

SMALL RUMINANT CRSP

SMALL RUMINANT COLLABORATIVE  
RESEARCH SUPPORT PROGRAM (SR-CRSP)

A Joint Venture between  
the United States Agency for International Development  
and Agricultural Research Institutes in  
the United States and Overseas

## **SMALL RUMINANT CRSP OVERSEAS PARTICIPATING INSTITUTIONS**

### **BRAZIL/EMBRAPA**

Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) is the national agricultural research agency in Brazil with Centers located throughout the country. Centro Nacional de Pesquisa em Caprinos, CNPC, the Sheep and Goat Research Facility in Sobral, is the Center with which the CRSP is cooperating. Additional research sites in the Northeast include CPATSA, the Federal Research Center for the Semi-Arid Tropics located in Petrolina and the EPACE State Field Station at Quixada.

### **MOROCCO/IAV**

Hassan II is Morocco's major university and primary agricultural training center. IAV, the Institut Agronomique et Veterinaire, is the research institute within the University with which the CRSP is working. Research will be concentrated at the Talsinnt Field Station in the Atlas Mountains and the Sidi Aissa Oak-Woodland Research Station, two government research facilities which have close formalities with IAV.

### **PERU/INIPA**

Instituto Nacional de Investigación y Promoción Agropecuaria (INIPA) is the national agricultural research and extension agency. The CRSP is cooperating with INIPA through close association with two agricultural universities in Lima, Universidad Nacional Agraria (UNA) at La Molina and the Instituto Veterinario de Investigaciones Tropicales y de Altura (IVITA) in San Marcos University. Research sites in other areas of Peru include a large government cooperative, SAIS Pachacutec, and the IVITA research station at La Raya.

### **KENYA/MLD**

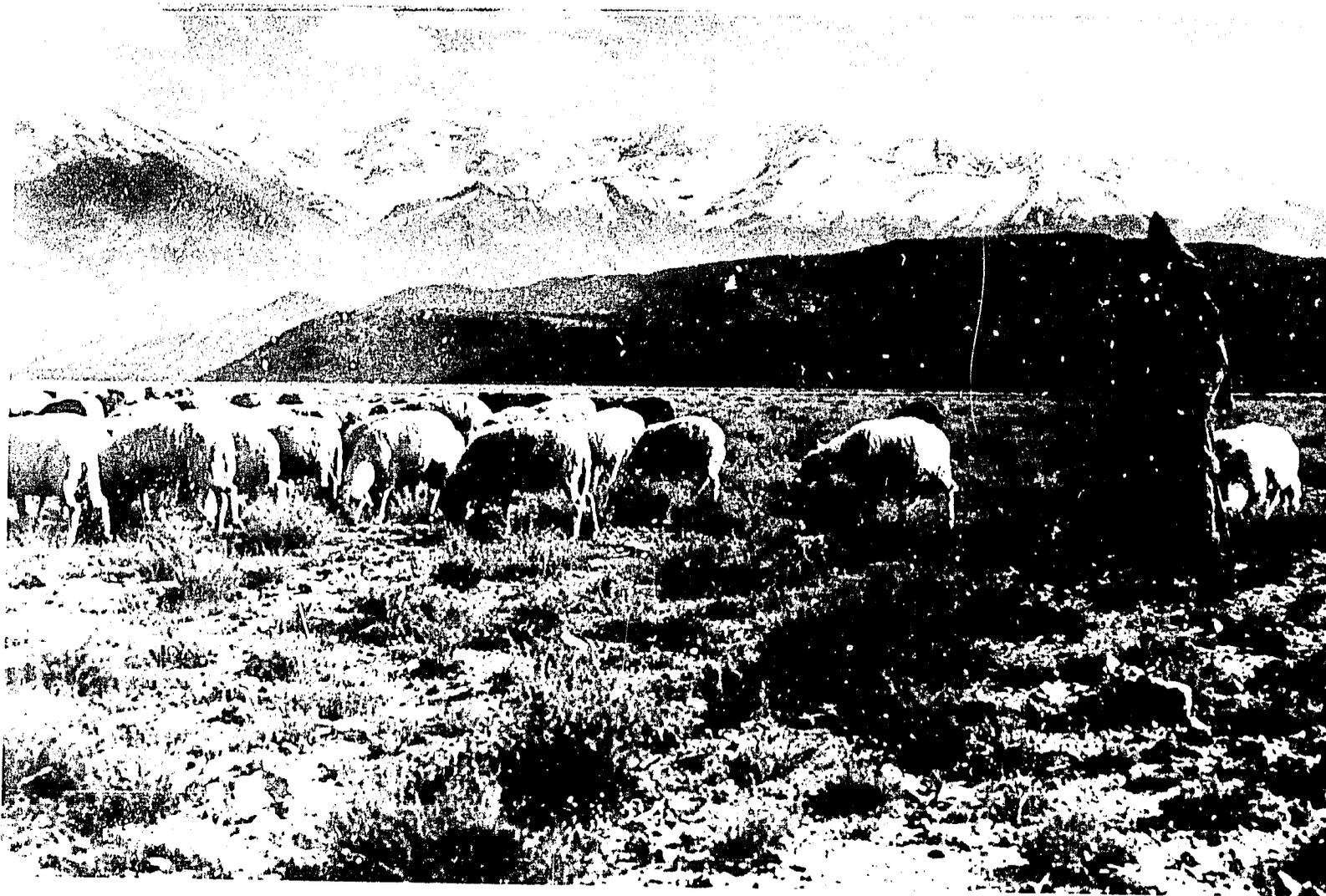
The Ministry of Livestock Development (MLD) is responsible for all livestock improvement programs in Kenya. One facet of the CRSP cooperation with the MLD is the use of the Ministry's field station at Maseno which is a major CRSP worksite. Other CRSP projects are located at Ol Magogo Farm at the Kenya government's Naivasha Animal Husbandry Research Station and in the Busia, Samia, Kakamega and Siaya Districts of western Kenya.

### **INDONESIA/AARD**

Within the Agency for Agricultural Development (AARD) is CRIAH, the Central Research Institute for Animal Husbandry. BPT, Balai Penelitian Ternak is the CRIAH Research Facility with which the CRSP is cooperating. Research is being conducted at the central facility in Bogor, at the outlying livestock experiment stations in western Java at Cicadas and Cilebut, in local villages in western and central Java as well as at the multiplication center at Margawati.

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Shepherd in Boumia, Morocco  
with the Atlas Mountains in  
the background.

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Afternoon meal at the Sunday market in Toqra, Southern Peru.



## THE CONCEPTS OF THE CRSP'S

The United States, as the world's largest generator of surplus food, has provided aid to millions of hungry people. Abundant harvests in the United States have been widely distributed in acute disaster relief programs and on a regular basis to food deficient nations. It has become apparent, however, especially in the last forty years as the world's population burgeons, that supplying the hungry world with food through distribution of surpluses in no permanent way alters the cycle of poverty and deprivation in the less developed countries (LDC's). Improving the capability of these areas to supply their own food needs is the only feasible long-term solution to the problem. Recently, to promote this goal, the United States Congress passed the International Development and Food Assistance Act of 1975.

Included in the act was Title XII—Famine Prevention and Freedom from Hunger, which states, "... in order to prevent famine and es-

ablish freedom from hunger the US should strengthen the capacities of US land grant ... universities in program-related agricultural institution development and research ... improve their participation in the US government's international efforts to apply more effective agricultural sciences to the goal of increasing world food production and in general should supply increased and longer term support to the application of science to solving food and nutrition problems of the developing countries."

The act also specified that the United States Agency for International Development (USAID) administer and fund Title XII with money from their existing budget and authorized the President to create the Board of International Food and Agricultural Development (BIFAD) to initiate implementation of the act. BIFAD appointed the Joint Research Committee (JRC) to oversee the research-related aspects of Title XII. It was their recommendation that Title XII-sponsored research be implemented through Collaborative Research Support Programs (CRSP's) and among their suggested topics was Small Ruminants.

# WHY A SMALL RUMINANT CRSP



Forty percent of the world's sheep and 77 percent of the world's goats are in the LDC's, owned primarily by small pastoralists and farmers of very limited means. The production per animal from these 700 million small ruminants is low. Despite this, they contribute very significantly to the economy and food supply in the less developed regions and demand for their products exceeds the supply. Improving the performance of small ruminants would directly improve the diet and standard of living of a great many people because the animals are inherently well suited to the needs of the smallholders and the conditions prevailing in the LDC's. For example, they:

- Have low initial and maintenance costs.
- Are able to use marginal land and crop residues.
- Produce milk and meat in small, readily usable quantities.
- Produce fiber and skins which sustain cottage industries.
- Are easily cared for by any member of the family.

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(TOP) Dr. Fitzhugh and Dr. Yazman with an outstanding Alpine doe from Petit Jean Goat Dairy, Winrock International, Arkansas.

(BOTTOM)  
Texel sheep grazing highlands in Indonesia.



# SMALL RUMINANT CRSP ORGANIZATION AND GOALS

The long-range goal of the Small Ruminant CRSP is to increase the food supply and raise the income of the smallholder engaged in small ruminant production. The problems of small ruminant productivity in developing countries are multifaceted and interact in a dynamic and complex manner. In response, the CRSP has mounted a multidisciplinary, collaborative program to investigate the biological and socio-economic elements of the agricultural production systems in the regions in which it is working.

Seventeen research proposals from 13 US institutions were selected to embark upon the first CRSP and University of California, Davis, one of the participating universities, was designated Management Entity.

- **The Management Entity (ME)** coordinates project activities through the Program Director with the support of the following three committees, each of which play a distinct role in function of the SR-CRSP.
- **The Technical Committee (TC)** is responsible for developing and implementing research projects in the US and overseas. It consists of the Principal Investigator of each CRSP project.
- **The Board of Institutional Representatives (BIR)** is an executive committee concerned with budget and policy. It consists of representatives from the administrations of each of the participating institutions.
- **The External Evaluation Panel (EEP)** acts in an advisory capacity and is responsible for review and evaluation of CRSP research activities. It consists of a multidisciplinary group of eminent scientists from institutions not participating in the CRSP.

Additional program coordination comes from Site Coordinators employed by the Management Entity to provide administrative and logistical support to CRSP personnel engaged in research at the overseas worksites.

A research program has been designed by US Principal Investigators and overseas counterpart scientists which meshes with the goals of the collaborating institutions and complements the host governments' current development programs. Open lines of communication and a high level of cooperation among all the projects' participants are maintained, both in the US and abroad. In many instances, research facilities and experimental animals, as well as data collection, integration and dissemination duties, are being shared. Every effort is being made to standardize experimental and analytical methodology and techniques. There is an active exchange of graduate students, technical personnel, and counterpart researchers between the US and the overseas worksites in order to promote a maximum exchange of information and ideas. This interaction facilitates the formulation of coordinated training programs and research plans which are critical for the SR-CRSP to remain a cooperative venture.

An important component of the collaborative effort focuses on integrating economic and sociological factors with agricultural data obtained in the field to delineate the current small ruminant production system and develop a coherent series of recommendations for improving sheep and goat productivity and marketing efficiency. These recommendations should consider how the elements which comprise the various agricultural production systems operate in relationship to each other to influence the overall function of the small ruminant husbandry and marketing system. This collective approach to confronting the severe constraints upon animal productivity in difficult environments, should facilitate the development of an integrated research endeavor which views the target agricultural production system from a comprehensive rather than an isolated perspective.

# SMALL RUMINANT CRSP OVERSEAS WORKSITES



Clearing and preparing ground to plant napier grass in Kenya.

Given the pattern of animal ownership in the LDC's, the group of people towards whom the SR-CRSP will direct its activities will be limited resource producers, smallholders, and nomadic husbandmen. The problems unique to their situation make research overseas not only appropriate, but essential if meaningful progress is to be made in improving small ruminant productivity under their management conditions. Because the international research component of the CRSP was considered the cornerstone of the project, great care was taken to select appropriate worksites representative of the various ecosystems and production systems encountered in the tropics.

Arid, semi-arid, humid, sub-humid, and highland ecosystems are all represented. Within these various ecosystems, sheep and goats are managed under both extensive and intensive production systems to provide meat, milk, hides, and fiber for commercial and home use. The principal extensive systems are the nomadic, transhumant, and/or sedentary graziers systems of Africa, Latin America, and the Near East. The main intensive systems are characterized by crop/livestock combinations found in Asia and Africa. The principal technological constraints in both extensive and intensive systems are inadequate year-round feed supply, disease and parasitism, non-selective breeding, and low rates of reproduction. In extensive grazing systems, rangelands are often over-grazed or mismanaged causing wide-spread destruction of vegetation and erosion of the topsoil which leads to a deteriorated rangeland and ultimately causes declining animal productivity. These technological constraints are exacerbated by the unavailability and/or high cost of many types of external inputs required to improve sheep and goat production systems, inefficient marketing systems, and by social factors constraining the application of improved practices.

In most instances significant improvements can be made in sheep and goat production systems. These improvements must be based on more efficient use of available land, feed, animal, and labor resources to achieve optimal production as well as to conserve and improve the natural resources of the tropical regions. Expanding the body of knowledge and increasing the level of competence of US and LDC scientists to conduct research on small ruminants and smallholder production systems will facilitate the development and testing of appropriate technologies and practices to improve productivity of target production systems in developing countries.

# BRAZIL

Mr. Tom Miller, SR-CRSP Site Coordinator and Dr. Aurino Simplicio at CNPC, Sobral, Brazil.



Northeastern Brazil is a tropical region with a population of 37 million people, 12 million of whom live in the 1 million km<sup>2</sup> semi-arid, interior Sertao zone. The climate of the Northeastern region is characterized by distinct wet and dry periods each lasting approximately 6 months, with relatively little seasonal variation in temperature. *Caatinga*, the vegetation typical of the semi-arid area, consists mostly of brush, small trees, and native grasses and legumes. Sheep and goats, the region's predominant livestock species, are raised to produce meat and some milk for home consumption, and the animals themselves along with their hides and skins are important generators of revenue.

The primary animal husbandry system in the interior is extensive range production and the low, highly seasonal rainfall results in a pronounced seasonal vegetation pattern. The drastic decline in available feed over the prolonged dry season causes the livestock on the *caatinga* severe nutritional stress, presenting a major constraint to animal productivity. The problem is worsened by the increased nutritional demands of post-weaning, late gestation, and early lactation. Animals in these stages of their production cycle during the dry season experience great difficulty maintaining acceptable growth and reproductive rates and at times, even surviving. This problem is further reflected in their small size, low yield and dressing percent, and depressed offtake.

There are approximately 6 million sheep in the Northeast, concentrated in the states of Piaui, Ceara, Pernambuco, and Bahia. These animals represent about one third of Brazil's total sheep population and they are the smooth hair type rather than the traditional wool type commonly found in the more temperate areas of the country. The entire region has about 9 million goats, most of which are found in the arid and semi-arid areas of the interior. Their proportion of the total livestock population increases as one moves away from the coast and rainfall decreases. The goats in this region constitute approximately 92 percent of the country's goat population with more than one third of them in Bahia State and more than one million head in each of the states of Piaui, Ceara, Pernambuco, and Paraiba.

A number of long-term programs for the purpose of raising the standard of living of Northeast Brazil's rural and urban sectors are currently being undertaken by the Brazilian government. Efforts to increase the production of small ruminants are regarded as a means of improving the nutritional level and earning capacity of the people of the Sertao, especially the most deprived and impoverished of that group, the subsistence-level farmer. In addition, an integrated program of research, extension, credit, and market development will aid the economies of the urban sector by increasing the supply of livestock products (hides and skins) upon which Northeast Brazil's regional industries depend and increasing the supply of meat available to city dwellers.

Because sheep and goats in Northeast Brazil provide a major source of animal protein and cash income, they make significant contributions to the food supply and economy of the region. For this reason, the Brazilian government has placed a high priority on improving their performance and the activities of the Small Ruminant CRSP are directed towards complementing and contributing to these efforts.



Sheep grazing cleared *caatinga* at CNPC,  
Sobral, Brazil.

# PERU



Recently shorn Corriedale sheep at Corpacancha, SAIS Pachacutec, in the Central Sierra of Peru.

The total small ruminant population in Peru is 13 million sheep, 2 million alpacas, 2 million goats, and a half million llamas. These animals are at least dual purpose and more usually multi-purpose. Goats, found primarily along the coast, provide meat and cheese; fiber and meat are provided by llamas, alpacas, and sheep. In addition, alpacas provide hides and llamas are used as pack animals at high altitudes. The expanding market demand for lamb in Peru has caused sheep to become increasingly more important as meat suppliers, in addition to their traditional role as export wool suppliers.

Sheep and alpacas are the predominant species in the Highlands and alpacas are especially prevalent and important at the higher elevations. As the world demand for alpaca wool grows, it will become increasingly more important to acquire the knowledge necessary to improve the productivity of this small ruminant which is so uniquely adapted to the high Andes.

The semi-arid Sierra highlands of the Peruvian Andes contain 2,000 *comunidades campesinas* (indigenous Indian communities), with a population of 345,000 families. Most of these *comunidades* are autonomous villages but some of them are associated with large cooperative agricultural units, Sociedad Agricola de Interes Social (SAIS), which were created by the Agrarian Reform Movement of a decade ago. These *comunidades campesinas* own 75 percent of all the agricultural land in the Sierra with holdings commonly found above 12,000 feet and at elevations as high as the 17,500 foot permanent glacier line. Only about 2 percent of this land is arable, with frost, hail, and snow imperiling crops grown at all but the lower elevations. Where planting is possible, the Indians primarily cultivate corn, quinoa, and potatoes. With 98 percent of their land suitable only for pasture, if it is indeed usable at all, the Highland Indians are very dependant on their livestock, particularly small ruminants, for food and cash income.

The primary animal husbandry system encountered in the high, semi-arid areas of Peru is extensive range production of sheep and alpacas. The *Puna*, the natural grazing land of the high Sierra upon which these animals depend, has an estimated area of about 25 million hectares. The increasing human population of the highlands adds pressure to an already overburdened production system and exacerbates existing problems which may result in permanent damage to the delicate ecosystem of the region.

Results from studies conducted in Peru which:

- indicate the appropriate production emphasis (fiber vs. meat),
- compare the productive efficiencies of different species (alpacas vs. sheep), and
- predict the number and mix of species for optimum rangeland utilization (stocking rates),

address universal problems in an integrated manner. Such studies could also provide other highland areas with criteria upon which to base their small ruminant improvement efforts, thus extending the results of the Small Ruminant CRSP research beyond the specific locale investigated.



Peruvian woman milking a criollo goat.

# INDONESIA



Indonesia, a humid/sub-humid tropical archipelago with a population of 135 million people, is the fifth most populous nation in the world. Its 3,180,000 sheep and 7,480,000 goats are concentrated in the areas of the highest population density, the islands of Madura, Java, and Bali. Java, with a population of 85 million people crowded on a land area the size of California, is the world's most densely populated island. Its sheep and goats are numerically important and fill a vital economic niche.

The primary animal husbandry system is a highly intensive one, in close association with highly intensive crop production. Most of the animals are raised in combined crop/livestock, small-holder, backyard production systems with a common herd size of two to five head per owner. They are primarily a cash crop, raised for their meat and manure and usually marketed rather than consumed by the producer.

The sheep found on Java display a continuum from thin tailed hair types to fat tailed wool types. Although there are local breeds and types, there is considerable evidence of extensive crossing with exotic breeds. The Kacang goat is the indigenous type and Kacang Etawah crosses are also common. The Etawah is actually a cross between the Jamanapuri imported from India and better local Javanese goat varieties.

Farm sizes have been declining precipitously in Java in recent years and the current average size is .3 hectares per farm. Decreasing farm size and increasing human population combine to create a situation in which ever larger numbers of people must subsist on ever smaller parcels of land. There is little land available for grazing or fodder production, hence intensive "cut and carry" confinement husbandry systems (in which the small ruminants are continually housed and fed a wide variety of agricultural and native feed-stuffs) have become well developed.

Increased crop intensity and yields have greatly increased the available supply of crop by-products and residues. Tree crops also contribute a wide variety of livestock feeds as do leaves gleaned from hedgerows, native and introduced grasses, and legumes. In addition to the widely practiced "zero grazing" confinement system, there is some grazing encountered along roadsides and other unused areas. Concentrates are rarely used, as land is at a premium for growing food or estate crops.

There are three major cultivation zones on Java, defined primarily by elevation, and each one is associated with corresponding crops. In the lowlands, wet rice farming predominates. Revenue producing estate crops, including coffee, tea, cocoa, rubber, and spices, are grown on the upper elevation slopes. The highlands are characterized by intensive vegetable production systems.

Although the sheep and goats raised in the villages on Java do not exhibit obvious signs of nutritional deficiencies, they do not display optimum productivity levels, growth rates, fertility, or lactation yields given the available resources. The diversity found in the small ruminant population on Java and their equally diverse feed supply provide challenging opportunities for the Small Ruminant CRSP to develop and implement innovative solutions to the constraints on animal productivity.

*(LEFT)* Fat tailed sheep in Indonesia.

*(BELOW)* Indonesian participants in a SR-CRSP Sheep and Goat Training Course field testing village surveys in Cibury Village, West Java, Indonesia.



# KENYA

Kenya displays a wide degree of environmental variability. With elevations ranging from sea level to 16,000 feet, its ecozones include semi-arid rangelands, humid equatorial coastline, the highland slopes of Mt. Kilimanjaro, and the imposing Aberdere Mountains. Within this ecological diversity, there are highly differentiated agricultural production systems which correspond closely to precipitation zones.

Areas of low agricultural potential comprise about 76 percent of Kenya's total land area and 80 percent of Kenya's total rangeland. There are approximately 7.5 million sheep and goats in these dry regions. The predominant livestock husbandry system in the desert scrub range of the north and northeast is the transhumant migration of pastoralists with their small ruminants and camels. The problems encountered by herders under these conditions are currently receiving considerable attention and the Small Ruminant CRSP intends to concentrate its efforts instead in the densely populated medium and high potential agricultural areas where the potential for small ruminant contributions to the food supply and the economy have not yet been adequately explored.

Ten percent of Kenya's land has medium potential for agricultural production with approximately 3 million small ruminants found in this

zone. The high potential agricultural lands account for 14 percent of the country's area and two million sheep and goats are in this ecozone. The agricultural production system in these latter two eco-climatic zones (II and III), is generally of the mixed crop/livestock type, with the livestock of secondary importance to cultivation.

Ninety percent of the Kenyan population relies on agriculture for its livelihood. Eighty percent of that group live on approximately 1.5 million small, private holdings in the zone II and III areas of the following provinces: Coast, Eastern, Central, Rift Valley, Nyanza and Western. Livestock, although a secondary enterprise, are found on most of these smallholdings. There are sheep and/or goats on .6 million farms and they comprise an important element in this mixed crop/livestock agricultural system. They are raised in an intensive "zero grazing" or limited grazing husbandry system and are both consumed by the producer and sold to provide revenue. The human population is expanding rapidly in these already densely populated areas causing farm size to shrink and diminishing the available resources per capita. As land holdings continue to decrease in size, parcels too small to support a dairy cow could support several dairy goats, which means small ruminants could probably play an even greater role than they do at present in contributing to rural diets and income in these regions. In addition, there is a growing domestic and export demand for small ruminants and their products to which these high potential agricultural areas may be able to profitably respond.

Because small ruminants could fit well within the land and capital constraints of the subsistence farmer, the government of Kenya has recently emphasized the direct importance of its national sheep and goat flocks to the low income smallholder by providing resources for their future development. The participation of the Small Ruminant CRSP in Kenya will facilitate the continuation of the government's research efforts to improve small ruminant performance.



United States and Kenyan scientists at Ol Magogo Station, Naivasha, Kenya. From left to right: Dr. Smith, Dr. Bradford Mr. Odenya, Mr. Berger (SR-CRSP Site Coordinator), Mr. Langat, Mr. Kitivo, and Mr. Okeyo.

# MOROCCO



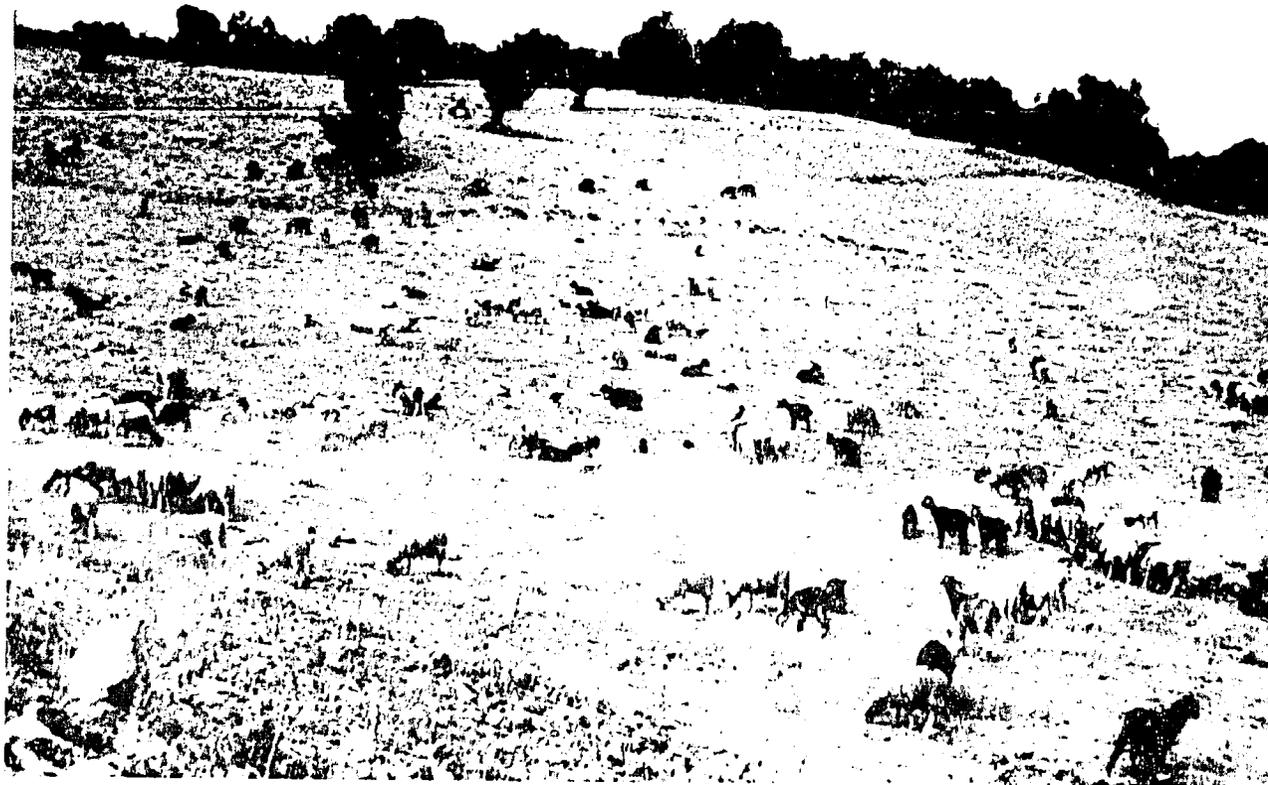
Morocco presents a varied number of ecosystems including coastal Mediterranean, highlands and semi-arid regions. The majority of the country's 18.6 million people live west of the Atlas Mountains in the coastal plain and plateau areas. Livestock production systems also vary from transhumant to smallholder with the primary focus on meat production from sheep and goats. Sheep and goat populations are currently estimated at 16 and 7 million head respectively. The numbers of both species have grown sharply over the past 25 years and are continuing to increase.

The sheep industry is one of the most important agricultural sectors in Morocco and is well integrated with the land use and crop production systems. Approximately 30 percent of Morocco's red meat demand is met by sheep and even more importantly, the price for meat from all other species is largely determined by prevailing mutton and lamb prices.

The industry rests upon five distinct types of sheep about which very little is known except that they appear to possess a number of extremely valuable traits such as high fecundity and a non-seasonal breeding cycle. Several sheep breeds are recognized including Timahdite, Beni Guil, Sardi, Beni H'sen, and D'man. Native goats have not yet been as specifically characterized and are generally designated as "black" or "white."

Morocco is currently receiving high priority as a primary overseas site and events are moving rapidly towards its establishment as the CRSP Near East worksite. An Initial Interim Agreement for work in two discipline areas, Range and Sociology, has been signed. The early involvement of these projects will likely be followed by the participation of two additional CRSP projects, Animal Breeding and Forages, at a date in the near future.





*(LEFT, TOP)* Souk rams in Morocco at the Khenifra livestock market just before Ramadan.

*(LEFT, BOTTOM)* Prolific D'man sheep with quadruplets, Rissani, Morocco.

*(RIGHT)* Intensive grazing by sheep and goats on common land near Itzer, Morocco.

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Information regarding specific projects may be obtained by contacting the Principal Investigators directly. Chief overseas counterparts are listed with each project description.



Members of Women's Dairy Goat Cooperative with native East African does, Busia District, Western Kenya.

Meat-type goats involved in SR-CRSP studies at the Texas A&M Agricultural Experiment Station, San Angelo, Texas.



## ANIMAL BREEDING AND GENETICS

There has, in general, been inadequate animal identification, poor record keeping, and unrestricted breeding in the native flocks of the LCD's, factors which have seriously hindered efforts to measure individual animal performance. Consequently, the genetic potential of the native stock has never been adequately assessed, particularly in relation to such important traits as disease resistance, fertility, and adaptability to the usually difficult environments in which they must survive and produce. In addition, there are regions in which the extensive crossing between local and exotic sheep and goat breeds has resulted in a continuum of genetic types.

Attempts to characterize local animals, evaluate their genetic potential and design coordinated large-scale selection, breeding, and genetic improvement programs are further complicated when there are few distinct breeds and only highly varied or nondescript stock from which to choose individuals for production trials. The lack of livestock performance data also hampers efforts to develop productive animals specifically adapted for introduction to a particular ecological zone.

Baseline data on the performance of indigenous small ruminants will be obtained in order to initiate selection procedures for upgrading the genetic potential of the native stock. The survival, fertility, and performance of local and local/exotic crosses will be compared in order to identify superior types, well adapted to local conditions. These individuals can then serve as foundation stock in well-planned breeding programs designed to produce animals for distribution to the smallholder.



Local sheep and goat market  
Cipanas in West Java,  
Indonesia.

**Robert L. Blackwell, Manuel Carpio, Jorge Velasco**  
**Overseas Site: Peru**

Available production data and breeding records will be used to calculate estimates of population parameters for important production characteristics including estimates of major environmental effects and relationships among relevant traits. These estimated population parameters will be used to design and focus further research efforts. Frequent observations on such traits as survival, reproduction, growth, quantity and quality of fiber production (particularly for the alpaca), and maternal ability will be made in long-term experiments conducted in the Central and Southern Sierra. Other experiments will study the comparative opportunity for improvement of native stock by selection among the native livestock population, grading up with improved Peruvian breeds, and using genetic stock from outside Peru. These studies will provide information which will be used to monitor and improve existing breeding programs and provide up-graded, selected, native and native/exotic cross breeding stock to farm cooperatives and local producers.

**G. Eric Bradford, David Kimenye, P. Sitorus, Subandriyo**  
**Overseas Sites: Kenya and Indonesia**

Before large numbers of dual purpose/dairy goats can be introduced into the smallholder agricultural system in western Kenya, animals which are well adapted to that particular environment must be developed. A survey will be conducted to obtain production data which will be used as a guide for selecting initial stock for breeding studies. The performance of local breeds and dairy/local crosses will be evaluated for such traits as trypanosomiasis resistance, fertility, milk production, and growth rate. Superior animals will be used in continued selection trials, and ultimately the genetic types best suited to make a contribution to the subsistence farmers of the region will be identified for multiplication and subsequent distribution.

In Indonesia, the effect of a number of production variables on reproduction and growth will be analyzed. Sheep in the local villages and at research stations will be evaluated for such characteristics as conception and birth rates, lamb survival, growth rates, and market weight. Rams identified as superior on the research stations will be bred to village ewes with performance records. This progeny testing will help ascertain whether ranking animals and rating individual performances at the experiment stations provides a valid indication of productivity under field conditions.

**J. Maurice Shelton, Elsie Figueiredo**  
**Overseas Site: Brazil**

A three-phase breeding improvement program will be conducted in Northeast Brazil. Sheep and goat genotypes will be identified and characterized for further study. Genetic parameters of desired traits and their compatibility will be estimated. Selection programs for the following four lines will be initiated: growth rate, fertility, resistance to caseous lymphadenitis, and index selection involving growth rate and fertility. Several types of sheep and goats under a variety of local conditions can be integrated into a common selection program after the initial genetic determinations have been made. Trends in other variables will also be observed as the selection process, a long-term endeavor, proceeds. In addition to the work in Brazil, the grazing habits, carcass composition, adaptability, and reproductive efficiency of fat tailed, hair, and Merino sheep will be compared in studies conducted in Texas.



## RANGE MANAGEMENT AND NUTRITION

Determining the genetic potential of the indigenous animals is complicated by the frequently poor environmental conditions under which they must function. The drastic seasonal fluctuations in the available feed supply so typically found in many semi-arid range areas does not afford the grazing stock a year-round nutritional status sufficient to enable them to fully express their genotype. This is especially true where natural pastures are overstocked and overgrazed, or where the supply of available dry season forage is severely limited because annual grasses and deciduous shrubs, rather than perennial herbaceous species, constitute the bulk of the plants in the region.

An ecological inventory and assessment of the native range resource; a determination of the seasonal variation in the availability and nutritive value of the range forage species; and an evaluation of seasonal effects on nutritional requirements, intake, and diet preferences of the grazing livestock at different stages of their productive cycle, will be conducted. The baseline information about traditional range management systems derived from these studies will facilitate the development of improved grazing strategies by providing a basis upon which to evaluate animal performance when such manipulations as varied stocking rates and modified or improved range conditions are applied.

The major objective is to both: maintain the productivity of the range resource as well as enable the animals, so dependent on the range for their major sustenance, to fulfill their nutrient requirements for optimal production. Grazing

trials on improved range in conjunction with the appropriate nutritional measurements can also serve to test the integration of such other improved management practices as the use of selected breed types and supplemental feeding, under realistic conditions.

**Fred C. Bryant, Arturo Florez, Ricardo Valdivia**  
**Overseas Site: Peru**

Condition classes, based on a complete range inventory, will be assigned to range sites to indicate the degree of deviation from their potential. The range inventory will include classifying climate, topography, soils, and vegetation, stratifying rangelands according to altitude and rainfall, determining total biomass production, and surveying the hydrological resources. In order to improve the vegetation and maintain the health of the perennial rangeland, systematic rest periods from grazing are required. Rotation strategies will be tested against the conventional practice of continuous grazing to demonstrate and validate this aspect of grazing management. Integration of native and improved pasture to enhance the nutritional plane of the grazing animals is also a high priority. The nutritional value of the range forages and sheep and alpaca diets will be determined to help identify the seasonality and extent of protein and energy deficiencies. Data collected on seasonal diets and animal forage preferences will facilitate the development of optimum species mix and stocking rates.

**John C. Malechek, Expedito Lopes, Roberto Mesquita, Gerardo Oliveira, Luis Valle**  
**Overseas Site: Brazil**

Prior to initiating effective grazing management schemes, the relative seasonal availability, palatability, intake, and nutritional value of the forage species comprising the diets of sheep and goats on the *caatinga* must be determined. Based on these results, the *caatinga* can be selectively cleared of unpalatable species, completely cleared, and/or planted to improved pasture. The subsequent changes in the manipulated *caatinga* will be monitored so comparisons can be drawn on the seasonal nutritional status of sheep and goats over a continuum of forage community conditions. Traditional stocking rates and grazing practices will be adhered to during this period of the investigation. After this assessment of various *caatinga* conditions is obtained, grazing rate and grazing season trials accompanied by appropriate nutritional analyses will be conducted. These will be followed by long-term evaluation of improved grazing management practices relative to animal nutrition and production as well as the plant community changes of the *caatinga*.

Victor Beraun and John Pitts  
measure current through a  
solar powered electric fence  
in Peru.



(ABOVE) Tethered local Javanese thin tailed, earless sheep grazing planted forage.

(RIGHT) Weighing village sheep in Indonesia.



## ANIMAL NUTRITION, FORAGES AND BYPRODUCTS

Forages and crop by-products constitute a major source of nutrients for livestock in the humid tropics, and their utilization integrates well with the utilization of marginal land and crop rotation programs. In semi-arid areas, cultivated forages and crop residues hold great potential to complement the available range forage and help narrow the nutrient gap as feed supplies diminish during the prolonged dry season. Cultivated cool season grasses and legumes and harvest residues, grazed directly or stored, could supplement protein and energy intake and increase livestock productivity by decreasing nutritional stress, particularly during growth and lactation.

There is, unfortunately, little information on the intake, digestibility, and nutritive value of many common tropical forages and crop by-products. This lack of knowledge about how various levels and combinations of common and exotic feeds influence potential animal productivity leaves unclear what constitutes optimum feeding regimens for animals at different stages of their production cycle. As there is currently no organized system for the efficient incorporation of these feedstuffs into rations, they are fed in combinations which do not necessarily make the best use of the available resources.

In order to most effectively use native and cultivated forages and crop residues, it is necessary to acquire a better understanding of the animals' nutritional requirements and characterize the nutritive value of the most readily available feedstuffs, including local forages and pasture. In the humid tropics, this entails evaluating the

local feeds and developing guidelines for formulation of balanced maximum profit rations which use the most advantageous combination of natural and cultivated forages at any given time of the year. In semi-arid areas, where range is the primary feed resource, it is vital that the seasonal variability in the nutritive value of the range be accurately determined in order to ascertain which cultivated forages provide the most suitable supplements to complement deficiencies. Where agricultural by-products are the basis for dry season supplementation, it is critical to know the nutrient value of the crop residues, which to date have not been extensively analyzed. This information can then be used to devise feeding systems geared to the specific conditions of each locale.

**William L. Johnson, Ederlon Oliveira, Nelson Barros, S. Rangkuti, M. Siregar, A. Djajanegara**  
**Overseas Sites: Brazil and Indonesia**

The primary objective of the research in Brazil is to devise economical supplementation systems which optimize nutrient intake for goats and sheep over the course of stress periods, particularly the prolonged dry season and during critical phases of their production cycle. Initial activities are focused on evaluating the available feed base including crop residues, cultivated forages, and leafy native legumes. In addition, animal growth, lactation, and reproductive response to varying levels of nutrient intake will be measured, especially the response to energy and protein supplementation. The influence of soil type and season on the mineral status of plants and animals will also be examined. Predictability of animal performance based on chemical and *in vitro* analyses of feedstuffs will be tested.

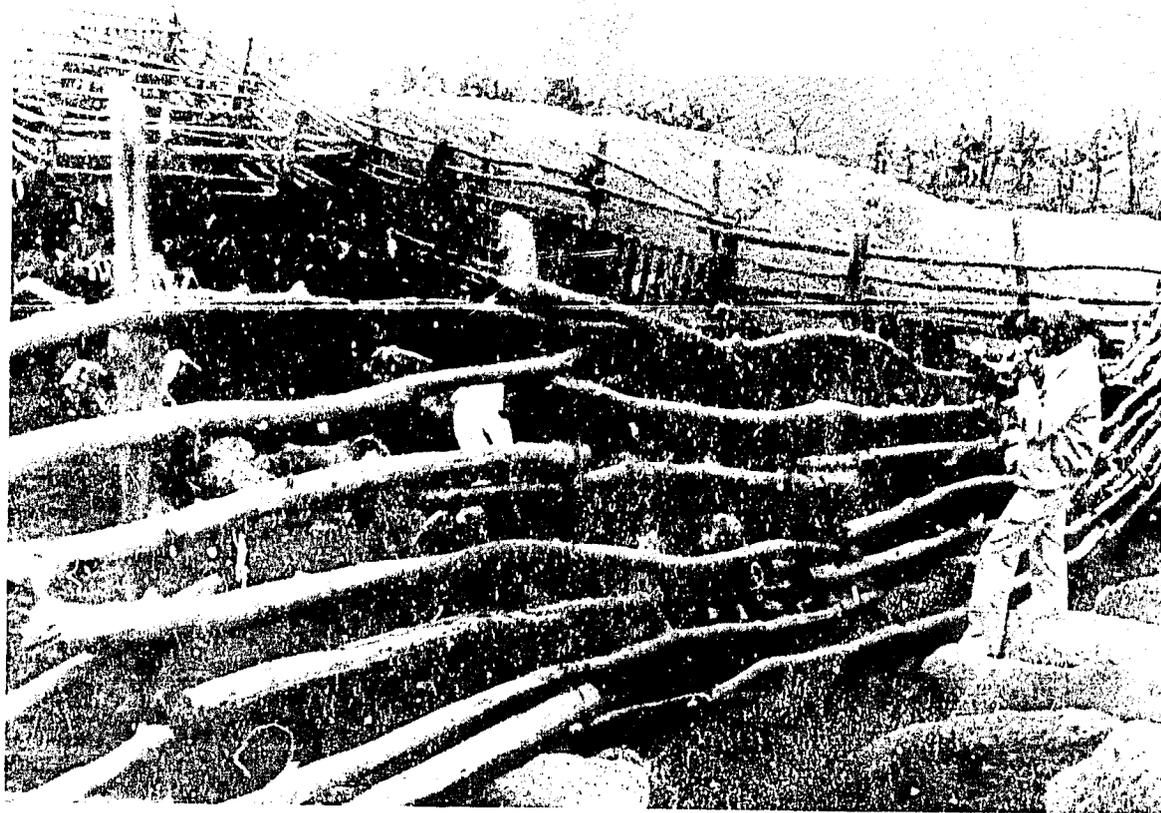
A survey of the many types and relative frequencies of the feedstuffs on Java will be conducted to catalogue and sample the range and diversity of the available feed resources. Intake data will be recorded and feed samples collected and analyzed from village animals to obtain a seasonal nutritional profile of the local small

ruminants. Animal performance data needed for ration formulation will be acquired in controlled feeding trials by measuring the *ad libitum* intake and production response of sheep and goats on rations with varying energy or protein levels. These diets, composed of representative feedstuffs commonly used on Java, will yield repeatable data on the nutritional value of the available feedstuffs and aid in the formulation of sound recommendations for a systematic feeding regimen.

**Robert W. Van Keuren, Arturo Florez, Ricardo Valdivia**  
**Overseas Site: Peru**

A survey will be conducted to characterize the forages in the Highlands and determine their potential adaptation, utilization, and preservation in this environment. A large perennial ryegrass/ladino clover pasture and smaller mixed pastures of alfalfa, orchardgrass, timothy, and red clover in paired grass/legume combinations, will be established and grazed to measure their yield, seasonal growth, persistence, and nutritive value. This knowledge, combined with an evaluation of animal adaptability and nutritional needs in relation to production response, will enable the project to plan a forage production system which integrates well with the range program and substantially contributes to improving overall animal productivity.

Dr. Foote, observing a herd of criollo goats north of Lima, Peru.



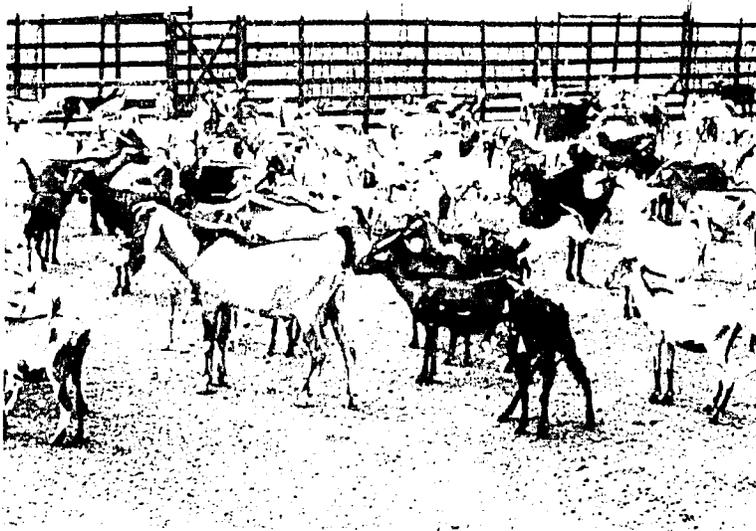
## REPRODUCTION

The reproductive rate in native flocks tends to be low as evidenced by low total numbers and weight of offspring per female bred. Factors which may contribute to this problem include delayed first estrus and parturition, low fertility and prolificacy, high embryo and postnatal losses, short reproductive life of breeding females, and maintenance of non-productive males and females in the flocks. The lack of knowledge of the basic reproductive processes of such indigenous animals as the alpaca, hair sheep, and Highland wool sheep further hamper efforts to improve the reproductive performance of these animals.

It is essential that the reproductive capabilities of the indigenous small ruminants be characterized and the processes limiting reproduction and animal productivity be identified. This will facilitate a better understanding of the interactions between traits relating to reproductive performance and animal productivity as well as the relationship of these interactions to nutritional status and general management procedures. The reproductive performance of various genotypes of sheep and goats will be measured and compared under natural and improved husbandry systems. This will provide the baseline information necessary to develop and test a reproduction management component which will enhance reproductive performance and can be used in conjunction with other improved management practices to increase animal productivity.

**Warren C. Foote, Edward A. Nelson, Cesar Novoa, Julio Sumar, William Vivanco, Aurino Simplicio, Simon Riera**  
**Overseas Sites: Peru and Brazil**

Individual reproductive processes including factors relating to level and efficiency of performance as well as seasonal influences will be measured on various genotypes of male and female sheep, goats, and alpacas. Measurements on the female will include age and weight at puberty and first parturition, subsequent fertility and prolificacy, and the birth weight and post-natal survival rate of offspring for each breeding/lambing year over the course of reproductive life. Ovulation rate, length of breeding season, and endocrine profiles will be monitored at selected periods. Rams will have age and weight at puberty recorded, lifetime reproductive characteristics monitored, and seasonal effects on changes in libido and semen production and quality examined.



(ABOVE) Typical local goats at a research station in Quixada, Brazil.  
(RIGHT) Alpaca owned by proprietors of handicraft shop in Puno, Peru.

Information will be collected from animals managed under traditional and improved management conditions. This will identify the factors limiting reproductive performance, measure genetic and environmental effects and their interactions, and establish estimates of reproductive potential for the genotypes under study. Investigators will then be able to determine the extent to which reproductive performance can be modified by changes in genetics and/or management practices to improve livestock productivity.



There exists a wide spectrum of health problems among the livestock in developing countries. Ailments which range from poorly characterized endemic parasite burdens to highly specific vector-borne diseases act in concert with other production system constraints and exert a considerable influence on overall animal performance. Poor health depletes the animals' resistance to environmental stress, compounds the debilitating effects of inadequate nutrition, and hampers reproductive performance, all of which cause reduced productive output and profit for small ruminant producers.

It is of great importance to identify and rank the health constraints which depress small ruminant productivity, taking into account both the prevalence and economic toll of the major disease problems in each area. This will provide a focus for initiating research and devising strategies which alleviate the impact of high-priority health problems. In order to implement effective preventive, therapeutic, and control practices which reduce morbidity and mortality, it will be necessary to improve diagnostic techniques and treatments for bacterial infections, viral diseases, and internal parasites; explore small ruminant immunological responses; and expand health management programs and animal health-care delivery systems.



## ANIMAL HEALTH

Drs. Marina and Emidio Silva collecting samples from an experimental doe at CNPC, Sobral, Brazil.

**Francis R. Abinanti, S. Njanja, D. P. Kariuki**  
**Overseas Site: Kenya**

A survey instrument to effectively measure the prevalence and economic significance of major small ruminant diseases has been developed which will attempt to link animal health problems with the socio-economic and ecological characteristics of smallholder communities. Data will be collected on: incidence of disease, reproductive performance, neonate loss, diseases of young and growing animals, management practices, and nutritional profiles. A portion of the animals sampled in the survey will be randomly selected for additional in-depth, long-term monitoring. In addition to the survey activities, improved diagnostic and control methods for sheep pox will be studied and new antihelmintics and coccidiostats will be tested in an effort to combat internal parasites. Information on small ruminant health problems will be coordinated with data on nutrition, genetics, and animal and land management to aid in the establishment and implementation of successful, cost-effective, herd health delivery systems.

**James C. DeMartini, Eddo Caletti**  
**Overseas Site: Peru**

A number of health problems in Peru have been targeted for study. Such chronic respiratory diseases as sheep pulmonary adenomatosis and chronic progressive pneumonia have been singled out as causing major flock losses. Investigation of clostridial diseases also has a high priority, particularly neonatal enteritis in the alpaca. In addition, problems of internal parasites (especially liver flukes) and reproductive difficulties (particularly ram epididymitis), will be studied. Epizootiological studies will focus on the prevalence of parasitic, bacterial, and viral infections. They will also aid in determining the effect of management on disease prevalence and provide further information on potential modes of transmission of these important diseases. Research performed will concentrate on developing means

to improve clinical, pathologic, and immunologic methods of diagnosis and effective prevention or treatment of these major disease constraints on animal productivity.

**Blaine McGowan, Carlos Costa**  
**Overseas Site: Brazil**

The Health project will define and investigate the causes of the major disease problems in Northeast Brazil, particularly the high abortion rates, kid and lamb mortality, and the incidence of endo and ecto parasites. They will collect data on the cyclic nature of parasite burdens, screen anthelmintics for efficacy, develop strategic worming practices, and study methods for protecting sheep against *Corynebacterium pseudotuberculosis*, the bacteria which causes caseous lymphadenitis. Serological survey, bacterial and viral isolation, and histopathological techniques will be employed in combination with necropsy and clinical treatments to better understand and combat these problems. Cooperative arrangements with several smallholders in the region will be established to monitor animal health on a yearly cycle. Based on the information generated from these studies, economically feasible herd health programs encompassing preventive and control techniques for the major disease constraints will be developed.

Milking class at Women's Dairy  
Goat Cooperative, Busia Dis-  
trict, Western Kenya.



## MANAGEMENT/ PRODUCTION SYSTEMS

Results of biological and socio-economic interdisciplinary research must be integrated and adapted to the needs of small farm systems in the tropics. Research activities will focus on resource management and the resolution of constraints necessary for successful production systems.

The characteristics of the existing agricultural production systems will be examined in order to determine the major constraints to dairy/dual purpose goat production and define research priorities. The work will include the identification of animal genetic resources, feed resources, health problems, product utilization, markets, labor requirements, and smallholder attitudes

towards raising goats. Experiments to design and evaluate appropriate management techniques for achieving milk and meat production on smallholdings will be conducted.

This information will be used to establish a benchmark data base of production and economic coefficients for the assessment of future production system modifications and interventions. In combination with the findings of the other CRSP projects, the data will be used to devise practical dairy/dual purpose goat management strategies which can be tested under realistic smallholder conditions and be successfully integrated within the current production system.

**Nancy M. Stott, Ederlon Oliveira**  
**Overseas Site: Brazil**

If the needs of local producers concerned with dairy goats are to be addressed, intensive management systems geared toward optimum milk production in semi-arid areas must be investigated. In order to devise successful husbandry methods for increased dairy production, more information is required about the most appropriate goat breed for milk production and the proper plane of nutrition for lactating does. Milk production from four goat breeds under intensive management in Northeast Brazil will be recorded and evaluated and data will be collected on the relationship between reproductive performance and nutritional level. Assistance will be provided in the establishment of an analytical nutrition laboratory at the Sheep and Goat Center at Sobral to facilitate these activities. Efforts will also be directed towards gathering and distributing processing techniques for butter and cheese production and assessing management systems for the rearing of young kids for meat production.



*(ABOVE)*  
Typical feeding system  
or rearing pre-weaning dairy  
goat kids.

*(RIGHT)*  
Goats, representative  
of the type found in  
Northeast Brazil, at CNPC,  
Sobral, Brazil.



**Henry A. Fitzhugh, D. S. Kitivo, J. Kekovole,**  
**P. N. Gachuki, M. Wanyoike**  
**Overseas Site: Kenya**

Results from interdisciplinary research efforts will be integrated to develop a dual purpose goat component suited to the needs of small farms in the humid tropics. Initially, surveys will be conducted in collaboration with other CRSF projects to characterize the current farming systems, identify major constraints, and establish baseline data for future evaluation of research results. Procedures will be developed for long-term monitoring of typical small farm production systems. Among the characteristics recorded will be periodic measurement of animal productivity including milk yield and fertility, seasonal fluctuation in the nutrient value of available feeds, and competition with other crop and livestock activities for land, labor, and capital. Breeding, nutrition, herd health, and management programs will also be assessed. Experiments will be conducted to evaluate local feed resources and define nutrient requirements of dual purpose goats to develop low-cost rations appropriate for goat production on smallholdings. Work at Winrock in conjunction with the effort in Kenya will include evaluation of various management systems and nutrient requirements for kids and lactating does and a documentation of the genetic and environmental sources of variation in growth, lactation, fertility, and health in five dairy goat breeds.



## SOCIOLOGY

Social and cultural conditions are important and play a vital role in determining the overall pattern of small ruminant husbandry. They exert considerable influence on the decision making process of smallholders and more research is needed to determine specifically where and how these factors operate within the context of the smallholder farming system.

It is particularly important that modifications of the present small ruminant farming systems do not disturb the fabric of smallholder society to the extent that they are harmful rather than beneficial. Potential interventions will be studied in depth with the objective of assessing the manner in which needed improvements could be implemented so they bring positive changes to the local population.

*(LEFT)* Fighting rams surrounded by spectators at local market in Garut, West Java, Indonesia.

*(RIGHT)* Champion fighting ram in West Java, Indonesia.

**Michael F. Nolan, J. Casaverde, J. Flores-Ochoa,  
V. Fernandez, R. Rivera, A. Aboud, J. Ithlauw,  
K. Suradisastra**  
**Overseas Sites: Peru, Brazil, Kenya, and Indonesia**

Several types of data collection methods, including in-depth observations and survey techniques, will be employed to define small ruminant production systems in each of the overseas sites. Field studies related to key socio-cultural constraints to improved small ruminant production will be conducted from both the small farmer and structural socio-economic perspective. Special emphasis will be placed on examining small-holder decision making, the role and influence of women and children in animal production, and the role of small ruminants in the rural communities' social fabric. Evaluation studies on proposed and implemented production system interventions designed to increase small ruminant productivity will also be performed.

In Brazil and Peru where extensive husbandry systems are predominant, emphasis will be placed on investigating the sociology of range management including an examination of previous attempts to alter traditional practices and introduce modified management techniques. Where appropriate, specific studies will focus on community control of public grazing land and its effect on the implementation of alternative practices. Also, comparisons between various types of small ruminant husbandry systems such as traditional communities and large government cooperatives will be made.

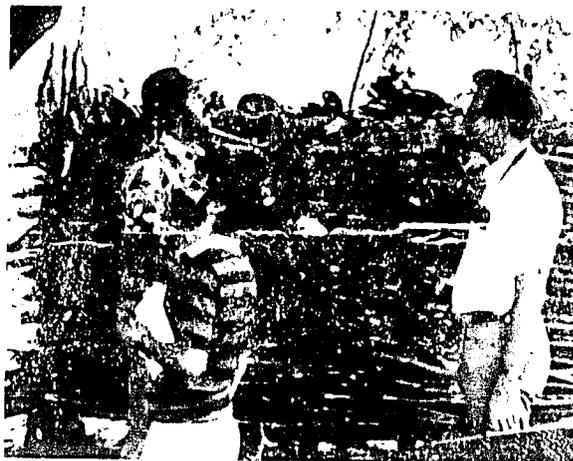
Kenya and Indonesia are characterized by highly intensive mixed crop/livestock production systems, in which the livestock are generally considered a secondary enterprise. Great emphasis will be placed on studying the role of the small ruminant within agricultural systems primarily oriented towards cultivation. Such things as production strategies among the landless in comparison to landholders, the role of women's cooperative groups in small ruminant production, and special non-agricultural roles small ruminants fulfill within the society, will be examined.



Dipping class at Women's Dairy Goat Cooperative, Busia District, Western Kenya.

In addition to the physical and biological constraints on animal productivity, a lack of knowledge of various production and marketing mechanisms and demand characteristics for small ruminant products further limits potential production system improvements. More specifically, the combined effect of on-farm problems of resource productivity and limited capital in addition to off-farm constraints on marketing,

Mr. Albuquerque, Mr. Gutierrez, and Dr. Burzlaff examining prickly pear feeding system for goats near Petrolina in Northeast Brazil.



## ECONOMICS

rural credit, and government pricing policy for agricultural products, results in few well-organized sheep and goat production systems. This creates a situation in which it is difficult for small ruminant producers to realize an adequate return on their animals, compounding their economic hardship.

Using data from all the projects, the economists will describe the physical, biological, organizational, and socio-economic aspects of the existing small ruminant production system. This information is necessary to undertake long-term farm management, production economics studies which analyze in detail the constraints influencing small ruminant production and profitability. These studies consider resource use problems on small farms and provide input for planning research. They also provide guidelines for the design, evaluation, and extension of alternative technologies.

Consumer demand marketing studies will be conducted to help define the constraints influencing consumption, marketing, pricing, processing, and distribution in order to initiate research efforts to alleviate these problems. The long-term prospects for the production and marketing of small ruminant meat, milk, hides, and fiber will be identified and the optimal product mix patterned for various target farmer groups will be defined.

**A. John DeBoer, Julio Echevarria, M. Sabrani**  
**Overseas Sites: Peru, Brazil, Kenya, and Indone**

Primary and secondary sources will be used to collect production system description data from both traditional farms as well as those using some aspects of improved technology. The farm management/production economics studies at each site will include baseline field surveys, marketing agent and central market surveys, and regular farm interviews and management data collection visits. Consumer market and demand studies will survey the institutions, policies, and constraints of the small ruminant market to establish and define its important characteristics.

These surveys will yield information on production and consumption patterns, resource requirements for various activities, and quantify seasonal constraints. This will facilitate an in-depth analysis of the crop/livestock system, accounting for such factors as demand, risk, and communal resource use problems. In some cases, survey and experimental data will be used to initiate the development of interdisciplinary linear programmed physical/financial models of the small farm crop/livestock complex. The models, incorporating both technical and financial aspects of the small ruminant system, can be updated and revised as new information becomes available. Data will be continually collected and analyzed to provide an initial assessment of the production system against which to compare the effects of the CRSP improvement efforts.

**I**ntegration of new technologies related to individual components of an animal production system by systems analysis techniques is a relatively new field of science which takes into account the interaction of many factors contributing to the function of the production system. Factors having major effects on small ruminant producing systems include disease and parasite stresses interacting with nutrition and breeding which further interact with management, marketing, and other socio-economic effects.

Computer simulation models of livestock production systems have been used successfully to increase the effectiveness of research results by

## SYSTEMS ANALYSIS

identifying knowledge gaps and establishing research priorities and needs. In addition, validated computer simulations can be used for evaluation of production alternatives. Model ap-



Dr. Cartwright with the horns from a champion Garut fighting ram.

lications of major interest are those that evaluate small ruminant production systems which incorporate and integrate the appropriate species within the particular agricultural system in each of the overseas sites. This evaluation will include the assessment of traditional and alternative management practices, feed resources and supplementation programs, available breed types, and application of research results.

**Thomas C. Cartwright, Jorge Velasco, Alberto Pumayalla, Elsio Figueiredo, A. B. Carles, A. P. Siregar**

**Overseas Sites: Peru, Brazil, Kenya, and Indonesia**

Dynamic, comprehensive, mathematical models based on biological functions, will be developed both for sheep and goat production systems with the individual animal as the modeling unit. Production from each of the overseas sites will be used to validate model input parameters. Input data specific to each location and management system related to forage quality through time, growth and lactation parameters, and management policies, are required for the validation process.

The validated simulation will serve as baseline data. Further simulations with varying inputs will then be used to identify the research required to develop techniques to accomplish specific objectives, synthesize alternative and ecozone-specific production systems, and supply biological input-output data of traditional and altered production systems for use by the Economics and Sociology projects in such analyses as production efficiency studies.

Specific production system components and alternative practices to be examined include: optimal breeding season; comparative productivity of exotic breeds and crossbreeding; use of supplemental feeding and cultivated forages; disease control programs; optimal weaning, culling and marketing ages; and practices related to market conditions and social customs.



Vicuña on the range in the Highlands of Peru.