FAO, 1972) estimates the involved human population at approximately 2 million people, but the livestock numbers to be over 50 percent of the region totals.

Generally, home base is in or near the winter grazing areas. These would include arid savannah zones around tribal settlements or villages and either in or near major agricultural areas where crop residue or other winter grazing may be available. As soon as weather permits during early spring, migration towards higher ground begins. The animals remain in the higher country until colder weather in late summer or autumn forces the return to base camp.

Transhumance almost exclusively involves camels, sheep and goats. Lambing and kidding are completed prior to transhumance, with weaning generally occurring along the migratory route. Milking for the production of cheese, butter, ghee or fresh milk is begun when the lambs reach 30 to 40 days and continued along the migratory route postweaning. Generally, lactating ewes receive the best grazing. Lambs followed by rams and non-lactating females receive the poorest grazing. This results in slower growth rates, later marketing and higher death losses in lambs. Generally, migration through the arid regions to higher elevation grazing areas results in large weight losses both in travelling to and returning from these areas. The Near East Regional

Study (FAO, 1972), ALAD (1974) and the government of Iran have estimated weight losses to be as high as 70 percent of the total weight of offtake from the region. Recent efforts at improving these conditions have emphasized improved watering and dipping facilities along migratory routes. Recommendations have also included evaluating the feasibility of supplemental feeding during migration and truck transport to summer ranges. It is not known if these practices are being tested at the present time.

Large flocks are generally the rule during migration. These are often communal flocks owned by villages or tribes with selected members of the village or tribe making the migration while other members are sedentary farmers. Large privately owned flocks may either be owned by the herders or by wealthy merchants, who contract with the herders. Traders and buyers follow the flocks, buying milk and surplus stock for transport to markets. Efforts to develop portable cheese making facilities have not been too successful, and when used are generally owned by traders rather than producers.

Sedentary Production Systems. Sedentary systems are based around village or tribal grazing lands in the arid savannahs, or around crop interstices, marginal lands or fallow land in agricultural areas. Approximately 30 percent of the sheep and goats and almost all of the cattle are found in these systems. Large areas of Turkey, Iran,

Iraq and Syria are used in sedentary systems of production. In addition, villages and cities have large populations of sheep and goats throughout the region that function primarily as scavengers. The numbers and productivity of these scavenger populations are generally underestimated.

Village or tribal lands are generally communally owned and grazing rights are not allocated. As a result, these lands are generally severely overgrazed and little incentive exists for animal population control or range improvement. This communal form of land tenure is widely considered to be the major social and political obstacle to improvement in livestock production in many countries of the region.

The management system in these areas basically evolves around grazing under herder on the communal lands during the day and return of the animals to the village where they are penned at night. If winters are not too severe, this practice is followed year around. Where winter weather prevents grazing, the animals are stall fed straw, coarse hay and in some cases limited concentrates, such as barley.

The sheep of the region are remarkable in their ability to survive and produce under the harsh environmental disease and other constraints that exist in the area. Almost all of the sheep are of the fat-rumped or fat-tailed type. Carpet wool breed types include over 90 percent of the sheep in the area; pelt-type sheep such as the Karakul include 4 to 5 percent; and Merino or fine wool-types include another 2 to 3 percent. Unique breeds in the area include the

Awassi of Iraq, Israel, Jordan, Lebanon, Syria, Turkey and other countries, which is the most widespreac breed in the region. Other important breed types include the Akaraman or Karamon and Kiviricik (Turkish Merino) breeds of Turkey; the Balouchi, Sanjabi, Moghani, Chall, Zel and Karakul breeds of Iran; the Arabi breed in Iraq and the Nejdi breed of Saudi Arabia. Many other local or tribal types are referred to as breeds, but generally are derived from the above mentioned breeds..

Productivity of sheep in the region is largely controlled by the harsh environment in which the animals are expected to produce. Research and demonstration units in the region, using improved breeding, nutrition and management practices, have shown that dramatic increases in productivity are possible. The following summarizes current levels of production and potentials with already demonstrated improved practices:

Trait	Estimated Current Production Level	Under Improved Management Systems
Lambing Rates, %	60-100	80-120
Lamb Mortality, %	10-60	5-20
Average Carcass Wt., kg	27	28-30
Average Milk Yield, kg	35-50	50-100
Average Grease Wool Wt., kg	0.7-2.0	1.5-3.0
Flock Annual Offtake, %	25-35	35-45

The lower range of estimates would be under more extreme poor environments, while the upper level would be under better environmental conditions. Limited work under highly intensive production systems has indicated that rapid progress can be made through selection and cross-breeding. In Israel, for example, large flocks of Awassi ewes are approaching 400 kg milk per lactation, with individual ewes exceeding 1000 kg. One large cooperative is now using only rams whose dams have exceeded 750 kg milk yield. Introduction of the Chios breed from Cyprus have also been successful under intensive conditions. Flocks of first cross Chios indigenous breed females have exceeded 200 kg milk yield and a 30 to 50 percent increase in percent lamb crop weaned.

Interest in feedlot fattening systems for sheep and lambs is increasing. Traditional feeding systems have actually been little more than holding actions where little better than maintenance diets based on straw are fed in order to spread out marketing. These traditional lots are generally controlled by butchers, traders or wealthy merchants. However, government interest in western style feedlot schemes, either government controlled or cooperatively owned, is widespread in the area. The major constraints at the present time appear to be inadequate supplies of high quality forages, lack of qualified management, and inadequate disease control measures.

CONSTRAINTS TO PRODUCTION

Although not necessarily in order of importance, the following are considered to be the most significant constraints to production.

Socio-Political Constraints:

1. According to the Near East Regional Study (FAO, 1972), the major constraint to improved livestock production in the region is the absence of an effective land tenure system that allocates grazing rights on communal lands.
2. Providing adequate services, education and other support is extremely difficult with nomadic and transhumant producers. These producers are generally inaccessable, and reluctant to change when reached.

Economic and Marketing Constraints:

1. Government policies in Middle East OPEC countries that are currently subsidizing live sheep and goat and meat imports are not adequately considering internal market disincentives to local producers caused by lower priced imports.
2. In many areas of the region, municipal authorities regulate meat prices, which generally favor consumers at the expense of producers.
3. Organized free markets are generally not available to producers. Middlemen, butchers and merchants generally control marketing. Wool is often sold three or four times by different levels of middlemen before it enters the local or export market.

Resource Inventory:

1. Probably the greatest need is for better rangeland resource surveys that are essential to land use planning and control.
2. Sheep production systems and practices are fairly well known in the region, but little is known about the region's over 47 million goats.

Technical Constraints:

1. The major technical constraint to improved sheep and goat production is inadequate feed resources. FAO (1972) estimates that an additional 1.1 million hectares are needed for fodder production to adequately support existing flocks and herds. Instead of this being provided, government policies are more often encouraging the conversion of better rangelands into marginal crop lands for cereal production, thus aggravating the problem.
2. Research is needed to develop more efficient crop-livestock production systems, utilizing specific fodder crops for livestock, fallow lands for pasture crops, strategic supplementation of cereals, etc.
3. Research is needed to develop stratified production systems which link range production systems to feedlots for finishing, and which will develop specialized intensive production systems that emphasize the high value products of milk and lamb in high potential areas.

4. The lack of trained personnel is a major problem in the region, and pay and status for professionals in agriculture is generally not sufficient to attract highly qualified people. At the present time, almost all management for development schemes in the region is provided externally.

POTENTIAL ROLE OF SHEEP AND GOATS

The obvious market potential for sheep and goats and their products clearly establishes the potential for sheep and goats in the area. If current projected trade deficits in sheep, goats and mutton are realized in 1985, then costs of imports to the region could be as high as 3 billion dollars annually. This should be adequate incentive to governments in the region to emphasize improving the domestic industry. The major question is how to increase production when most analyses have generally concluded that existing rangelands are already overstocked. The following four areas are generally recognized as the areas providing the highest potential for increasing productivity.

Improved Management of Rangelands. Many have speculated that reducing livestock numbers by one third, on existing ranges in the region could actually result in a larger net offtake of product. Grazing control accompanied by range renovation, improved livestock water, more efficient migration systems and other practices that have often been recommended clearly merit serious consideration. Investments in structural changes must clearly be accompanied by a major investment in education and training at all levels.

Integrated Crop--Livestock Production Systems. Pastoral and agricultural enterprises are generally not integrated and have not

been considered as integrated programs in development studies and planning. As an example, the ALAD report in 1974 estimated idle or fallow crop land in the region to exceed 40 million hectares annually, a major portion of which could be used to produce forage for animal production during idle years without affecting subsequent cereal production. Sheep have proven effective in similar environments and production systems in Australia, western North America and the highlands of Africa.

Intensive Production Systems. If sheep and goats and their products were allowed to reach potential market prices, and the same were true for cereal grains, a strong case could be made for highly intensive sheep production systems involving irrigated pastures, harvested forages, supplemental cereal grain feeding and even zero grazing confinement systems at the present time. With the long-range outlook for needed sheep and goat meat in the region, highly intensive production systems that would permit both increased animal numbers and increased productivity per unit may well be the major hope for reducing potential trade deficits.

Stratified Production Systems. Most developed areas of the world that demand higher quality products than can be produced from marginal range lands have evolved into specialized production systems--i.e. production of feeder lambs on ranges and finishing these lambs in other areas on improved pastures or in feedlots. Economical

weight gains and product improvement can also be achieved with older stock beyond its productive life on the range. Some evidence of stratification can already be seen in the area, but traditional producers are not currently sharing in the benefits of these programs. Stratification could also potentially achieve desired results in reducing rangeland grazing pressures.

RECOMMENDATIONS

Sheep and goats, and their products of meat, milk and fiber, clearly merit further development efforts in light of regional demand and potential trade deficits. It is also clear that changes must occur in traditional production systems and non-traditional production systems merit further investigation. The following general recommendations are divided into those related to government policy and those related to technical improvements.

Government Policy

1. Governments in the region that are subsidizing sheep and goat and and meat imports in order to meet consumer demand at reasonable prices should carefully review the impact of subsidized imports on profit and production incentives in the domestic sector. Reallocation of a portion of import subsidies to provide domestic producer incentives that would result in the desired changes in the domestic industry could be a very wise long-term investment.
2. Improving land use through greater grazing control and allocation of grazing rights is basic to maintaining or improving productive rangelands for future generations.
3. Internal marketing systems that provide more direct benefit and incentive to domestic producers must be developed by governments in the region. Control of meat prices by municipal governments should be eliminated, and open markets that reflect product value

encouraged. Government intervention in marketing could be coupled with production subsidies, grazing control, development schemes, education programs, etc.

4. The only other alternative available to countries with investment capital but inadequate natural resources to increase domestic production is external investments in sheep and goat production. The authors of this report are aware of such investments in both developed and developing countries.

Technical Improvements

1. Major investments in rangeland improvement and range management research and education programs are clearly needed, but must be precluded by greater control of rangelands use.
2. Major investments, preferably on a regional basis, in sheep and goat research are clearly justified. Emphasis should be placed on:
   a. Evaluation, improvement and utilization of indigenous genetic resources for meat, milk, wool and mohair production.
   b. Development of integrated crop-livestock production systems, with emphasis on more efficient use of fallow lands.
   c. Evaluation of intensive production systems involving irrigated pastures, harvested forages, cereal grain supplementation, zero grazing systems, lamb feedlots, etc.
3. Almost all of the above recommendations will require major investments in education and training - at the research scientist, administrative, extension worker and producer levels.

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ASIA AND ASIAN SUBCONTINENT

191

SHEEP AND GOAT PRODUCTION IN THE ASIAN SUBCONTINENT

For the purposes of this report, the Asian subcontinent includes India, Pakistan, Afghanistan, Nepal and Bangladesh. Agriculture and livestock production are the largest contributors to the gross national product in this region. Probably a larger portion of the population in this region are subsistence cultivators and pastoralists than in any of the developing regions of the world.

The total land area of this region is over 500 million hectares, which contains approximately 20 percent of the world's human population. To put this into perspective, Africa has six times the land area of the Asian subcontinent yet has only 10 percent of the world's people. The pressure on the land resources by the increasing human population is tremendous. Table 1 presents the 1961-65 average and 1974 human and animal populations for the region, and their relative percentages to 1974 world totals.

The human population of the region has increased approximately 30 percent during the last 10 years, while the increases in livestock numbers have been far below this rate. Probably the most overwhelming statistic for the region is the huge cattle population of India, which is essentially non-productive in terms of meat production. The huge amount of feed resources required to maintain these cattle would make a substantial difference in food supply if the resources were diverted toward small ruminant production. There is some indication that the number of cattle may actually be decreasing rather than increasing as the statistics indicate. The other major livestock species in the region is the buffalo,

Table 1. Human and Animal Populations in the Asian Subcontinent, and Their Percentage of World Totals.

	Number		Percent Change	Percent of World Total	Livestock Per Human
	1961-65	1974			
	(000)	(000)	%	%	No.
Humans	595,577	774,242	30.0	19.8	
Cattle	216,325	229,337	6.0	19.5	.30
Sheep	72,719	78,066	7.4	7.6	.10
Goats	84,249	98,335	16.7	24.7	.13
Buffalo	62,585	74,737	19.4	57.4	.10
Camels	1,952	2,257	15.6	17.0	.003
Horses, Mules, Asses	5,386	5,032	-6.6	4.2	.006

FAO Production Yearbook, 1974

which is the most important source of farm power in the region. Both buffalo and cattle are milked in the agricultural areas.

Both sheep and goats are increasing in numbers in the region, with goats increasing at a more rapid rate than sheep. India dominates the region with approximately 69 million goats and 40 million sheep. Pakistan has 14 million goats and 18 million sheep, while Afghanistan has approximately 4 million goats and 17 million sheep. The subcontinent contains approximately 25 percent of the world's goats. Although Africa has more goats per person, the concentration of goats per unit of land is approximately five times as great in the Asian subcontinent.

The productivity of sheep and goats in the region is presented in Table 2. Within the region, sheep are more productive in the rest of the region than they are in India. Sheep are the principal livestock species for nomadic and transhumant pastoralists in Afghanistan and Pakistan and, due to their importance to these people, probably are better managed than in the smallholder flocks of India. When compared to the rest of the developing world, offtake rates and meat production per head are acceptable for sheep.

Both percent slaughtered annually and production of meat per head for goats in the region exceed world averages. The 42.8 percent annual slaughter for goats in India at the same time that numbers are dramatically increasing clearly indicates a high productivity. Milk production is deceiving, since government estimates were based on only approximately 10 percent of the goats in India being milked. Unofficial

Table 2. Productivity of Sheep and Goats in the Asian Subcontinent in 1974.

Area	No. Animals	% Slaughtered	Meat Per Head	Milk Per Head	Wool Per Head
	(000)	%	kg./yr.	kg./yr.	kg./yr.
Sheep					
India	40,000	31.9	2.9	-	0.9
Rest of Region	38,066	31.8	3.9	13.4	1.4
Goats					
India	69,000	42.8	3.9	9.9	-
Rest of Region	29,335	34.8	3.9	37.2	-

FAO Production Yearbook, 1974.

estimates are that milk production from goats is rapidly increasing in India, with approximately 20 percent of the goats being milked (Sengar, 1976). Since almost all goat's milk is consumed locally, any milk production data can only be classified at best as an estimate.

The four principal range types within the ecozones of the region are the tropical savannahs, tropical forests, desert bush and temperate mountains and foothills. Much of India falls into the classification of tropical savannah, with rainfall from 250 mm to 1500 mm. Tropical forests in the southern peninsula are limited, with many areas that once would have fit this classification having been cleared and put under intensive crop production. The desert bush zone ranges from the northeast plains of India through Pakistan and Afghanistan, with variation from sub-tropical in the southern part to temperate desert in the north. The Himalayas and other mountain ranges border the entire region on the east.

Sheep and goats are produced in the subcontinent under nomadic, transhumant and sedentary production systems (Turner et al., 1973). The migratory flocks exist in those areas where vegetation is scarce and/or seasonal due to climate. The sedentary flocks are generally associated with agricultural areas and owned by both farmers and landless producers. A discussion of production in the region is, therefore, most appropriate on the basis of two broad range classifications that dictate the production systems. These are the tropical savannah/tropical forest zones and the desert bush/temperate mountain zones.

HUMID TROPICAL SAVANNAHS AND FORESTS

The tropical savannah and forest includes a major portion of India and Bangladesh and a smaller portion of Pakistan. As stated previously, rainfall in this zone ranges from near desert 250 mm to 2500 mm in the extreme southern peninsula where the limited areas of tropical forests remain. The humid tropical savannahs, as discussed in this section, receive over 500 mm annual rainfall. The only areas of the tropical forest zone that includes livestock production are those areas that have been cleared and are intensively cultivated.

Essentially all of the arable land in the area that has adequate rainfall is intensively cultivated. In terms of livestock production, practically every available nutrient resource is utilized. The question in this region is not how to take advantage of underutilized nutrient resources, which is the case in much of the developing world, but how to reallocate these nutrient resources into more productive livestock systems in a culturally acceptable manner. The almost 20 percent of the world's cattle found in this region provide relatively little to the direct human food supply. It is recognized that perhaps 5-10 percent of these cattle are ultimately slaughtered, approximately 10 percent may be milked and another 20-30 percent are used for draught power. However, this still leaves 50 to 60 percent, or over 100 million cattle, that serve a production function relationship that is less than would be expected in other regions of the world. The amount of nutrients required to maintain this hugh cattle population is simply staggering, especially when the total food supply available for the human population is considered.

In the high rainfall area (above 800 mm rainfall), livestock are generally owned by sedentary farmers and landless peasants. The only exception to this is the migration of flocks (mostly sheep) into the cropping areas from the arid ranges to utilize crop residues and unharvested forages. Migratory flocks are generally large (100-2000 head), while sedentary flocks are normally 2 to 10 head with occasional flocks of 50 head or larger.

The principal breeds of sheep found in the high rainfall area are the Nellore and Mandya, which are non-wool or hair breeds for meat production (Turner et al., 1973). The Sonadi and Malpura, which are primarily carpet wool breeds found in the more arid zones, are occasionally seen in the high rainfall areas. The principal native breeds of goats are the Jamnapari, Beetal and Barbari (Mishra, 1976). Introduced dairy goat breeds such as the Saanen, Alpine, Toggenburg and Anglo-Nubian are increasingly popular.

Mishra (1976) described the breeds of goats in India, their productivity and recommended management practices. The Jamnapari breed of goats has been one of the most widely used genetic resources in the world, with breed types and introductions in practically every region of the tropics tracing their origins to this breed. They are multicolored from white to brown to black, have long pendulous ears, are tall and leggy with mature males averaging 96 cm and mature females averaging 82 cm at the withers, and are heavy with mature males averaging 80 kg and mature females 50 kg. The average milk yield is 1 kg/day with lactation length of 200 to 270 days and practically no supplemental concentrate feeds. Under improved conditions yields of up to 400 to 500 kg have been achieved. Kidding rates average 1.5 kids per doe.

The Beetal breed is intermediate in size between the Jamnapari and Barbari breeds, with milk yields similar to the Jamnapari. The Barbari are called the dwarf milk goats of India. Mature females will weigh 25-30 kg and mature males 35 to 45 kg, with wither heights averaging 55 cm for females and 61 cm for males. Milk yields of 100 to 200 kg are expected, depending on available feed. They are more prolific, averaging 2 kids per doe, and will kid at least three times in two years. The breed is also considered well adapted to stall feeding and grazing in or near villages and cities. The Bengal breed which is the dwarf meat-type goat in India, is also considered highly prolific (2-3 kids per doe) and very hardy.

Within this zone, goats can be found in a wide range of production and agro-economic situations (Sengar, 1976). These range from carefully managed intensive production systems, 2 to 5 head stall-fed systems, tethering systems and loss grazing or scavenger systems in or near villages and cities. Landless farm workers own a significant share of the goats. They will usually take their one to three goats to the fields when they work, tether them along roadsides or canals, and collect unwanted weeds or crop residues for the goats to eat while they work. The goats are taken home with them after work where they are confirmed. The other system is continuous confinement for the goats and cut and carry the feed to them by the small farmers and landless workers. These goats are very important to both sustenance and supplemental income for the landless peasants. This agro-economic system is already so delicately balanced that identifying specific practices to change for improvement of the system is extremely difficult.

Although an average of two does producing 3 or 4 kids and 200 to 400 liters of milk annually does not sound like an important production system.

it is vital to the survival and economic security of millions of families in the subcontinent. Diversion of feed resources to this system, along with organized technology inputs and marketing systems, could go a long way to alleviating hunger and improving the agro-economic system. A 10 percent reduction in the cattle herd of India, for example, would permit about a 100 percent increase in the milk and meat production from goats. This would come from both increased productivity of existing goats due to improved nutrition and additional capacity for more goats. Other technology changes such as genetic improvement and improved animal health would result in further increases.

Constraints to Production

The major constraints to improved production are the lack of perception of the importance of small ruminants on the part of planners, a reluctance to develop strategies to alleviate the problems created by the huge population of the relatively low-productive use of cattle, and the resulting critical problem of scarce nutrients that restricts productivity of existing herds and flocks. The constraints listed in this section are discussed under general categories of socio-political, economic and technological constraints and are not necessarily in order of importance.

Socio-Political Constraints:

1. The greatest constraint to improved food production from livestock in the subcontinent is the tremendous number of cattle that are used for purposes other than direct human nutritional consumption. The cultural role is well recognized but the problem of how to remedy the situation persists.

2. Planners, government officials and development agencies generally do not recognize the importance of sheep and goats to subsistence producers, nor their potential for commercial production. This mentality was so serious that Pakistan officials were persuaded to legislate an extermination program for goats. The failure to recognize that the production process was the effect of several complex problems rather than the cause of the problem still prevails in much of the conventional wisdom about livestock production in the subcontinent.
3. Sheep and goat producers are generally near the bottom of the social scale. Professions which serve them, such as extension specialists, also suffer from this image.

Economic and Marketing Constraints:

1. A major portion of sheep and goat products in this region are used for subsistence, making an economic analysis quite difficult.
2. Sheep and goats are normally marketed through traders, with producers often receiving less than fair market value.
3. No efforts have been made to organize milk marketing for goat's milk, which restricts its use to local or home consumption (Singh and Sengar, 1972).

Technological Constraints:

1. Improving nutrition is the major constraint to increasing sheep and goat productivity (Shaid, 1974).
2. With small flock size, within flock genetic improvement is extremely difficult.

3. Animal health and disease problems exist and are generally well understood, but the veterinary services and supplies are often not available to smallholder and landless producers.

Potential Role of Sheep and Goats

Within the humid tropical savannahs of India, the greatest opportunity appears to be in increasing both number and productivity of dairy goats (Sengar, 1976). There is a general feeling that government officials would be receptive to a well structured program for this purpose. The following points should be considered:

1. India already has the basic infrastructure of research facilities, scientists and extension services. All that is needed is a coordinated effort that is adequately supported.
2. With the urgent needs for increased milk production, a smallholder milk marketing scheme for goat's milk similar to those that have proven successful for dairy cattle and buffaloes should be tested. It should be remembered that the success of these programs was their integration with a total program including credit, veterinary and extension services, etc.
3. The improved breeding stock required for a successful program must be developed under large government or cooperative schemes, since the smallholder can not develop these resources by himself.

Probably the greatest opportunity for improving sheep production is within the larger migratory flocks within the tropical savannahs (Turner et al., 1973). The provision of veterinary and extension services and

improved breeding stock from central herds could greatly increase the productivity of existing flocks. However, this is dependent on the development of pasture improvement and other programs that would increase the nutrient resources available for production.

ARID SAVANNAHS, DESERT SHRUB AND TEMPERATE HIGHLANDS

The reason for discussing these diverse range types together is that the production systems utilizing them are closely integrated. Migratory flocks, both nomadic and transhumant, spend the cooler part of the year grazing desert and arid savannah ranges, then will move into the mountains during warmer periods. In the southern part of the Indian desert and arid savannah ranges, the migration may be south into the cropping areas to utilize crop residues and unharvested feeds. Essentially all production systems in the area are migratory to take advantage of widely scattered and sparse feed and water resources.

The north and west of India and south Pakistan represent a large desert area known as the Indian desert. This area is separated from the arid lands of Afghanistan by the Hindu Kush mountain range and is bordered on the east by the Himalayas. Rainfall will generally exceed 1400 mm in the temperate highlands and drops rapidly to below 300 mm in the arid lowlands. Colder winter temperatures permit use of the hot arid desert regions, with migration upward into the highlands beginning in late spring. Rain falls mainly in the late spring, summer and early autumn.

Livestock Production Systems

Sheep and goats are clearly the more important in this area than cattle. Although it was impossible to separate small ruminant and cattle numbers for this area of India, the numbers of Afghanistan and Pakistan are probably typical for the desert area of India. Afghanistan and Pakistan have combined totals of 35 million sheep, 18 million goats, 17 million cattle and 10 million buffaloes. Sheep are obviously more important than goats to the desert and temperate highlands ranges. Approximately 40 percent of India's sheep are in these range areas.

With minor exceptions around cities and villages in higher rainfall or irrigated areas, sheep production is migratory (Turner et al., 1973). Nomadic herders will move their flocks from winter desert grazing areas to spring foothill ranges to summer mountain pastures and then either back to fall foothill ranges or into cropping areas to graze crop residues or unharvested crops in marginal areas.

The majority of the migratory herders would be more properly classified as transhumants (McArthur, et al., 1976). These groups will have one or more settled bases in their traditional summer and winter grazing areas, and may also have areas where they will cultivate some crops along their migratory routes. Transhumant herders may also be fully integrated in certain areas with settled agricultural villages,

with a few persons taking the village flocks to mountain pastures in the early summer. Nomadic traders and laborers also follow the flocks along their migratory routes. These groups generally do not recognize national boundaries and rarely benefit from government services.

Livestock are clearly the most important sector of the agricultural economy in these areas (Hakimi, 1976). Livestock products account for approximately 20 percent of the gross national product and 30 percent of the total export income in Afghanistan. Within the livestock sector, sheep products account for nearly 90 percent of export income in Afghanistan. Data could not be obtained that separated these figures for the arid range and temperate highland regions of Pakistan and India, but the relative importance of sheep to these areas is estimated to be similar to Afghanistan.

Many breeds of sheep can be found in these areas, although there appears to be considerable genetic similarities among most types. The major groupings would be the lower yielding and lower quality coarse wool breed types, good quality carpet wool breed types, native finer wool breed types and introduced wool breeds. Typical breeds found in the Indian desert region would be the Sonadi (poor coarse wool) and Magra (good carpet wool), with the Kashmir Merino (finer wool) found in the Himalayan region (Turner, et al., 1973). Introduction into India of Corriedales from Australia, Rambouillets from the United States and other wool breeds from

other areas are known to have been made. Emphasis in India for these ecozones is to improve wool production. The other important breed resource in the area is the Karakul, with fur production from young lambs being the primary production.

Constraints to Production

The major constraints to production in the area are the shortage of feed resources, which forces the migratory production systems that make it extremely difficult to provide government programs and services to producers. Several of the constraints previously discussed are of equal importance to this region, but will not be repeated in detail.

Socio-Political Constraints:

1. The migratory nature of production systems creates problems in providing government assistance. At the same time, producers in these areas are generally suspicious of government intervention and often do not recognize geo-political boundaries or authorities.
2. The image of sheep and goat producers in India is generally low and their proximity to government centers is remote. As a result of these and other frustrations, there is often a tendency of government planners to ignore them in lieu of more pressing local problems.

Economic and Marketing Constraints:

1. Organized marketing is very limited and poorly structured in the region. The only major efforts have been in the area of wool marketing. As a result, migratory traders are often the primary beneficiary at the expense of producers.
2. Government intervention into export pricing policy often results in lower prices for producers due to the urgent need for foreign exchange earnings.

Technological Constraints:

1. The scarcity of nutrients, particularly during the winter months, is probably the most serious technical constraint to production.
2. Animal health and disease problems are serious in these areas - due primarily to inadequate veterinary services and supplies, poor housing and sanitation during winter months and lowered resistance to diseases due to inadequate nutrition.
3. The almost total lack of extension and veterinary services for migratory producers creates difficulties in implementing any technological changes that would improve production.

Potential Role of Sheep and Goats

The potential role of sheep and goats in these ecozones is greatly enhanced by their already dominant role in the livestock sector. Sheep and goat production are the way of life and the major source of income for approximately 20 percent of the population of the area, and the most logical use of approximately 80 percent of the land areas. The challenge now is to develop and structure programs that will meet the needs of the people and their livestock and will be consistent with government policies and objectives.

One of the major needs in this region is for the government infrastructure and support services required to implement improvements to the system within the socio-political constraints previously mentioned. Improvements in feed production on winter ranges and through forage production in irrigated cropping areas would provide the feed needed during the critical winter period. However, this needs to be part of a total program that includes credit for housing, genetic resources and other improvements, and should include improved veterinary and extension services. The

objectives of the Herat Development Project in Afghanistan are structured along these lines.

RECOMMENDATIONS

The most important single recommendation for the Asian subcontinent is for government planners and policy-makers to place the importance of sheep and goats into proper perspective. This ranges from a recognition in human terms of the importance of goats and sheep to the millions of smallholder and landless farm workers in the humid savannahs to the importance of sheep to the total economy of the arid range and temperate highlands areas. The major contribution of sheep production to the gross national product and export earnings of Afghanistan is clearly an example.

General Recommendations

Certain general recommendations can be made that apply to all countries and ecozones within the region. The first of these is the previously stated need for recognition of the importance of small ruminants to the area's people and economy. Following are other important general recommendations:

1. The small ruminant needs to be viewed as an integral part of smallholder crop-livestock production systems, rather than as an unique input to the ecosystem. The intensive land utilization by smallholder agriculture in the humid tropics almost dictates the integration of livestock into the system to utilize residues, weeds, crop interstices, etc. The small land holdings further almost restricts efficient productive use to small ruminants. This concept deserves thorough consideration, analysis, testing and support in integrated research programs.

2. The market infrastructure for efficient and equitable transfer of products from producer to consumer are essentially non-existent for small ruminants. The only possible exception are limited efforts to organize wool marketing and pelts from Karakul sheep. This must receive high priority for sufficient producer incentives to encourage implementation of desired technology and thus meet country goals for production.

3. Development schemes planned or being implemented in the region are often one-dimensional (i.e.- improve wool production in a given province or state by introduction of better wool producing breeds). While the goal of such a program is worthy, the one-dimensional effort of breed introduction into the system will likely fail without coordinated efforts in credit services, nutrition programs, veterinary and health services, extension services, marketing programs, etc. The primary foundation for all development programs should be the desires of the target population, and their effective inputs into the planning and implementation processes.

Specific Recommendations

Several existing projects could be endorsed or new projects recommended. However, for the purposes of this report, two projects are emphasized as representative of the type of coordinated efforts needed in small ruminant development projects for the region. These should be viewed as more specific examples of those points that were emphasized in the general recommendations.

Goat's Milk Marketing in India

India has pioneered the development of smallholder milk marketing

schemes from cattle and buffaloes. Several dairy cooperatives have been developed and are successfully operating, but not without several years of hard work to develop the total program needs. Although the primary thrust of these schemes is to assemble, purchase, process and transport milk from producer to consumer, their success has related to total program inputs such as smallholder organization, veterinary and extension services, producer credit, immediate cash payments, willingness to accept small quantitities of milk, artificial insemination, etc.

With the growing importance and tremendous potential of dairy goats for smallholder farmers and landless producers, a cooperative scheme for milk marketing from dairy goats merits serious consideration. This milk mardeting scheme could either be incorporated into one of the current dairy marketing cooperatives or developed separately. The following steps should be a part of this project.

1. Determination of the specific area where the project is most feasible. This should include an analysis of whether an independent development scheme or incorporation into an existing dairy cooperative is the most feasible approach.
2. Develop the total package - assembly points, pricing policy, credit services, breeding stock, veterinary and extension services, etc.
3. An implementation plan and schedule.

Herat Development Project - Afghanistan

The Herat Development Project in Afghanistan is one of the first major efforts in the region to improve conditions for migratory producers. The total project combines all of the components from credit to services

and marketing that are essential for such a development scheme. The major constraints at this point appear to be inadequate research and training support services to assure appropriate technology development for the project.

Similar projects, with the full complement of support services, are clearly needed throughout the arid and temperate highland regions of the subcontinent.

211

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213

SHEEP AND GOAT PRODUCTION IN SOUTHEAST ASIA

The countries included in this region for this report are the Phillipines, Indonesia, Malaysia, Thailand, Laos, Cambodia, Vietnam and Burma. Countries visited as a part of this study were the Phillipines, Indonesia and Malaysia.

The entire region can be classified as within the sub-humid to humid tropical ecozones. The area generally is within the tropical forest range type; however, a significant portion of the tropical forests have been cleared over the centuries resulting in cleared hillsides, valleys and alluvial plains or deltas. In some limited areas where mountain shadows restrict rainfall, the range ecotype approaches woodland shrub.

Over 80 percent of the region exceeds 1500 mm annual rainfall, with amounts exceeding 8,000 mm in parts of the dense tropical forests. The climate of the area can perhaps be more accurately described by the following four classifications on the basis of seasonal rainfall patterns: (1) no dry season and no pronounced period of maximum rain; (2) no dry season, but a pronounced period of maximum rain; (3) short dry season (1-3 months) and a period of maximum rain; and (4) two pronounced seasons, wet and dry, with the dry season lasting 3-5 months.

Temperature variations are slight in the lowlands (sea level to 300 meters elevation), with temperatures ranging from 23°C to 32°C (Tillman, 1976). The range in temperatures increase at higher elevations, and as the distance from the equator increases.

Agriculture is the dominant enterprise for the people of the region.

Hutasoit (1974) estimated that over 65% of the people of Indonesia are dependent on agriculture for their livelihood, while Rumich (1967) estimated that the percentage engaged in agriculture exceeded 80 percent in the Phillipines. Essentially all land under cultivation is intensively cropped, with the principal crops being rice (which is the staple food), corn, vegetables, fruits, soybeans, cassava, peanuts, cocoa, coffee, tea and copra. Crop production is very intensive, with double and triple cropping annually where rainfall and irrigation permit. Smallholder subsistence agriculture is the norm in the intensive cropping areas, with population densities being among the highest in the world for agricultural areas in these regions (Hutasoit, 1974). The exceptions to subsistence agriculture are certain areas where large plantations cultivate crops such as rubber, oil palm, coconut, sugar cane, pineapple, coffee, tea, copra, etc.

The total land area of this region is approximately 400 million hectares. The human population was estimated at near 310 million, which was 7.9% of the world's population in 1974. Various sources have estimated that approximately 80% of the population of the region lives on no more than 30% of the land area. Population densities, for example, on the islands of Java, Madura, Bali and Lombok in Indonesia exceed 600 people per km^2(Tillman, 1976). Table 1 presents the 1961-65 average and 1974 human and animal populations for the region, and their relative percentages to 1974 world totals.

The human population of the region increased approximately 35 percent during the last 10 years. Increases in livestock numbers are far below this rate, with sheep numbers actually declining during the period. The

215

Table 1. Human and Animal Populations in Southeast Asia, and Their Percentage of World Totals.

	Number				
	1961-65	1974	Percent Change	Percent of World Total	Livestock Per Human
	(000)	(000)	%	%	No.
Humans	223,705	309,597	38.4	7.9	
Cattle	21,279	24,103	13.3	2.0	.08
Sheep	3,732	3,571	-4.3	0.3	.01
Goats	8,990	10,017	11.4	2.5	.03
Buffalo	17,802	18,968	6.5	14.6	.06
Horses, Mules, Asses	1,194	1,346	12.7	1.1	.004

FAO Production Yearbook. 1974.

data in Table 1 clearly show that livestock are not a major component of the agricultural system. Numbers of livestock per human are the lowest for any of the developing regions of the world. The consumption of protein from livestock sources is therefore quite low.

Mubyarto (1974) estimates the consumption of protein from animal sources in Indonesia at 2.2 grams per day, which is less than one-half of the projected minimum needs of 5 grams per day. This translates into less than 3 kg meat and one liter of milk annual per capita consumption. Mubyarto (1974) states that the principal factor limiting consumption is physical supply. Although milk consumption is clearly not very high for the region, imports of powdered milk into the region are increasing dramatically (FAO, 1974).

Most of the livestock in the region are found in the densely populated areas. Hutasoit (1974), for example, estimates that 54% of the cattle in Indonesia are on the island of Java. Tillman (1976) states that about 53% of the combined population of cattle and buffaloes are used for draught purposes. Since cows are usually at least two years old before used for plowing, this means that probably another 25% of the herd is committed to use for draught. Hutasoit (1974) estimates that there are only 55,000 dairy cows in Indonesia and most are located near the larger cities. It is not clear whether the low level of milk production is due to low demand for milk or a high demand for draught animals and the diversion of limited resources to the production of cattle and buffalo for draught purposes. The increasing imports of milk powder would suggest the latter case as the appropriate explanation. This will likely continue, as sources in the

217

government of Indonesia project a need for a 50% increase in draught animals during the next decade.

The productivity of sheep and goats in the region are presented in Table 2. The numbers for Indonesia are separated from the rest of the region, since Indonesia has approximately 90 percent of the sheep and

Table 2. Productivity of Sheep and Goats in Southeast Asia in 1974.

Area	No. Animals	% Slaughtered	Meat Per Head	Milk Per Head	Wool Per Head
	(000)	%	kg./yr.	kg./yr.	kg./yr.
Sheep					
Indonesia	3,223	32.1	3.1	-	?
Rest of Region	348	43.4	5.7	-	0.8
Goats					
Indonesia	7,468	35.8	3.6	4.0	-
Rest of Region	2,549	32.3	4.3	4.0	-

FAO Production Yearbook. 1974.

approximately 75 percent of the goats found in the region. Although the percent slaugtered annually and kg. meat per head per year for sheep in the rest of the region are above world averages, the relatively low productivity of sheep in Indonesia probably accounts for their declining popularity. Milk and wool production from sheep are not important for the region. Annual percent slaughter and kg. meat per head from goats for the region are comparable to world averages. It should be emphasized that governments readily acknowledge that the above data on numbers and productivity are estimates, as in-depth sector surveys and inventories have never been conducted for sheep and goats. Rumich (1967, 1968) insists that goat numbers in the region are grossly underestimated, and that

productivity is much higher than the statistics indicate.

Livestock Production Systems

Livestock production in the region is clearly tied to subsistence agriculture. As stated previously, the principal role of cattle and buffalo in the region is the provision of draught power. Goats and sheep are secondary agricultural enterprises for smallholder crop producers, but have an important niche in the subsistence objectives of the smallholder. Mubyarto (1974) states that efforts to consider livestock production as other than a subsistence enterprise will likely fail, and that government programs must view the farmer as producer and consumer.

Sheep and goat production systems are based on the type of agriculture practiced (Rumich, 1967). If double cropping is practiced through irrigation, then the small ruminants are generally raised in confinement. When dryland cultivation and fallow during the dry season is practiced, then the small ruminants are generally grazed throughout much of the year. A few commercial goat dairies are known to exist in the area, and livestock dealers can occasionally be found with larger (50-100 herds; however, these represent a very small portion of small ruminant numbers.

In the intensive or irrigated crop areas, herds of 2-10 goats are confined in sheds or cages that are generally either a part of or near the family home. The pens are usually elevated and forages are cut and carried to the animals for consumption. Coarser feedstuffs such as coarse grasses, palm leaves, cassava leaves and other crop and tree leaves are the principal sources of goat feed. Meat is the primary product of the system, with manure and hides as important by-products. Milk is rarely

219

produced for other than local consumption; however, Rumich (1967) cites the case of a commercial goat dairy in East Java selling milk to Chinese, Arab and Pakistan customers at 160% of the local price of cow's milk.

In the areas where dryland cultivation is practiced and a marked dry season occurs, goats and sheep will graze the fields during the fallow season and roadsides and crop interstices during the cropping season. Animals roam free or are loose herded by children during the fallow season and are closely herded, tethered or confined during the cropping season. Herds of 2-10 are common.

In sparsely populated and marginal agricultural areas, goats and sheep either roam free or are loosely herded the year around. The only other principal concentration of goats is in or near villages, where goats can be seen grazing roadsides, vacant lots, ditches, vegetable growing areas, etc. Animals are penned at night in all of these systems.

According to Rumich (1967, 1968) mating is generally uncontrolled and castration is uncommon, thus limiting the amount of selection practiced. Lambing and kidding tend to be year around with no seasonal peak distributions. Two lambings or kiddings every 12 to 15 months are not uncommon, with ewes averaging 1.0 to 1.5 lambs per lambing and goats averaging 1.5 to 2.0 kids per kidding. Triplets are not uncommon in both species.

Regardless of the production system, the major problem in livestock production in the region is generally accepted as chronic nutritional stress. This generally is associated with severe undernutrition during the dry season in certain areas and during the cropping season in areas where every parcel of land is intensively cropped. Many marginal areas are now

being cropped due to population pressure and are further restricting land available for livestock production. Goats generally appear to be in better condition than other livestock species, although it is not known whether this is due to their hardiness or due to favored treatment by their owners.

Sheep are generally of the hair type with limited production of coarse carpet wool. Most of the sheep have a medium fat tail or fat rump and are not clearly defined as breed types. The breed types tend to be multi-colored and small, with mature ewes weighing 20 to 30 kg. and mature males weighing 30 to 35 kg. No evidence could be found of selection programs or breed introductions in the region. Speculation is that the sheep breed types in the region trace to importations centuries ago from China, Mongolia and other regions of Asia.

The goats of the region are generally classed as "indigenous" and are known to have been raised in the area for over 1000 years. The major breed group is the Kambing Katjang, found throughout Indonesia and Malaysia, with the goats of the Philippines also broadly resembling this breed. Rumich (1967) describes the Kambing Katjang breed as relatively small with an average height of 50-60 cm. and average mature wright of 30 kg. Color ranges throughout various shades and combinations of brown, black and white. The breed is known to thrive under the most varied environmental conditions and production systems. The age at puberty is 6 to 7 months with first parturition at 12 to 13 months of age. Twins are common and triplets are frequently produced although milk production is not normally adequate to raise triplets.

The Jamunapari breed has been imported from India into most countries in the region. Its primary use is in meat production, but are often milked for consumption by producers. Some small scale dairies are using the Jamunapari breed. Rumich (1967) states that the influence of the Jamunapari breed has spread rapidly throughout Indonesia. The Jamunapari x Kambing Katjang cross, referred to as the "Etawah" in Indonesia, has spread throughout the country and is increasingly popular.

Other breeds in Indonesia are the Kambing Maritja, which is a local variation of the Kambing Katjang, and the Kambing Gembrong, which is found only on the island of Bali and produces a special hair prized by local fishermen for artificial lures. There is evidence in the Phillipines of Spanish importations of goats into the region in the 1500's (Rumich, 1968). Various importations of British Alpines, Saanens, Anglo-Nubians and Toggenburgs into the region have occurred, but their genetic influence has not been widespread.

Constraints To Production

The pressing problems of human population pressure, industrial development and increasing staple food production have taken priority over emphasis on livestock production. As a result, little is known about the constraints to production and potential of sheep and goats in the region. Within this context, the following constraints can generally be identified as important.

Socio-Political Constraints:

1. The major constraint is the almost total lack of production and market damend data on which planners can base development decisions. There is a sincere desire on the part of governments to develop

programs consistent with smallholder desires and needs, but this is extremely difficult when the view of smallholders toward sheep and goats is not understood and, as a result, has not been considered in the planning process.

Economic and Marketing Constraints:

1. The major use of sheep and goat products is for producer subsistence or local consumption, thus economic analysis of price and demand are extremely difficult. Mubyarto (1974) reported income elasticity of damand values for animal products of 1.7+ in Indonesia, which indicates that animal products may be luxury items.
2. Marketing costs for the small producer are generally very high when animals are sold for export beyond the local region. Mubyarto (1974), in Indonesia, reported that farmers receive less than 50 percent of live animal value paid by retailers. The rest is distributed among middlemen or traders and shippers.
3. Administration of credit to subsistence smallholders is difficult at best. Credit has generally not been available to the livestock porduction sector other than for the purchase of draught animals.

Technological Constraints:

1. Competition for land resources for crop production versus animal production, and competition within the livestock sector for the scarce nutrients available for production, results in a major limitation of production potential. Nell and Rollinson (1973) suggest that the over 450,000 tons of rice bran, feed grains and

other grain by-products that are currently exported from Indonesia could be used to supplement livestock diets. This, however, is a complex economic and technical question that defies simple solutions.

2. Animal health and disease problems are serious constraints. Although exact mortality data are not available, the gap between stated levels of reproduction and offtake rates indicates high mortality rates. The most serious problems are respiratory diseases, internal parasites and foot and mouth disease (Hutasoit, 1974). Temadja et al. (1974) states that the most limiting factors for an organized animal health program are (1) lack of adequate veterinary facilities, (2) lack of trained personnel, (3) poor communications, and (4) high operational costs of delivery to smallholder producers.
3. The lack of castration, small flock or herd sizes and other management practices severely restrict opportunities for improving the genetic potential of sheep and goats.

Potential Role of Sheep and Goats

Assessing the potential role of sheep and goats on the basis of the existing technical data is, as previously stated, extremely difficult. There is a general consensus among government officials and researchers that smallholder producers view their potential as more important than past conventional wisdom, but developing programs to satisfy this producer interest is frustrating with the current knowledge base.

There is a lot of interest in the region, particularly in Indonesia and the Phillipines, in "new lands" development and smallholder farmer transmigration schemes from densely populated areas to less populated areas.

Interest has been expressed by government officials on the potential role of small ruminants in these schemes. This merits further consideration, but must await more definitive data on production systems, marketing programs, demand, investment requirements, technical inputs, etc.

There is a general consensus among those research scientists and government officials concerned with livestock development that the small ruminant could be promoted as a method of conservation as well as a highly productive animal on marginal lands that should not be intensively cultivated (Devendra, 1977). There is an urgent need to explore the feasibility, from the viewpoint of the smallholder, of a mixed crop livestock enterprise that integrates soil conservation and improvement into optimum productivity.

RECOMMENDATIONS

Recommendations should be viewed within the two major production expansion opportunities for small ruminants. The first of these is the traditional intensive agricultural sector where the national herds are now found. The other is the opportunity to make effective use of sheep and goats in the so-called "new lands" being developed for settlement and crop production. Increased interest in small ruminants is evident within several government agencies and research institutions in the region. This stems from pressures to improve the quality of life for the small producer and the interest in improving both quantity and quality of food available to the expanding human population. The following recommendations are made on the basis of this background, with the hope that specific projects could evolve in the future.

1. Improved Communications. The formation of a network among the various countries in the region to evaluate ongoing research,

set research priorities, determine funding needs and to evaluate development potential is clearly needed. Knowledge of the production potential of small ruminants exists in research organizations, government agencies and among those providing external development assistance. Individual scientists and government officials can be found in all countries in the region with both interest and capabilities to address the problem areas. The major problem with current research activities is their narrow focus on specific biological problems, without sufficient breadth to have impact on development evaluation. Thus, as one reviews the issue at higher decision making levels, the interest is high but the documented evidence to support investments is sadly lacking. Improved communications among scientists and governments in the region would greatly increase research and planning efficiency.

2. Resource Inventory. All countries within the region need a better understanding of current populations and production practices for small ruminants. This must include an analysis of supply-demand and cost-price relationships. Available feed resource inventories and nutrient needs for small ruminant production systems must be a part of the analysis.

3. An In-Depth Analysis of Selected Development Schemes. Although additional basic data is desperately needed, governments are not likely to wait five to ten years for final results and recommendations before adding small ruminant components to these schemes. A cooprdinated team approach is therefore recommended for the in-depth analysis of one or more of these development schemes on

the feasibility of adding the small ruminant component. This should include, as a minimum:

a. Target producer interests and goals.

b. Basic production feasibility analyses.

c. Marketing analyses, processing and distribution requirements.

d. Investment requirements by both the government and private sector.

e. An implementation and operation plan that includes the total small farmer production system.

227

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240

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