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**SMALL RUMINANT
COLLABORATIVE RESEARCH SUPPORT PROGRAM**

ANNUAL REPORT 1984-1985



**SMALL RUMINANT
COLLABORATIVE RESEARCH
SUPPORT PROGRAM
(SR -- CRSP)**

**UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA 95616**

PN-ABH-310

**THE SMALL RUMINANT
COLLABORATIVE RESEARCH SUPPORT PROGRAM
(SR-CRSP)
ANNUAL REPORT
PROGRAM YEAR SIX
1984-1985**

Prepared by the Management Entity

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PART I
SUMMARY OF ACCOMPLISHMENTS

SUMMARY OF ACCOMPLISHMENTS

The Concept of the CRSPs

The US, as the world's largest generator of surplus food, has provided aid to millions of hunger victims. Abundant harvests in the US have been widely distributed in acute disaster relief programs and on a regular basis to food deficient nations. However, as the world's populations burgeon, it has become apparent that supplying the hungry world with food through surplus distribution does not permanently alter the cycle of poverty and deprivation in LDCs. Recent famine in Africa has again demonstrated that the only long-term solution is to improve the capability of these areas to supply their own food.

To promote this goal, the US 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 establish freedom from hunger, the US should strengthen the capabilities 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 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 (CRSPs). Among their suggested topics was small ruminants.

Fifty-six percent of the world's sheep and ninety-six percent of the world's goats are located in LDCs. They are owned primarily by small pastoralists and farmers of very limited means. Despite their low production, these animals contribute significantly to the economy and food supply in these 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 smallholders and the conditions prevailing in the LDCs. For example, they:

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

Statement of Goals

The primary goal of the Small Ruminant CRSP is to improve meat, milk and fiber production from sheep, alpacas and goats in order to increase the food supply and raise the income of the smallholder. In addition to gaining a better understanding and increasing the efficiency of subsistence level small ruminant production systems, a major objective of the program is to strengthen the research capacity of overseas and US agricultural institutions.

To accomplish these broad objectives, the SR-CRSP is providing leadership for interdisciplinary research programs and furnishing opportunities for advanced training of scientists interested in small ruminants. This results in increased numbers of professionals with the necessary analytical skills and motivation to engage in an organized effort to alleviate the problems confronting small ruminant producers. Publishing and disseminating SR-CRSP project results contributes to an enhanced data base for directing future research, designing sound management recommendations and formulating policy guidelines which mitigate the constraints on small ruminant productivity. Increased attention is being given to preparation of extension type material to inform developing country professionals who, in turn, will be expected to adapt it to their local conditions. The various projects involved in research in the overseas sites play a vital role in the fulfillment of these goals.

The individual projects of the SR-CRSP were designed to help alleviate some of the major problems which severely hinder small ruminant productivity in the less developed countries (LDCs).

Problem Area	Research Area
Inadequate year-round feed supply	Nutrition and Feeding
Improper grazing practices	Range Management
Poor reproductive performance the	Research on reproduction in male and female
Non-selective breeding	Genetic improvement of local breeds and crossbreeds
Disease-Parasitism	Animal Health
Sub-optimum utilization of available resources	Management
Cultural constraints and lack of capital	Socio-Economic Research
Lack of coordination and integration in improvement efforts	Systems Research

The Small Ruminant CRSP has been in active operation since the middle of 1979 when the first subcontracts were awarded to participating institutions. The accomplishments of the SR-CRSP during the last six years fall into three categories: research, training, and public service. A major report that describes these accomplishments is titled "Partners in Research" and was published in lieu of the 1982-1983 annual report. Further progress was documented in the 1983-84 Annual Report.

The nature of the SR-CRSP, its participating institutions, principal investigators, subject matter areas, countries of operation, and goals and objectives are described in an informational brochure that is available from the Management Entity Office. SR-CRSP scientists, both US and foreign, have generated over 1,200 research reports, papers, abstracts and verbal presentations related to SR-CRSP activity. A compilation of these publications and presentations up to July 1985 is available from the ME along with a training roster. A working paper series and a technical report series were commenced within the SR-CRSP whereby research results and experimental data could quickly be documented and disseminated. One or more of these reports are developed into publications for peer-reviewed journals and then, as research packages are validated and tested, the information is developed into practical reading material for the farmers, extensionists and laymen to use in the field.

The Organization of the SR-CRSP

The Management Entity (ME). Seventeen research proposals were selected to embark upon the first CRSP and the University of California, Davis, (UCD) was designated the Management Entity. A program director was appointed and three committees, each of which play a distinct role in the function of the SR-CRSP, were established.

The Technical Committee (TC) is an executive committee of the SR-CRSP which develops and implements research projects in the US and overseas. It consists of all Principal Investigators.

The Board of Institutional and Host Country Representatives (BIR) is an executive committee primarily concerned with budget and policy. It consists of representatives from the administrations of the participating institutions.

The External Evaluation Panel (EEP) is an advisory committee responsible for reviewing and evaluating CRSP research activities and progress. It consists of a multi-disciplinary group of eminent scientists from institutions not participating in the CRSP.

Overseas Counterparts. Overseas counterparts at the level of higher administration and at the scientific levels have regularly attended and participated in the Technical Committee and Joint Technical Committee and Board meetings. In some countries, there are Program Administrative Committees (PACs) which solicit input about the SR-CRSP from ministry, university and international agencies. Host Country Representatives became full voting members of the Board in January 1984.

The SR-CRSP Budget

Funds for the SR-CRSP were committed by AID under the terms of Grant No. AID/DSAN/XII-G-0049 for the first six years and DAN-1328-G-SS-4093-00 for years seven through nine. Both grants require a minimum cost sharing contribution of 25 percent from the participating US institutions. The terms of the grant are favorable for a research program, always a long-term venture, providing a two year funding horizon and three year planning horizon for participants. The SR-CRSP budget for the initial six year funding period was 19 million US dollars. The overseas collaborators contribute substantial additional resources toward the SR-CRSP.

SR-CRSP Overseas Worksites

The group of people toward whom the activities of SR-CRSP are directed are the limited resource producers in LDCs, such as 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 these conditions. Because the overseas research component of the SR-CRSP was considered the cornerstone of the project, great care was taken to select appropriate overseas worksites which met the following criteria.

- o The sites are representative of the various ecozones and production systems encountered in the tropics. The applicability of SR-CRSP findings should extend beyond the borders of any nation in which the research was conducted and be useful in other areas of similar climate and topography.
- o The countries in which the sites are located have established agricultural institutions which are staffed by scientists, trained personnel and students with whom the SR-CRSP investigators have an opportunity to collaborate. These institutions also provide the extension links which are pivotal to the implementation of SR-CRSP findings. The current overseas and collaborating institutions are:

Brazil:	Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA)
Peru:	Instituto Nacional de Investigacion y Promocion Agropecuaria (INIPA)
Indonesia:	Agency for Agricultural Research and Development (AARD)
Morocco:	Institut Agronomique et Veterinaire-Hassan II University (IAV)
Kenya:	Ministry of Agriculture and Livestock Development (MALD)

Bibliography of Major Meetings and Reports

Since the Annual Report in 1983-84, the following reports and minutes have been prepared:

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| 1. | Third Kenya Workshop Proceedings | Mar 1984 |
| 2. | Host Country Workplan for Brazil | Nov 1984 |
| 3. | Host Country Workplan for Indonesia | Dec 1984 |
| 4. | Host Country Workplan for Peru | Jan 1985 |
| 5. | Host Country Workplan for Morocco | Feb 1985 |
| 6. | Host Country Workplan for Kenya | Mar 1985 |
| 7. | Technical Committee Executive Minutes | Apr 1985 |
| 8. | Technical Committee Minutes | Apr 1985 |
| 9. | Minutes of the Board of Institutional Representatives | Jun 1985 |
| 10. | Seventh EEP Report | Aug 1985 |
| 11. | Research Publications and Training Roster 1978-85 | Aug 1985 |

PART II
COMMENTS ON SR-CRSP BY PARTICIPANTS

INTRODUCTION

The Principal Investigators of the Small Ruminant CRSP were asked to report, briefly, on issues of greatest importance to their particular research work; to comment on the difficulties, problems, and advances they are experiencing. The following 92 short articles describe the progress they are making.

These papers from the Principal Investigators, scientists, and collaborators on the Small Ruminant CRSP are a collection based on research topics, ideas, and concepts formulated during the six years of the program, of real achievements and of anticipated future work. Originally called "success stories" they evolved as a mixture. Indeed, much of the work started at the onset of the project has borne exciting results for scientists, researchers and farmers in both the LDCs and at home in the US. And there is interesting and promising work currently underway at our overseas sites.

These pieces are designed for audiences of varying scientific expertise to serve as a resource for further refinement and development for researchers and scientists at institutes and universities, to act as catalytic input for the design and implementation of creative and pioneering work in the future.

Publications relating to the SR-CRSP, including the Directory of Publications which details further papers published in a variety of journals, are available upon request from the respective Principal Investigator or the Small Ruminant CRSP Office, University of California, Davis, CA. 95616, (916) 752-1721.

Small Ruminant Flock/Herd Health Program in Smallholder Systems

H. J. Olander

University of California, Davis

PROGRESS IN THE STUDY OF CASEOUS LYMPHADENITIS

Scientists of the CNPC laboratory in Northeast Brazil collaborating with scientists from the University of California at Davis under the SR-CRSP program of USAID have made progress in combating a serious goat disease.

Caseous lymphadenitis of goats, caused by Corynebacterium pseudotuberculosis, is a chronic insidious disease which is highly prevalent and causes great economic loss among the small holders of the sertao. Control of this disease has been fraught with difficulties, largely due to the lack of a diagnostic test for the detection of carrier animals.

The Synergistic Hemolysis Inhibition (SHI) test, developed at Davis, has been applied in a variety of situations to both infected and non-infected herds in the northeast. Sensitivity and specificity were excellent for detecting infected animals. This test, which is rapid, inexpensive, and reliable, should prove of major benefit in devising schemes for the control of this devastating disease.

A better understanding of the immunology of the disease has been gained through the development of a skin test, using an antigen made from fragmented bacterial cells. Skin reactions, which are an indication of the extent of cell mediated immunity, can now be compared to antibody levels, which are a measure of humoral immunity. Thus the two arms of the immune response can be compared to determine the relative contributions of each and so gain a better understanding of host response in this disease.

An experimental model for the establishment of caseous lymphadenitis in goats was developed at the University of California, Davis, because research efforts to date have been somewhat hampered by lack of a reliable method to produce the disease. The researchers found that intradermal inoculation with an aliquot of both cultures of Corynebacterium pseudotuberculosis produced consistent lesions, both superficial and internal, typical of the natural disease.

Monitoring of serum samples from both infected and control animals via the Synergistic Hemolysis Inhibition (SHI), demonstrated that this test was a reliable indicator of infection, and could prove to be the sorely needed means of diagnosis for infected and carrier animals.

In addition, SR-CRSP support continued in other EMBRAPA animal health projects, specifically - effects of trace minerals on goat production, incidence of hydrometra in native goat populations, and effects of goat housing on severity of parasitic infestation. In the United States, SR-CRSP lent support to a study involving the occurrence of Mycoplasma mycoides subsp. mycoides in goats in this country.

Collaborating scientists on this research were: Selmo Alves, Harvey Olander, Corrie Brown, and Jose Brieto Leite.

Genetic Improvement of Sheep and Goats

G. E. Bradford

University of California, Davis

EFFECT OF DEGREE OF WOOL COVER ON PERFORMANCE OF DORPER SHEEP IN KENYA

Observations of wool and hair sheep in the tropics, and considerations of the protein and energy cost of synthesizing wool suggest that, where meat production is the sole or principal goal of sheep production, hair sheep should be superior to wool sheep in production efficiency in the tropics.

For his research for the M.S. degree at U.C. Davis, William Odenya of the Kenya Ministry of Livestock Development (MLD) scored the amount of wool cover on several hundred sheep of the Dorper breed (which had originated from a hair x wool breed cross), and related this to various production parameters. His analysis showed a difference of near 3 kg in individual lamb weaning weight, in a flock with a mean weaning weight of 22 kg, between ewes free or nearly free of wool compared to completely woolled ewes, with the higher lamb weights produced by the ewes with less wool. These results indicate that a substantial increase in lamb production could be effected simply by selecting in such sheep populations for animals with less wool cover. Since the trait is easily scored, measurable in both sexes, and moderately to highly heritable, it should be possible to make rapid genetic change, with no requirement for expensive equipment or sophisticated selection procedure.

Personnel collaborating in this research were: W. Odenya of the Kenya Ministry of Livestock Development and G.E. Bradford of the University of California, Davis.

GENETIC BASIS OF PROLIFICACY IN JAVANESE SHEEP

Javanese sheep have been reported to be highly prolific in several reports such as Mason's FAO report on Prolific Tropical Sheep, but the genetic basis of this has not been known. SR-CRSP studies of both Station and village sheep show that the prolificacy is highly variable, among ewes, and producers have no way of knowing which ewes are going to have litters of 3 or 4 lambs and which will have only 1 or 2. This makes it difficult to implement efficient feeding and management practices to utilize the prolificacy.

Measurement of ovulation rate and analysis of 1980-1984 data on litter size in the experimental flock at Cicadas provide strong evidence for segregation of a Booroola-type gene with a large effect on ovulation rate and litter size in all three strains of Indonesian sheep in the flock: Thin Tail, Fat Tail and Semarang. Those animals carrying the gene have an average number of lambs born of 2.5-3.0 with a range of 1-6, while those not carrying it have a mean of 1.3-1.5 with only 1's and 2's. The data to date do not prove absolutely the existence of such a gene, but this is the best explanation for the unusual variability in prolificacy and pattern of genetic transmission of this prolificacy. Research currently in progress should provide conclusive evidence in the near future. If the existence of the postulated gene is confirmed, then it should be possible to produce strains with consistently high or consistently low prolificacy, permitting more efficient allocation of feed and management resources depending on genetic potential. The initial matings to produce such strains have been made, and stocks approaching the specified goals should be available within 4-5 years.

Personnel collaborating in this research were: G.E. Bradford, J.F. Quirke, P. Sitorus, B. Tiesnamurti, I. Inounu, F.L. Bell and Subandriyo.

IDENTIFICATION OF LONG LAMBING INTERVALS AS A
MAJOR CONSTRAINT TO VILLAGE SHEEP AND GOAT
PRODUCTION IN INDONESIA

Offtake rates of animals in village sheep and goat flocks in Indonesia are lower than would be expected for the prolificacy and viability levels recorded for these flocks. The reason has been found to be intervals between parturitions averaging over a year and up to 15-16 months, with an unusual level of variability. Data from the Station flocks suggest that intervals of 8-9 months are quite feasible with moderate nutrition. Analysis of intervals between services suggests that estrus is not being accurately detected, and that some females are being mated when not in estrus or are not being mated at all for many months after parturition.

Work has been initiated in the villages to test methods of improving mating efficiency. If successful, improvements in number of young per breeding female per year of as much as 50% or perhaps more could be realized.

Personnel collaborating in this research were: F.L. Bell and I. Inounu.

ESTABLISHMENT OF SHEEP RESEARCH CAPABILITY AT TADLA FARM
INSTITUT AGRONOMIQUE ET VETERINAIRE, MOROCCO

The SR-CRSP Breeding Project, with some funds from the ME and the Nutrition Project, has established a successful sheep research flock on a farm where no livestock were kept prior to mid-1982, and collected data on over 1000 lambings in the first three years. The work has involved design and construction of pens, development of feeding and watering systems, identification and record keeping systems, and facilities for weighing and for laparoscopy. Serious drought problems the past two years and other factors have greatly reduced the supply of alfalfa hay, on which the feeding program was originally based. The on-site breeding project specialist has implemented alternative feeding systems based on straw, molasses, urea, fallow grazing, et., which have maintained sheep performance at very acceptable levels.

A major constraint to lamb viability and growth was identified in the first lambing season, with the documentation of a severe white muscle disease problem. Treatment with Selenium/Vitamin E has eliminated the problem. As a result of this work, the Institute has sent a faculty member to the U.S. for graduate studies in mineral nutrition, and that person will return to Morocco to lead a research effort to determine whether this deficiency is affecting sheep performance adversely on a much wider scale in Morocco.

Personnel collaborating in this research were: Y.M. Berger, A. Lahlou-Kassi, I. Boujenane, L. Derqaoui, D.L. Johnson and G.E. Bradford.

BREED OF RAM EFFECT ON EWE FERTILITY

Introduction of rams into a flock of anestrous ewes will often hasten the onset of the breeding season, but there are few reports on differences between ram breeds in their effect on incidence of estrus or fertility of their mates.

The D'Man breed of sheep was chosen for study in the Morocco CRSP breeding project because of the reproductive performance of females, which are prolific, early maturing, and have a long breeding season. Research results to date show clearly that the D'Man ram can also make a highly significant contribution to productivity of the flock. Sardi ewes placed with D'Man rams had a 15% higher fertility (ewes lambing of ewes exposed) than those placed with Sardi rams, in 700 matings over 4 seasons. The difference was greatest for matings at the start or the end of the breeding season for Sardis. Ewes mated to D'Man rams also lambed earlier within the season, and had slightly higher ovulation rates and litter sizes. F₁ lambs have superior survival compared to pure Sardi lambs, and growth rate to 1 year of age equal to that of the larger (at maturity) Sardi breed. Thus, use of D'Man rams in crossing increases reproductive performance immediately, as well as producing F₁ daughters with higher performance than their dams.

Personnel collaborating in this research were: A. Lahlou-Kassi and Y.M. Berger.

GENETIC POTENTIAL OF D'MAN BREED

Lahlou-Kassi (1982) in his doctoral dissertation showed that D'Man ewes had a longer breeding season than a less prolific Moroccan breed, based on year round detection of estrus in unmated ewes. Research in the SR-CRSP breeding project has documented that the longer breeding season of D'Man ewes results in much higher average fertility on an accelerated lambing program, and this plus their higher prolificacy results in higher average total weight of lamb weaned per ewe, in spite of lower individual lamb weight of pure D'Mans.

F₁ D'Man x Sardi ewes are showing the early puberty and high fertility of the D'Man parent, and litter size intermediate between the two parent breeds. The net result is excellent total performance. At present Moroccan breeds have either very low (Sardi, Timahdite, etc.) or very high prolificacy (D'Man). Neither is optimum for the improved management systems potentially available in many mixed crop-livestock production areas of Morocco. A frequent approach when animals of the desired combination of traits is not available is importation of exotic breeds, which often prove poorly adapted to local conditions. It appears that animals with the desired reproduction potential for a range of production environments in Morocco can be developed by varying the percentage of D'Man inheritance in combination with other Moroccan breeds, eliminating the need for importation of exotic breeds and the problems associated with that.

Personnel collaborating in this research were: A. Lahlou-Kassi, Y.M. Berger and G.E. Bradford.

IDENTIFICATION OF BREEDS WITH HIGH EMBRYO SURVIVAL

Ovulation rate and embryo survival are the principal factors determining number of young born per parturition. Most breeds of sheep appear to have similar embryo survival, and the view has been advanced that there is little genetic variation in embryo survival and hence little opportunity for making genetic improvement in this important component of performance. Prior to the SR-CRSP program, only one breed, the prolific Romanov, had been reported to have superior embryo survival. Research in the UCD breeding project with the prolific breeds in Indonesia and Morocco has shown very high embryo survival, 5 to 10% above the generally accepted mean at all ovulation rates, in both those groups. This suggests that prolific breeds generally may have higher embryo survival than non-prolific breeds, which provides encouragement that genetic improvement can be made in this trait in sheep. Such improvement would not only contribute to an increase in number of lambs born but also to a decrease in variability. The SR-CRSP research therefore is providing information that can be used for new approaches to sheep improvement generally.

Personnel collaborating in this research were: A. Lahlou-Kassi, J.F. Quirke, Y.M. Berger and G.E. Bradford.

PROLIFIC SHEEP FOR THE SMALL FARMER

Productivity of sheep kept for meat production depends largely on the number of lambs weaned per ewe per year. This, in turn, is determined by frequency of lambing, number of lambs born per lambing (prolificacy), and proportion of those born which survive. Breeding season and prolificacy are determined primarily by genetic potential of the breeds available. Fortunately, among the world's hundreds of herds of sheep, there are a few that are "prolific", which means that the ewes frequently give birth to two or more lambs at a time, sometimes producing as many as four or more. A high level of feeding and care is required to raise these multiple birth lambs successfully, and this is often available in smallholder flocks in mixed crop-livestock production systems. This is the production environment targeted by the USAID Small Ruminant Collaborative Research Support Program (SR-CRSP) in several of the participating countries.

The best known prolific breeds are the Finnish Landrace and Romanov, and these are frequently used as a source of inheritance to improve prolificacy in temperate countries where ewes typically are lambled once a year. However, both are seasonal breeders, and hence are limited in their usefulness for systems aiming at more frequent lambings.

Research in the SR-CRSP in Morocco and Indonesia is documenting the performance potential of two other highly prolific breeds which clearly have advantages for those countries, and which might someday contribute to increased productivity of sheep in the U.S. In Morocco, Dr. Eric Bradford of the University of California at Davis, has teamed up with a group led by Dr. A. Lahlou-Kassi of the Institut Agronomique et Veterinaire in Rabat in investigation of the D'Man breed. This breed, kept in small flocks in oases south of the high Atlas Mountains, and fed on alfalfa and cull dates, is one of the world's most prolific breeds. Earlier work by Dr. Lahlou-Kassi had shown that ewes of this breed have early puberty and exceptionally good aptitude for year-round breeding and frequent lambing. Work in the SR-CRSP project has shown that the D'Man transmits this early puberty and extended breeding season in crosses with a non-prolific breed, and that prolificacy of the crossbreeds is intermediate between that of the parent breeds. Thus, the D'Man can be used to improve lambing frequency, and the proportion of D'Man inheritance can be varied to give the desired level of prolificacy for different production systems in Morocco. The D'Man crosses look exceptionally promising for the irrigated agriculture areas of the country.

In Indonesia, sheep are kept in small pens close to the houses in villages, with green fodder cut and carried to them everyday. Exceptionally prolific ewes are found in both the Javanese Thin Tail and Fat Tail breeds, but there are also many ewes which are not prolific. The SR-CRSP research there indicates that this is due to presence in some ewes of a single gene for prolificacy. Based on this finding, work is now underway to develop strains which will consistently produce either a high or a low level of multiple births. The high strain can be used where producers have the resources and the willingness to apply a

high level of management, with the assurance of a much greater return than at present, where only a small proportion of the ewes are consistently prolific. The low strain can be used where the environment is not suitable for highly prolific sheep, avoiding the high rates of lamb mortality found when prolific sheep do not receive adequate nutrition and care.

Two workshops have been sponsored by the SR-CRSP to foster exchange of knowledge about development and utilization of prolific sheep. The first involved a group of nine scientists from five countries who met in Egypt and Morocco to discuss research accomplishments and needs related to prolific sheep in those countries. This meeting was so stimulating and successful in exchange of information that the participants proposed that a larger conference be held to bring together available knowledge on prolific sheep from throughout the world. Such a conference was organized by the SR-CRSP Director, David W. Robinson and by Dr. Roger Land, a participant in the Egypt-Morocco workshop and now Director of the U.K.'s Animal Breeding Research Organization. The Conference, held in Edinburgh in 1983, involved over fifty leading scientists from seventeen countries and produced the most comprehensive reference on the subject to date, the book "Genetics of Reproduction in Sheep" (Butterworths, London, 1985).

The SR-CRSP work on prolific sheep not only has high potential for benefiting small farmers, but through identification of unique germplasm resources and contributions to widespread exchange of information on prolific sheep research, it is advancing the field for the ultimate benefit of all countries where this species is a part of agricultural systems.

An Investigation of Small Ruminant Health Problems

J. C. DeMartini

Colorado State University

BREEDING SOUNDNESS EVALUATION STUDY OF RAMS IN PERU -April 1985

Breeding soundness evaluations field studies have been conducted on rams of two enterprises in Peru in April 1985. One enterprise was TupacAmaro in the high Sierra district of Junin, selected because the ram population has undergone a fairly intensive management program for a number of years. In 1974, a vaccination program was started with these rams utilizing the REV.I vaccine, a Brucella melitensis bacteria. The entire ram lamb population has been vaccinated with palpation of all rams for gross epididymal lesions and removal of these animals from the breeding flock.

The second enterprise was located in the Puno district in the Alta Plano where the ram population has not received Brucella vaccinations. The entire population was palpated and those exhibiting epididymal lesions were removed. This provides a comparison of a vaccinated and nonvaccinated population which has been subjected to the normal routine palpation program. Indications are that the ram population is very fertile and that there should be genetic selection for increased fertility within the ewe population. Both enterprises were very cooperative in accepting suggestions for management changes. Dr. Ameghino has been able to set up breeding flocks of 200 ewes utilizing varying ram to ewe ratios from 2 to 6%, since the current high level of 6 to 7% may be wasteful.

The next step in the SR-CRSP program will be to establish six or eight demonstration enterprises, so that the local people will be able to observe the progress that can be made by utilizing a breeding soundness evaluation program in the rams and by doing selection of the female breeding stock. The economic impact of increasing the lamb crop by at least 10% and of reducing ram:ewe ratio from the customary 6 to 7% to 3 to 4% will be incorporated in the study.

Collaborating personnel in this research were: Enrique Ameghino of San Marcos University and Cleon V. Kimberling of Colorado State University.

EXPERIMENTAL TRANSMISSION OF SHEEP PULMONARY ADENOMATOSIS

Sheep pulmonary adenomatosis (SPA) is a virus-induced lung tumor that is the single most important cause of adult losses in Peru, according to research conducted by the Colorado State University animal health project in conjunction with San Marcos University in Lima, Peru. This project, part of the Title XII Small Ruminants Collaborative Research Support Program (SR-CRSP), seeks to identify new methods of diagnosis and control of this devastating disease that constrains livestock production among small farmer communities as well as in large sheep producing cooperatives in Peru. New more effective means of diagnosis and control of SPA are dependent upon identification and in vitro cultivation of the causative virus, and this is, in turn, dependent upon experimental reproduction of the disease in an animal model system. To date, this has not been achieved in North America, although workers in Scotland and South Africa have recently reported successful induction of SPA in neonatal lambs injected with lung fluid from naturally occurring cases of the disease.

During the past year, CSU researchers in a project involving a Peruvian veterinarian working toward his Ph.D. in animal virology, have located in Wyoming 2 cases of SPA, an extremely rare condition in the U.S. Lung fluid and tumor material collected from these animals was used in attempts to transmit SPA to ovine-colostrum deprived newborn lambs. Out of a total of 32 lambs inoculated, 10 died or were sacrificed at 2-4 months post-inoculation. Of these 10 cases all have shown characteristic SPA lesions upon histologic examination. All of the animals inoculated started producing antibodies to ovine progressive pneumonia (OPPV) virus within 4-8 weeks after inoculation with material from the clinical cases. OPPV is another retrovirus that causes respiratory disease in sheep in the United States and throughout the world. The co-transmission of OPPV and SPA leads one to speculate that the causative viruses of these two sheep respiratory diseases may be related or synergistic in development of these diseases.

The ability to transmit experimentally SPA in the United States should lead to further advances in developing new strategies for the diagnosis and eventual control of this disease in Peru and other countries.

Collaborating scientists were J. DeMartini and Enrique Ameghino.

PERINATAL LAMB MORTALITY IN THE CENTRAL SIERRA OF PERU

Perinatal lamb mortality is one of the major factors in impairment of productivity of sheep raising enterprises around the world. In a study conducted by the SR-CRSP scientists at Colorado State University and San Marcos University, Lima, Peru, perinatal mortality on one of the largest sheep raising enterprises in Peru was measured over a 10 year period. Between 1971 and 1980, a total of 603,694 lamb births was recorded. Mortality during the first 3 days of life was 37/1000 births and for the period from 4 to 30 days mortality was 6/1000. Non-infectious conditions such as the weak lamb syndrome, accidents, injuries, and starvation were the leading causes of mortality. Diseases of infectious cause were second in importance, but may have been underdiagnosed. Most of the mortality occurred during the first 3 days of life and was usually related to nutritional, environmental, and management factors. During the remainder of the first month of life, deaths from infections predominated, accounting for 60% of mortality from 4 to 30 days.

The low rate for perinatal mortality in lambs in Peru may be attributed in part to excellent management conditions under the pastoral-shepherd system employed on the cooperative. The innate resistance of the Junin breed of sheep, developed locally, may also have been a factor in lowering mortality.

Clearly, the pattern of perinatal lamb mortality in Peru as well as elsewhere in the world leads one to conclude that the problem is multifactorial in nature, caused by interaction of a variety of nutritional, infectious, genetic, management and environmental factors early in life. Prevention will depend on identification of specific risk factors which lead to the development of the weakened lamb. Intervention programs must then be developed and evaluated under controlled conditions to determine whether the patterns of mortality can be altered.

Collaborating scientists were J. DeMartini, Enrique Ameghino and John Reif.

CLOSTRIDIUM PERFRINGENS TYPE A
AND ENTEROTOXEMIA IN ALPACA

Clostridium perfringens Type A enterotoxemia constitutes the most important acute infectious disease in neonatal alpaca and llama. Type A enterotoxemia occurs mainly within the first month of life frequently in an outbreak in which the mortality rate may reach 50 percent. This disease is observed as a toxemic syndrome resulting from enterotoxin produced by Clostridium perfringens during the active sporulation phase which is then released into the small intestine. This enterotoxin has been reported in food poisoning in humans and type A enterotoxemia in other domestic animals.

Peru has 80 percent (4 million) of the total camelid population in the world. The camelids are managed by approximately 200,000 peasant families and are considered a unique, reliable economical livestock activity for the Andean population which inhabits the harsh highland (above 11,000 feet). Therefore, the occurrence of type A enterotoxemia causes a socio-economical impact on the activities of the alpaca producers especially on the small holder who raises alpaca with very little knowledge of modern animal husbandry techniques.

Alpaca and llama raising has a dual purpose: fiber and meat production. A supplemental activity is represented by the fur industry. The alpaca fiber possesses high textile value, with a price estimated to be four times higher than sheep wool and constitutes one of the primary livestock export products for Peru. During the last decade alpaca producers underwent enormous losses as a consequence of type A enterotoxemia. In 14 (82%) of 17 associative enterprises in which inquiries were made, mortality rates were reported from 26-70.2%. These unexpectedly high rates might be attributed to enterotoxemia. A similar picture was observed for alpaca mortality rates of small owners (17.8 - 50%) Within the epidemiology of alpaca enterotoxemia, the weather factors, principally heavy rainfall, have to be mentioned as an important component on the modification of the ubiquitous biology of C. perfringens type A, and the susceptibility of the neonatal alpacas.

Studies on type A enterotoxemia in alpacas have been focused on the characterization of the enterotoxemia from C. perfringens type A isolated from enterotoxemic alpacas in Peru. This involves the production, purification, serological detection and biological activity of type A enterotoxin in alpacas as a primary animal model. From this point, the development of sensitive and accurate tests for detection of both enterotoxin from enterotoxemic alpacas and from sporulating type A cultures as well as detection of antibodies against enterotoxin from infected animals have been considered priority activities. Further studies will be concentrated to define the mechanism of pathogenesis of enterotoxin in alpaca.

During the last few years it has been possible to conduct several experiments on purification of type A enterotoxin and its detection with serological tests, and biological assays as well as experimental inoculation of cell-free type A cultures in alpaca. Using reference enterotoxin (Food and Drug Administration, Washington, D.C.) and a C.

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perfringens type A strain (University of Massachusetts) it was possible to identify the electrophoretic profile of type A enterotoxin from alpaca strains on SDS-PAGE. The production of rabbit anti-enterotoxin allowed us to develop the serological tests which were used to evaluate the purified toxin and to detect enterotoxin from sporulating cultures of type A.

These tests will be used in the future to define the pathogenesis of enterotoxemia in alpacas, and to assay preventative measures against further outbreaks of enterotoxemia.

Collaborating scientists on the program were Antonio Ramirez and Dora Human of San Marcos University and J. DeMartini and Robert P. Ellis of Colorado State University.

PROGRESS ON COLIBACILLOSIS (DIARRHEA)
IN BABY ALPACAS

Alpacas represent the major meat and fiber producing animal for people living in the high Andes at altitudes above 11,000 feet. Major causes of death among any baby animal are diarrhea and pneumonia. For the past three years, we have been investigating the bacterial causes of diarrhea in baby alpacas. Prior to our studies, E. coli as a cause of alpaca diarrhea had not been investigated.

Beginning in the birth season of 1982 (January-April), many strains of E. coli were isolated from baby alpacas with diarrhea. From the 100 strains isolated, twenty were selected for baby alpaca intestinal studies. From these studies, it was evident that eight strains (40%) were definitely capable of causing diarrhea, 8 (40%) were probably capable of causing diarrhea, and 4 (20%) were negative.

Further studies were done to define the identity of the particular strains of E. coli which were isolated. Fifty strains were imported into the U.S. (Colorado State University). These strains were serotyped (at Pennsylvania State University) and assayed for enterotoxin production. Seventy percent of the isolates were serotyped. None of the serotypes was commonly found in other animals. In fact, they were more similar to serotypes found in humans. None of the isolates produced enterotoxins currently found on other E. coli which cause diarrhea in man and other animals (sheep, pigs, cattle and horses).

We are currently preparing to continue our studies in the alpaca and sheep in Peru. We will infect some young alpacas and lambs, and bring samples of their intestines back to CSU for electron microscopic studies. This will allow us to determine which strains are colonizing, or attaching, to the small intestinal wall and causing diarrhea. From this point, we will define the method by which attachment occurs, and develop diagnostic tests for detecting attachment.

Our ultimate goal is to be able to quickly and accurately detect diarrhea-causing E. coli in alpacas, and to produce methods of preventing such diarrhea in the future through adequate management programs. Management may include vaccination against the specific strains of E. coli which are the most common causes of alpaca colibacillosis.

Collaborating scientists in the program were Dr. J. DeMartini and Robert P. Ellis of Colorado State University and Antonio Ramirez and Dora Human of San Marcos University.

**Sociological Analysis of Small Ruminant
Production Systems
M. F. Nolan
University of Missouri, Columbia**

LOCAL RESOURCE MANAGEMENT SYSTEMS WORK

While donor agencies have had difficulty developing programs for protecting rangelands, there are a number of indigenous institutions that have successfully managed their pastures for hundreds of years. These systems may offer guidelines for the implementation of modern range management projects.

Field studies of a three centuries old traditional pasture management system in Morocco funded by the Small Ruminants Collaborative Research Support Program (SR-CRSP) and conducted by researchers from the University of Missouri-Columbia (UMC) and the Institut Agronomique et Veterinaire Hassan II (INAV) in Rabat, Morocco, are contributing to the understanding of how to organize pasture conservation.

Data are being collected from a number of pasture protection areas in the High Atlas mountains of Morocco known as "Agdals." These systems are simple, inexpensive to manage and often protect the environment. Research is being conducted to identify the characteristics of successful pasture conservation systems as opposed to those which are in decline. One of the interesting findings to date is that traditional systems rely less on the regulation of animal numbers and more heavily on regulating the length of the grazing season than do typical range management projects. Such a system can protect the environment and is more acceptable to pastoralists.

Although the present study examines a traditional Moroccan institution, the results of the study used in conjunction with the existing scientific literature on pastoralism may contribute to the solution of pastoral development problems in the rest of North Africa, in Asia, Sub-Saharan Africa and Latin America.

Collaborating scientists in this research were: Abdallah Hammoudi, Mahdi Mohammed, Jere Lee Gilles and Lloyd Mendes.

LIVESTOCK PRODUCERS IN PERU

About half of Peru's rural population are members of legally recognized Peasant Communities, located throughout the slopes and valleys of the Andes. While it has been known for some time that the production of Small Ruminants, particularly sheep and alpaca, are a vitally important part of the production systems of many peasant communities, it was often assumed that most of the animals were concentrated primarily in the hands of livestock peasants.

Through support of the SR-CRSP, rural sociologists at the University of Missouri together with the staff from Peru's Direccion de Comunidades Campesinas y Nativas have been engaged in a re-analysis of a study of 2716 of Peru's peasant communities conducted by the Peruvian government in 1977. This is a unique data source, since no other study has managed to conduct a systematic survey of such a large number of these rural Andean institutions. One of the first questions that was hoped could be answered was that of the importance of mixed livestock and crop producers for the national livestock picture.

Early findings suggest that less than a third of the sheep held by Peruvian peasants are found in primarily livestock producing communities, while about half of the alpaca are found in these communities. The remaining two-thirds of the sheep population and half of the alpacas are located in communities of mixed agricultural and livestock producers. These "agro-pastoralists" also control about three-fourths of the land in potato and corn production.

The importance of these findings lies in the fact that the agro-pastoral producers have a very different set of physical, economic, and social constraints than do those who are only involved in livestock production. While Andean livestock communities are usually found at altitudes above 13,000 ft., typical agro-pastoral communities tend to be found at "lower" altitudes, between 8,000 and 13,000 ft. Since they are also intensively engaged in two very different productive activities, their labor needs and availability can also be very different from those involved only in livestock production. Women often have primary responsibility for livestock in agro-pastoral communities, while men tend to take the lead with crops.

Those living in peasant communities differ from private farmers in that most of their pasturelands are held in common, and many of the production decisions are made in community assemblies. Although each household is assigned its own plots and owns its animals, much of the work involves the coordination of several households.

Besides its work with universities on experiment stations, the SR-CRSP in Peru is currently involved in validating technologies for eventual use in agro-pastoral and livestock communities. Two teams of field workers are living in an agro-pastoral and a livestock producing community. They are collecting detailed information on aspects of livestock production in these two very different kinds of production systems.

Collaborating scientists in this research were: Jose Portugal,
Keith Jamtgaard and Mike Nolan.

SOCIO-ECONOMIC ANALYSIS BECOMES PART OF LDC AGRICULTURAL RESEARCH PROGRAM

When the SR-CRSP was formed in 1978, rural sociology and agricultural economics were made an integral part of the program. The University of Missouri-Columbia, Department of Rural Sociology and Winrock International were, respectively, assigned responsibility for these two disciplines. As the program developed and counterpart LDC institutions were identified it quickly became apparent that one problem which would be faced by the sociologists and economists was the lack of counterpart scientists in their fields in the institutions selected. This was not surprising inasmuch as most of the LDC collaborating institutions who agreed to participate in the SR-CRSP were, at the core, agricultural research and/or livestock research oriented.

While there were differences in the extent to which socio-economic studies were "welcomed" in the five SR-CRSP sites, by 1984 the value of these studies had become apparent to LDC scientists and research administrators. This manifested itself in the creation of new socio-economic research units within the agriculture/livestock research organizations with which the SR-CRSP is working. One good example of this is EMBRAPA's National Goat Research Center in Brazil which has created a new socio-economic evaluation unit within the Center. Currently it is staffed by a professional agricultural economist who receives technical support from the SR-CRSP/Winrock economics project. A sociologist for this unit is expected to be hired in 1985. A similar situation existed in Kenya. The research division of the Ministry of Agriculture and Livestock Development formed a new socio-economic unit, recruited and hired both an economist and sociologist who worked as counterparts to resident SR-CRSP scientists. Both the sociology and economics SR-CRSP projects are now sponsoring those counterpart scientists for doctoral studies at U. S. universities. Similar developments have also occurred in Peru.

In Indonesia the projects have worked with Central Research Institute for Animal Science to strengthen and expand its socio-economic unit. This has been done through graduate training, research support, technical assistance and microcomputer acquisition.

While the role of sociology and economics in the SR-CRSP is primarily to provide information and evaluate consequences of interventions in SR production systems, it now seems clear that one of the most important outputs of the projects will be the creation of units within agricultural research organizations which will be able to provide this same information and feedback to LDC researchers even after the SR-CRSP has run its course. That may well prove to be the most important legacy of these projects.

Collaborating scientists in this research are: Kedi Suradisastra and Agus Muljadi of Indonesia; Mkonge Nbabu and Fanny Nyaribo of Kenya; Christina Espinoza, Lidia Jimenez, Domingo Martinez and Corrine Valdivia of Peru; and John DeBoer, Hank Knipscheer, Keith Jamtgaard, Eric Reynolds, Mike Nolan, Mark Gaylord and Nestor Gutierrez of the U.S.

MICROCOMPUTERS AND RESEARCH PRODUCTIVITY

It has long been recognized that one of the major impediments to quantitative research productivity in developing countries is the lack of access by researchers to modern computing technology. Either the country lacks such facilities altogether or they are organized to serve administrative (not research) needs. In either case, the ability of researchers to perform complex statistical manipulations on large data sets is severely limited.

Beginning in 1982, the SR-CRSP/Indonesia program made significant investments in microcomputer hardware, software and staff training. Microcomputers, as contrasted to mainframe computers, are relatively inexpensive, easy to operate and less susceptible to climatic (e.g. heat, humidity) "stress" than their larger cousins. In the last five years they have also become increasingly powerful and can now handle complex tasks and large data sets with relative ease.

This small investment quickly revolutionized the approach SR-CRSP counterpart scientists, located in the Central Research Institute for Animal Science (CRIAS), took to research and analysis. Instead of traveling 40 miles (one way) to Jakarta and having to wait hours (or even days) for a computer run to be completed on a mainframe computer in the Ministry of Agriculture, scientists could schedule a session on one of the microcomputers purchased by the SR-CRSP and accomplish as much in one day as might have taken two weeks previously.

The Indonesia experiment proved so successful that microcomputers have now been purchased for every SR-CRSP site, with an effort to maximize hardware compatibility among sites to allow for the sharing of software and data.

Based on this experience, SR-CRSP scientists feel that, over time, the microcomputer revolution, which is now well established in the U.S., may prove to be an even bigger agent of change in the developing world. Clearly, it has already had a major impact on the lives of biological and social scientists working with the SR-CRSP in Peru, Brazil, Kenya, Morocco and Indonesia.

Collaborating scientists in this research were: Kedi Suradisastra, Agus Muljadi, Mike Nolan and Henk Knipscheer.

INCA AND WESTERN VETERINARY MEDICINE COMPARED

Veterinary beliefs among the modern-day Inca -- the Quechua Indians of Peru -- formed the subject of comparative studies by the Rural Sociology component of the Small Ruminant CRSP. Folk diagnoses, etiologies and techniques for treatment and control of herd diseases were documented by University of Missouri-Columbia social scientist Dr. D. M. McCorkle. These ethnoveterinary concepts and practices ran the gamut from supernatural ones such as "evil winds" and invading spirits, through 16th-century Spanish notions like "hot" versus "cold" diseases, to naturalistic explanations, e.g. dirty corrals, contaminated drinking water, and loco-weed poisoning.

These native descriptions of animal ills and their clinical signs, causes, cures, and prevention were next "translated" into the scientific terminology of Western veterinary medicine, and then their accuracy was assessed. This was not an easy task, because ethnomedical systems worldwide -- whether Western or non-Western, human or animal -- generally name and diagnose diseases by their symptomology. But armed with its sophisticated microscopes, chemical tests, advanced autopsy procedures, and etc., medical science instead classifies diseases by their causes, i.e. etiologically.

The result is that a single symptomological folk category often spans a wide variety of diseases which are quite distinct in scientific taxonomies. For example, qicha 'diarrhea' in Andean herds may correspond to some six different ills arising from varying bacterial and parasitic infections. Or, to take another example closer to home, "flu" in the human population of the U.S. may gloss any number of etiologically distinct ailments. Conversely, focusing upon only one among a syndrome of symptoms, the scientifically "same" disease is sometimes assigned to different categories. To illustrate, in the Andes, erratic behavior among sheep may be variously ascribed to plant poisoning, coenurosis, or "evil winds."

Sorting out and interrelating the two systems of veterinary medicine -- folk and scientific -- is an important part of efforts to improve animal health and, with it, herd productivity and herd owners' economic and nutritional well-being. Developers will be unable to communicate useful veterinary knowledge from the Western, scientific world to native stockraisers if this knowledge is not first translated into the appropriate ethnoscientific idiom. Otherwise, as the SR-CRSP and other projects have documented, new techniques run the risk of being feared, misunderstood, and misapplied by the very people they are designed to benefit.

Moreover, some ethnoveterinary techniques have real curative and preventive value. For example, McCorkle found that Quechua Indians achieve a 100% cure rate of contagious keratoconjunctivitis among their sheep -- even though they often ascribe this ailment to supernatural causes and therefore take curative measures which include magical, as well as more strictly medical, elements. Andean stockowners are also frequently successful at curing manges among their llama and alpaca. And, there is evidence that some items in the indigenous pharmacopoeia

are useful, e.g., in assuaging diarrheas or preventing ectoparasitic infestation. In this latter regard, in one of its community studies in Peru, SR-CRSP is currently experimenting with using a local medicinal herb to prepare cheap but workable prophylaxis for ovine ectoparasites. This sort of bottom-up approach to veterinary development provides another illustration of the usefulness of ethnoscientific research in focusing development efforts on cost-effective and truly "appropriate" technology interventions.

Following up these baseline investigations in ethnoveterinary science, the SR-CRSP Rural Sociology component next plans to examine the incidence and spread of animal diseases as these relate to herd management practices in the Andes. To tackle this problem, a concerted, interdisciplinary approach is required. To this end, McCorkle will return to Peru in company with Dr. M. D. Salman, an SR-CRSP veterinary epidemiologist at Colorado State University. Working in tandem with Peruvian social and veterinary scientists, they hope to set up a longitudinal program to explore the complex links among small ruminant ills, animal husbandry practices, and the limitations on third-world stockowners' social, economic, and technological resources.

Collaborating scientists in this research were: Jorge Flores, Lidia Jimenez, Constance McCorkle and Mojak Salman.

MANURE IMPORTANT LIVESTOCK PRODUCT IN ANDES

Manure is a primary small ruminant production emphasis among most stockraisers in highland Peru, report SR-CRSP researchers from the University of Missouri-Columbia's Rural Sociology project. The majority of Andean peasants who keep small ruminants (sheep, llama, and alpaca) practice intensive agriculture in addition to their pastoralism. In fact, they produce the bulk of this South American country's staple food crop, potatoes. "But," say Andean cultivators, "without the fertilizer that the manure from our animals gives us, we would have no potatoes." Independent research by soil scientists working in Peru confirm this view; and SR-CRSP findings indicate that typically Andean peasants require about a ton-and-a-half of manure annually for their fields.

The manure to be used as fertilizer is collected and stored in the corrals where herds are quartered each night. When the planting season arrives, the year's manure production is sacked up and carried out to the fields, where it is mixed into the earth as the potatoes are sown. Animal droppings also serve to replenish the soil during other parts of the year, when herds graze on the fallow fields, naturally manuring them. At certain times, herds also utilize the high-altitude (+4250 m) rangelands where agriculture is impossible. By so doing, the animals render the plant resources of this otherwise nonproductive biome useful for agriculture. Ruminants process the tough Andean grasses into precious fertilizer, and even obligingly transport it down to the croplands below.

In addition to its critical role in Andean agriculture, manure is important in other ways. Most notably, in the frosty, treeless heights of the Andes, animal dung constitutes nearly the sole source of cooking and heating fuel. And, it is a useful construction material in mixing mortars for adobe houses and corrals. Indeed, so valuable is this small ruminant product, that, in addition to being bought and sold, in many Peruvian communities the manure itself can be used in almost the same fashion as money -- to pay wages for agricultural labor, to rent extra land for cropping, or to lease a corral. It is even exchanged as a gift among friends and relatives!

Westerners are apt to overlook the importance of manure in peasant economics because we are accustomed to value animals for other products instead -- meat, milk and cheese, wool, or leather. Andean peasants naturally value these items, too. But fuel and fertilizer form part of the "bottom line" of human existence in the harsh, cold sierra environment. Since peasants there have almost no source of fuel other than dung, and since they can seldom afford to purchase chemical fertilizers, this critical resource understandably tends to overshadow other small ruminant products in significance.

The "bottom-line" importance and the multiple uses of manure in the Andes help to explain one behavior which has puzzled some researchers -- peasants' seemingly irrational reluctance to slaughter aged, ailing, or otherwise unthrifty animals. Instead, peasant stockowners maintain disproportionately large numbers of animals who are well past their reproductive prime and their meat-, milk-, or fiber-producing peak.

But, these same animals do continue to produce desperately needed manure! While this is not the only reason for peasants' conservative culling practices, it is certainly one of the principal considerations.

In sum, the essential importance of this small ruminant product to human survival in areas like the Andes sometimes tempts one to wonder: should development efforts shift their focus away from breeding bigger and better meat-, milk-, or wool-producing animals to instead creating a specialized manure-giving race of ruminants? While this speculation is here made somewhat tongue-in-cheek, the main point should nevertheless be clear: the role of this humble animal product in non-Western economics must be carefully assessed before development plans are laid.

Collaborating scientists in this research were: Lidia Jimenez, Jorge Flores, Mario Tapia, Constance McCorkle, Keith Jamtgaard and Mike Nolan.

WOMEN AND SMALL RUMINANTS

For the past four years studies designed to assess the roles of women in small ruminant production have been undertaken by the Small Ruminant CRSP Rural Sociology Project in Kenya, Indonesia and Peru. Working closely with local social scientists, University of Missouri rural sociologists have demonstrated that women have major responsibilities for sheep/goat production and often make major management decisions as well.

In Peru, women (and children) are the persons most often responsible for the management of family flocks. Men, by contrast, spend a disproportionate amount of their time in the production of food crops.

Indonesian women share responsibilities for providing feed for sheep and goats which are raised in small flocks (4-5 animals) under intensive management conditions. They also play significant roles in treating health problems and taking animals to market.

The situation in Western Kenya is more complicated as women, in many cases, are the heads of farm households. Traditionally, it has not been culturally acceptable for women to care for livestock, except poultry. However, this tradition is undergoing rapid change and more and more women farmers are expressing strong interests in raising the dual purpose goats which are being developed for that region.

All the research results point to the need to explicitly recognize the important contribution women make to small ruminant production. As the SR-CRSP evolves to a point where serious efforts are made to transfer new technology to small ruminant producers, special care will be given to insure that the "real" farmer is the one who is taken into account as new ideas are tried. Host country collaborating scientists in this effort have included: Lidia Jimenez and Christina Espinoza of Peru; Sri Wahyuni and Kanta Damanik of Indonesia; Amanda Noble, Constance McCorkle and Michael Nolan of the University of Missouri.

Evaluation and Genetic Improvement of Small Ruminants
in Extensive Management Systems.

R. L. Blackwell

Montana State University

POTENTIAL IMPACT OF GENETIC MANAGEMENT ON ANIMAL PRODUCTIVITY IN THE ANDEAN REGION

The animal breeding research in Peru indicates substantial improvement in productivity can be attained by effective utilization and management of the genetic resource. The sheep population of the Andean region of South America is composed of the unimproved Criolla animals, improved breeds that have been introduced in recent decades, and a locally developed breed (Junin) in the central Andes of Peru. The Criolla sheep are in the majority throughout the region; in Peru they outnumber the improved breeds by a ratio of at least 4:1. Most of these Criolla sheep are in the hands of the Campesinos where management practices and environmental conditions are limiting.

Montana State University breeding research in collaboration with Peru's National Agrarian University and SAIS Tupac Amaru in the central Andes made direct comparisons with the Junin, a sample of the Criolla sheep, and the F_1 cross (Junin x Criolla). Two measures of productivity, yearling body weight and fleece weight, were used in the evaluation. The results show the Junin were 13 kg heavier and produced 1.1 kg more grease wool than the Criolla. This is a 46 and 98 percent superiority in favor of the Junin.

The comparison between the Junin x Criolla with the average of the two parental types (midparent) provides an estimate of heterosis. The percentage superiority of the F_1 over the midparent average was 12.6% for yearling weight and 28.7% for fleece weight. The implications of these findings for sheep improvement in the Andean Highlands is a substantial increase in meat and wool production from the Criolla population. Assuming a modest 15% offtake from the twelve million Criolla sheep, the 10 kg increase in yearling weight of the F_1 , results in a conservative estimated increase in carcass meat of approximately 8,000 metric tons. The increase in wool production in the F_1 as projected in wool per head will accrue to all the 12 million F_1 's that would replace the Criollas. The projected increase in productivity assumes, of course, the level of management and other productive inputs equal to those of SAIS Tupac Amaru.

Direct comparisons between the Junin and the Corriedale shows that there is little genetic difference between the two breeds. These improved stocks of sheep now residing in Peru provide the essential genetic nucleus available for grading-up the Criolla.

The substantial heterosis observed provides encouragement in the effort to improve the Criolla. First it provides an immediate increment in productivity above that expected in the first cross. Successive back crosses to the improved breeds (Junin or Corriedale) should continue to enhance productivity potential of these sheep and bring them to the level of the improved breeds. The heterosis effects are expected to diminish with additional backcrosses. This is of no great concern, however, since the aim is to improve the national flock. Hence the Criolla should be gradually replaced by improved, graded-up animals.

Collaborating personnel in this research were: Manuel Carpio, Ben Quijandria, Peter Burfering, Gladys Huapaya, Prospero Cabrera and R. Blackwell.

ACCEPTANCE OF PERFORMANCE TESTING PROCEDURES

The concept of objective measurement of animal phenotypes for purposes of evaluation and selection is fundamental to genetic improvement of animals. Procedures for measuring, recording and using this type of information to make management decisions is commonly referred to as performance testing. The breeding project in Peru has emphasized the importance of this concept. The development of useful, yet simply applied methodology for performance testing has been an important component of the project.

Success, measured in terms of acceptance and application of the procedures, has been reasonably good. This is particularly true in the Altiplano area near the Chuquibambilla Research Station operated by the National Technical University of the Altiplano (UNTA). This station has land, animals and other physical resources for research. Most important, however, is the dedicated personnel with whom we work at this location. Holando Alancastre, who is in charge of the research program at the station, has put in place the performance test program. Located in an important livestock producing region, the station has close contact with many farms that produce breeding stock. Farm managers have requested assistance in the application of performance testing procedures to their enterprises. The UNTA personnel at Chuquibambilla are providing outstanding leadership through training, advising and demonstrating performance test procedures with some support from the MSU breeding project, primarily through the Site Coordinator. Presently five or six farms are directly involved in this activity with UNTA, where more than 3500 animals are being tested for growth and wool production.

Additional personnel and other resources are needed to deal effectively with more farms and more animals. The potential for beneficial impact on animal agriculture has been recognized by farmers and agricultural leaders alike. This low cost, effective technology, supervised by university personnel working directly with SR-CRSP, is being accepted as a useful tool in livestock production. This illustrates again the benefits of the combined role of teaching, research and extension in a university that is located in close proximity to the industry it serves.

Collaborating personnel in this research were: Ben Quijandria, Manuel Carpio, Rolando Alancastre, Gladys Huapaya, Prospero Cabrera, Peter Burfening and R. Blackwell.

PROLIFIC SHEEP IN THE ANDES

Low reproductive rates in sheep is a serious production limitation in the Peruvian highlands. Twinning is rare and a relatively high percentage of ewes fail to lamb. The Finnish Landrace breed is noted for its high prolificacy (multiple births). Ewes with 25 percent Finn genes produce 15-20 percent more lambs than Targhee, Columbia or Rambouillet ewes under Montana range conditions.

Finn genes were introduced to Peru via Finn x Targhee rams (50% Finn) along with straight Targhee rams to evaluate the effect of Finn genes on reproductive performance in the environment of the Andean region. The first daughters of these Finn sires from Junin dams have produced two lamb crops. Although there was a small increase in natural ovulation rate at mating time in the quarter Finn ewes they did not have higher twinning rates. Genetic differences for prolificacy resulting from the substitution of 25% Finn genes failed to produce the expected increase in prolificacy. This suggests that the high altitude environment of Peru masks the effect of this genetic diversity, resulting in a classic genotype by environmental interaction. No specific evidence for this failure of the prolific genotype to be expressed is available from this research.

A second aspect of the reproductive problem in Peru, that of ewe fertility, was addressed in this project. Ewe fertility was quantified by the percentage of ewes lambing. Three genetic groups of ewes were produced--100% Junin, 50% Targhee-50% Junin and 25% Finn-25% Targhee-50% Junin. The lambing rates were 74% for the Junin, 33% for the half Targhee and 87% for the quarter Finn ewes. The ewes were 2 and 3 year olds. Lifetime reproductive rates may differ. However, if these results are confirmed with additional data the increase in fertility of the 25% Finn ewes will be of economic significance. The very poor performance of the 50% Targhee ewes is surprising because the breed is considered to be reasonably high in fertility under Montana range conditions. Therefore, this may be another indicator of problems that could be expected when importing an unadapted breed to the severe environmental conditions of the Andes.

Collaborating personnel in this research were: Manual Carpio, Maximo Gamarra, Gladys Huapaya, Prospero Cabrera, Peter Burfening and R. Blackwell.

MATERNAL EFFECTS CREATE PROBLEMS IN SELECTION FOR GROWTH

As part of the SR-CRSP breeding project in Peru records from the Montana Agricultural Experiment Station have been analyzed to investigate genetic parameters in sheep populations. This research sponsored cooperatively by the MAES and USAID at Montana State University has identified negative genetic correlations between direct and maternal effects for growth traits in sheep. The existence of this negative genetic correlation will adversely effect progress from direct selection for growth rate.

This research centered on the relationship between direct genetic effects--those associated with individual animal genotypes for growth rates--and maternal effects--those associated with the genotypes of the female that affect her mothering ability. Heritability estimates for direct effects were near 20 percent for both birth weight and weaning weight. The heritability estimates for the maternal component of birth weight and weaning weight were approximately 30 percent. However, the genetic correlation between the direct and maternal effect was large and negative. The interpretation of these results are as follows.

If we select directly for weaning weight or rapid early growth rate we can expect some progress. However, the negative correlation between the traits indicates that progress from direct selection for early growth rate will be dampened by the existence of the negative correlation with maternal genotype that affects the weaning weight through the preweaning maternal environment. That maternal component could possibly be the level of milk production. As a result the net response, measured in terms of pounds of lamb weaned in the total system, will be reduced even though we improve genetic merit for growth rate of lambs by direct selection.

These results indicate that a more complex breeding system is needed if we are to improve genetic merit for both growth rate and maternal ability. One solution is to obtain or develop lines of sheep which have high genetic potential for maternal ability, probably milk production (dam lines), to be mated with lines of sheep with high genetic potential for growth rate (sire lines). The resulting offspring should be able to capitalize on their genetic merit for rapid growth rate in a high level maternal environment.

Data from the Peru breeding project will be available soon to obtain independent estimates of these population parameters in the environment of the central and southern Andes.

Collaborating personnel in this research were: Gladys Huapaya, Prospero Cabrera, Peter Burfening, Don Kress and R. Blackwell.

USE OF INTRODUCED BREEDS TO IMPROVE PRODUCTIVITY OF LOCAL SHEEP IN THE ANDEAN REGION

The high elevations at which sheep are raised in the Andean region imposes a severe restriction on their production. Local stocks which have been raised in the environment for many decades apparently have developed an accommodation to those environmental conditions. The University of California and Montana State University in collaboration with the Colombian Institute of Agriculture investigated production levels and breed adaptability using data collected in Colombia over a 16 year period. Four introduced breeds (Rambouillet, Corriedale, American Romney and the British Romney) and the local Criolla were compared. Great variability between breeds exist in reproduction, growth, fiber production and survivability. The introduced breeds tended to excel in growth rate and wool production relative to the Criolla. However, production levels were much lower for the introduced breeds in Columbia than in the country or region of origin. In comparing the breeds on the basis of weight of lambs weaned per ewe in the flock at breeding time, the Criolla ranked a close second in spite of its low growth rate. This trait combines reproductive rate, growth rate and survival.

Success in reproduction and survival is a good measure of adaptation. In this instance the Criolla sheep were generally the highest in ewe fertility and in lamb survival. Apparently the recently introduced breeds had not yet adjusted to the high elevation environment although the project had been in progress for at least 16 years. Testing is essential. The evaluation should include their merit in crossbreeding and grading up of the local stock. Even that method may not achieve the ultimate potential immediately. Crossbred Targhee x Junin ewes in the Peruvian Andes have demonstrated low reproduction, indicating a poor immediate adaptation. This finding suggests greater attention needs to be given to selection within the indigenous populations or within crossbred sub-populations that contain genes of both the local and the exotic breeds.

Collaborating personnel in this research were: Manuel Carpio, Maximo Gamarra, Ben Quijandria, Gladys Huapaya, Prospero Cabrera, Peter Burfening and R. Blackwell.

Goat and Sheep Nutrition and Feeding Systems
Research in Northeast Brazil, West Java and Morocco
W. L. Johnson
North Carolina State University

FEEDING LAMBS IN THE DRY SEASON WITH CORN RESIDUE BASED DIETS

Santa Inez and Morada Nova lambs have made excellent gains on diets containing up to 50% of corn stover, the residue which remains after harvesting ears for grain, in trials at EMBRAPA's National Goat Research Center in Northeast Brazil. Average gains of 93 to 129 grams per day were obtained in a series of experiments with the two breeds of tropical hair sheep. These trials have been conducted during the prolonged dry season in this semi-arid climate, at a time of year when the normal feed source for sheep, a "Caatinga" brush rangeland, stops growing. Under normal conditions weanling lambs will grow very little and may lose weight and even die if not supplemented.

The first trial, conducted in 1980 by EMBRAPA researchers with support from North Carolina State University nutritionists as part of the Small Ruminant CRSP, showed not only good lamb gains and excellent health, but also a carcass yield of 52%. The diet, offered to lambs in total confinement, consisted of 51% ground corn stover, 28% cottonseed cake, 20% ground corn grain, and 1% iodized salt.

Attempts to formulate a cheaper diet were made in subsequent years. In 1981 it was shown that up to 15% of the diet could consist of ground "mata pasto," a native legume, as a replacement for part of the cottonseed cake, which must be purchased. This is an important finding, because farm surveys have shown that producers will not readily adopt a practice that requires cash outlay. Gains averaged 93 to 106 grams per day with varying levels of mata pasto in the diet, compared to a loss of 11 grams per day for a similar group of lambs grazing Caatinga without supplemental feeding. The following year a second legume meal was tested. "Cunha" (*Clitoria ternatea*), an introduced legume which has passed agronomic trials with flying colors, was harvested in the wet season, dried, ground, and used to replace 100% of the expensive cottonseed cake. Average daily gains were 102 grams. In this same experiment, matapasto was again used successfully as 14% of the total diet, but when it was included at 28% (replacing all of the cottonseed) lamb gains dropped by one-half.

In 1983 this research had to be suspended due to the extreme drought, which prevented farmers from planting corn. In 1984, however, the rains were normal and corn stover was again available. Research resumed, this time for a cheaper energy source to replace the corn grain. Sorghum grain, cassava meal, and algaroba pod meal all appear to be satisfactory replacements for the corn grain; the choice of one of these energy sources can therefore be based on cost and availability. When the diet consisted of only ground corn stover and cunha meal (equal parts, with 1% salt added) animal performance was slightly less than when one of the above energy concentrates was used.

Dry season confinement of lambs in climates similar to Northeast Brazil can save up to six months in reaching market weight, at the same time sparing limited range feed resources for maintaining the adult breeding flock.

Participating personnel in this research were: Nelson Barros, Ederlon Oliveira, Francisco de Assis Arruda, K. P. Pant, and Jose W. dos Santos for the National Goat Research Center in Sobral, and W. L. Johnson, T. W. Robb, and Jorge Kawas for North Carolina State University.

CORN RESIDUE BASED SUPPLEMENTS FOR WEANING KIDS IN THE DRY SEASON

Goats in Northeast Brazil usually graze or browse native "Caatinga" brushland vegetation with little or no supplement even when the dry season becomes severe. Young kids suffer most in this situation, because their dams' milk dries up and they themselves are still too small to consume sufficient nutrients from the Caatinga leaf litter.

EMBRAPA and North Carolina State University nutritionists, with support from the Small Ruminant CRSP, have been searching for ways to improve kid growth. In 1981 a representative group of kids of the native "SRD" breed were allotted diets containing 51% corn crop residue plus 28% cottonseed cake, 20% ground corn grain, and 1% iodized salt, fed in confinement. The kids gained an average of 38 grams per day, while a companion group grazing in the Caatinga lost 25 grams per day or failed to survive. Replacing part of the confinement ration with chopped green napier grass did not influence the results.

While these results were encouraging, it was felt that gains might be even better if intake could be improved. The following year, therefore, further innovations were tested. Molasses was added as 5% of the diet; intake did improve, but daily gains remained at 37 grams. The level of corn stover was reduced to 30%; intake was no better and gains were actually lower (29 grams per day). However, when both changes were made at the same time, results were significantly better. Gains increased to 48 grams per day with 40% stover and 5% molasses, and jumped to 61 grams per day with 30% stover and 5% molasses.

The biggest surprise came with a group of kids which were fed the 30% stover, 5% molasses diet, and were also allowed to graze or browse in the Caatinga for several hours each day. The intake of the stover-based diet was the same for these kids as for the group receiving the same diet in total confinement, but their daily gains increased to 72 grams. For reasons not readily apparent, the semi-confined animals had a higher digestibility of the dry matter and fiber in their diet.

It is therefore recommended that during the dry season in a semi-arid climate similar to Northeast Brazil, young growing goats should be offered a balanced ration in confinement daily, and also be allowed some time to browse in the native rangeland.

Participating personnel in this research were: Nelson Barros and Ederlon Oliveira for the National Goat Research Center in Sobral, and W.L. Johnson and T.W. Robb for North Carolina State University.

CULTIVATED FORAGES FOR FEEDING GOATS IN NORTHEAST BRAZIL

In the semi-arid Northeast of Brazil, where a prolonged dry season brings hard times for all livestock, animal nutritionists are constantly searching for economical alternative feed sources. With support from the Small Ruminant CRSP a series of experiments has provided some preliminary information about using cultivated forages for lactating or growing goats, which are the most susceptible to productivity dropoff during the dry season.

Two experiments were conducted at the state research farm in Paraiba. The first compared buffel grass hay and sorghum hay for lactating German Alpine and Anglo-Nubian dairy goats during the first 90 days of their lactation period. Without further supplementation, average milk yield was about 850 grams per day with buffel grass and 1,000 grams per day with sorghum. When 400 grams of corn was added to the basal forage diet, milk yield increased by 200 grams per day over buffel grass alone, and by 360 grams per day over the sorghum alone. In a second experiment a basal diet, chopped green sorghum forage fed to appetite plus 400 grams ground corn per day, was supplemented with 100 grams of one of three protein sources: cottonseed cake, jackbean meal, or a mixture of both. Replacing cottonseed cake with jackbeans, at any level, resulted in a 20% decline in milk yield.

Another experiment was conducted at EMBRAPA's National Goat Research Center in Sobral, Ceara. Four silages were compared in a trial designed to measure voluntary intake and forage digestibility. Cunha, a legume (*Clitoria ternatea*), was consumed at a higher rate but was less digestible than forage sorghum, whether harvested at an early or late stage of maturity. The net result was no significant difference among mean intakes of digestible dry matter from the early-cut cunha, late-cut cunha, early-cut sorghum, or late-cut sorghum.

For goat producers who can raise high quality forages with minimum cash input, the productivity of their herd can be improved by feeding these forages to their goats. Young, growing kids will get through the dry season in better condition if fed such a forage daily. If the farmer wishes to use his goats for milk consumption or for cheesemaking, feeding a high quality forage such as cunha or sorghum will help assure a profitable undertaking.

Participating personnel in this research were: W. H. Sousa for the Paraiba State Agricultural Research Agency (EMEPA); Heloisa Carneiro, M. Bezerra, F. Arruda and Luis Freire for the National Goat Research Center of EMBRAPA; T. W. Robb, Jorge Kawas and W. L. Johnson for North Carolina State University; Carlos Zometa, Jorge Kawas, and J. M. Shelton for Texas A&M University.

ENERGY SUPPLEMENTS ACCELERATE GROWTH AND PUBERTY IN FEMALE TROPICAL SHEEP AND GOATS

In every livestock production enterprise, the age at which puberty (first estrous) is attained will greatly influence overall lifetime productivity and economic return over rearing cost for the breeding herd. In a semi-arid tropical environment such as Northeast Brazil, puberty of sheep and goats can be delayed if their growth is interrupted during the prolonged dry season when native range feed resources are scarce.

A multidisciplinary research team at the National Goat Research Center in Sobral, in collaboration with nutritionists of North Carolina State University, conducted an experiment to see how energy intake could influence growth and puberty of ewe-lambs of the tropical Morada Nova hair sheep breed. Lambs were kept in confinement so that feed intake could be measured. A ground corn stover and corncob mixture was fed to appetite, and lambs were assigned to receive one of four levels of ground corn grain: 50, 200, 350 or 500 grams per animal per day. All lambs were also fed 105 grams of cottonseed meal per day, plus water and common salt. At the beginning of the experiment the lambs averaged 140 days old and 12.6 kg body weight.

Average rates of gain were 42, 49, 60 and 74 grams per day for the four levels of corn supplementation. Average weights at first estrous varied from 19 to 23 kg, and were not influenced by dietary treatment. Therefore there was a tendency for the lambs on the highest level of supplementation to reach puberty slightly faster than the others: 266 days of age for the highest level of corn, versus 296 days average for the other three groups. It is unlikely that the 30-day advantage in reaching first estrous will compensate for the additional cost of energy supplement. From this trial it was concluded that Morada Nova ewe-lambs should be fed a diet which will allow a post-weaning daily gain of at least 35 grams. They will then reach first estrous at nine to eleven months of age, weighing a minimum of 18 kg. Higher levels of dietary energy are not likely to accelerate age of first estrous sufficiently to justify the cost.

A second, larger experiment was recently started with native Moxoto goats, a small tropical breed used primarily for meat production. In this experiment 120 prepubertal doe-kids were placed in a typical "caatinga" brushland range area for daily grazing. The kids were divided into four treatment groups, one group receiving no additional supplement and the other groups receiving sorghum grain at either 0.6%, 1.2%, or 1.8% of body weight each day. This is a longterm experiment with several objectives, one of which is to investigate the effect of supplementation on the onset of puberty.

When the experiment started, about two months before the end of the dry season, the kids weighed an average of 11.3 kg. The group receiving no supplement lost about one kilogram before the rainy season forage became fully available, then recovered to a little more than their initial weight by two months into the rainy season. The groups receiving sorghum all avoided the late dry season weight loss; only the

animals on the highest level of grain managed to gain significantly before the rains started, however. Overall rates of gain for the first five months of the experiment were 4 grams per day for the zero supplement group and 8, 12, and 19 grams per day for the low, medium, and high levels of sorghum supplement, respectively. Very preliminary analysis of estrous observations indicates that animals in all three supplemented groups reached puberty an average of one month earlier than animals in the unsupplemented group.

These results, together, indicate the importance of adequate nutrition for female lambs and kids during their growth phase, to allow them to enter the breeding herd as early as possible.

Participating personnel in this research were: Nelson Barros, Ederlon Oliveira, Aurino Simplicio, Simon Riera (IICA consultant), Omar Sanchez (IICA consultant), Joao Ambrosio de Araujo Filho, and Eugene Johnson (IICA consultant) for the National Research Center in Sobral; W. L. Johnson, and Jorge Kawas for North Carolina State University; Warren Foote, and John Malechek for Utah State University; Harvey Olander for the University of California, Davis; and Maurice Shelton for Texas A&M University.

TREE LEGUME FOLIAGE CAN SUPPLEMENT LOW QUALITY FORAGE DIETS FOR SHEEP AND GOATS

Collaborative research on small ruminant feeding systems in Indonesia has demonstrated that low level supplementation with the foliage from legume trees can improve animal productivity, increase feed efficiency, and reduce feeding costs. The legumes can be fed as supplements to basal diets of lower quality crop residues, or native or cultivated tropical grasses.

As is true throughout much of the humid tropics, several species of legume trees are well adapted to the soils and climate of Indonesia. The potential feeding value of their foliage, flowers and pods has long been recognized. However, little was previously known about their comparative nutritive value as feeds for ruminants or the dietary levels at which they are most effectively utilized.

The legumes being investigated are Gliricidia maculata, Leucaena leucocephala and Sesbania grandiflora. An early experiment with growing lambs in which the basal diet was napier grass (Pennisetum purpureum) showed that replacing up to 70% of the napier grass with foliage of either of the three legumes increased lamb weight gains from 20 to 50 grams per day. Growing goats showed a similar response. Feeding higher levels of the legumes had no further beneficial effect. The largest proportional increase in weight gain and dietary efficiency was obtained at low levels of legume feeding. Supplementation with enough green legume foliage to provide about 125 grams of supplemental dry matter per day increased weight gain by 120% and feed efficiency by more than 80%. Adding higher levels of the legume had a much smaller effect. In a later experiment with native Indonesian goats, the base diet was also napier grass. Young kids on this diet gained no weight at all, while other groups receiving about 15% of their diet as either gliricidia, leucaena or sesbania gained about 20 grams per day. The digestibility of all four diets was similar, as was the total daily dry matter intake and the daily intake of crude protein. This suggests that the improved gains are more a reflection of protein quality than quantity. Laboratory studies have shown that a greater portion of the legume protein may bypass the rumen and thus be more directly available to the animal.

Another experiment showed that the frequency of offering the legume supplement can vary. Weight gains of sheep or goats were similar whether the legume was fed daily, or if the same total amount was fed all at once every three days. In the villages of Indonesia where family labor is used intensively both for crop production practices and to care for the livestock, it is important to consider that legume supplementation is beneficial even if skipped on some days.

Participating personnel in this research were: Wayne Mathius, M. Rangkuti, Hamzah Pulungan, and Sorta Silitonga S. for the Research Institute for Animal Production in Bogor; J. E. van Eys, and W. L. Johnson for North Carolina State University.

CASSAVA LEAVES AS A PROTEIN SUPPLEMENT FOR GOATS AND SHEEP

The tubers of the cassava plant (Manihot esculenta, Crantz) are widely used in the humid tropics as food for humans, or processed for export. The large yields of cassava leaves, however, are not commonly used for human consumption. Their high crude protein content (20 to 25% of their dry matter) makes them potentially valuable as a supplement in low quality forage diets for ruminants. However, little is known about the quality of cassava leaf protein; furthermore, the occasionally high level of cyanogenic glucosides could limit their usefulness.

As part of the Small Ruminant CRSP, studies have been initiated at the Research Institute for Animal Production in Bogor, Indonesia, to evaluate cassava leaves in diets for sheep and goats.

Maximum weight gains of the lambs and kids in these studies were obtained when intake of cassava leaves did not exceed the dry matter of the grasses which comprised the basal diet. Feeding this level of cassava leaves doubled the average daily gain, compared to the pure grass diet. Adding corn grain or rice bran to the grass-cassava leaf diets did not further increase weight gains of either sheep or goats.

The protein quality of cassava leaves was tested by supplementing them with other sources of protein. When a rumen by-pass protein (fish meal) was fed, weight gains were not significantly different from animals fed only the grass-cassava leaf diet; feed utilization was improved slightly.

In these experiments only wilted cassava leaves were tested. Wilting for 24 hours destroys a major portion of the cyanogenic glucosides. In the 12 to 16 week duration of each of the above trials, no major health problems were observed. Results of these studies suggest that when sheep or goats are offered diets based on by-product roughages or low quality forages, wilted cassava leaves can be fed safely at levels up to 50% of the dry matter intake. On forage diets supplemented with concentrates, however, lower levels of cassava leaves should be fed. Also it is important to keep in mind that at higher levels of cassava leaf feeding, antiquality compounds such as cyanogenic glucosides can be dangerous.

Participating personnel in this research were: Wayne Mathius, Hamzah Pulungan, and M. Rangkuti for the Research Institute for Animal Production in Bogor; J. E. van Eys, and W. L. Johnson for North Carolina State University.

CASSAVA ROOT PRODUCTS AS ENERGY SUPPLEMENTS FOR GOATS AND SHEEP

Cassava is one of the most extensively grown food crops of the humid tropics, and its area of cultivation is still increasing. One of its advantages is its high yields even on poor soils. Although the energy value of the cassava root is high, protein content is extremely low.

Lambs and kids, after weaning, need a concentrated energy source in their diet in order to continue rapid, efficient growth to be ready for market. Corn, the traditional high-energy grain, is usually too expensive in tropical countries like Indonesia. With this in mind, experiments using cassava root meal in diets for growing lambs or kids were initiated at the Research Institute for Animal Production in Bogor.

Results of these experiments have shown that the addition of a limit of 500 grams per day of chopped cassava roots to napier grass diets for lambs or kids of 10 to 15 kg liveweight can double their average daily weight gain.

Cassava root meal was fed in other trials, in diets based on napier grass which had been equalized in protein content. Weight gains for the lambs and kids were improved when cassava root meal constituted 30 or 45 % of the total dry matter intake. At the maximum, daily gains with cassava supplemented diets were nearly three times higher than gains on napier grass plus protein supplement alone. Above the 45% level, daily weight gains were depressed.

Results of these studies suggest that cassava roots in chopped or ground form can be incorporated beneficially in small ruminant diets to a maximum of about 40% of the dry matter intake.

The high levels of starch in the cassava root makes it ideal for mixing with feeds that contain high levels of soluble or non-protein-nitrogen. Cassava roots could thus provide a cheap energy supplement to forage diets which are adequate in crude protein or, alternatively, be an important component in fattening rations for lambs or kids.

Participating personnel in this research were: Hamzah Pulungan, Wayne Mathius, and Achmad Prabowo for the Research Institute for Animal Production in Bogor; and J. E. van Eys and W. L. Johnson for North Carolina State University.

BY-PRODUCTS OF SOYBEAN PROCESSING IN DIETS FOR SHEEP AND GOATS

Soybean products such as tahu (tofu), tempeh and soy sauce are consumed in large quantities in Southeast Asia. Production of these foods is very often in the hands of small industries, resulting in considerable quantities of by-products that are frequently discarded. Chemical characteristics of these by-products suggest that they could be used effectively in small ruminant diets. However, no previous information has been available on their nutritive value or the optimum level for their inclusion in forage based diets.

As part of the Small Ruminant CRSP, research is now being conducted on the use of soybean by-products in small ruminant feeding systems. The site of these activities is the Research Institute for Animal Production in Bogor, Indonesia, in collaboration with North Carolina State University.

By-products from tahu, tempeh and soy sauce production are all uniformly high in crude protein (20 to 30% of dry matter) and have moderate fiber levels (25 to 35% acid-detergent lignocellulose). In one set of experiments, tahu or tempeh by-products were fed up to 75% of the total daily dry matter intake, in combination with native grasses, to growing lambs and kids. At this level, weight gain for lambs averaged 120 grams per day, while kids gained up to 100 grams per day. These gains are comparable to gains obtained with free choice feeding of commercial concentrate. At lower feeding levels of the tahu or tempeh by-products, weight gains decreased in proportion to the increase in forage intake.

By-products of soy sauce manufacture are high in salt, which limits the level at which they can be fed. In experiments where rice straw diets were supplemented with 15% soy sauce waste, average weight gains were more than three times higher than for animals fed rice straw without the soy by-product. All diets contained equal levels of nitrogen, in the form of urea.

Results of these experiments indicate the potential for using soy by-products in feedlot diets or as supplements for low quality forages. The average tahu or tempeh factory in Indonesia produces 300 to 500 kg of by-product daily, an amount sufficient to feed up to 200 to 300 lambs in a fattening operation.

Participating personnel in this research were: Hamzah Pulungan, Sorta Silitonga S. and S. Ginting for the Research Institute for Animal Production in Bogor; and J. E. van Eys for North Carolina State University.

MOTHERING ABILITY OF JAVANESE EWES IS IMPROVED WITH BETTER FEEDING

Native sheep in West Java are raised under intensive management which has allowed the evolution of a gene for prolificacy, or multiple births. Too often, however, when twins are born their subsequent survival rate is low, possibly because the ewe is unable to produce enough milk to nourish them adequately.

A study conducted through the Small Ruminant CRSP has investigated the milking potential of Javanese ewes under conventional and improved feeding systems. The study was carried out at the Research Institute for Animal Production in Bogor, West Java, in collaboration with North Carolina State University and the University of California at Davis.

Previous research by Bogor and UCD scientists has documented the rates for twinning, triplets or quadruplets in Javanese ewes. The present study involved ewes that were suckling either single or twin lambs. Treatments were either a standard village type diet of tropical grasses or an improved diet, with concentrate supplement added to meet 110% of the energy and protein requirements published by the U.S. National Research Council.

For ewes suckling singles, the improved diet increased milk production by one-third and weight gain of the lambs by 40%. In the case of ewes suckling twins, milk production increased only 10% and average daily gains of the lambs increased by 20%, over the performance observed on the village-type diet. The lower response of the ewes with twins may be because of their poorer condition at time of lambing, due to the added stress of having supported multiple fetuses.

At the higher level of feeding, lamb mortality was eliminated altogether.

It therefore appears that under village conditions, increasing the level of feeding for ewes can improve lamb survival and performance. However, the amounts of milk recorded in this study suggest that Javanese ewes have a limited capacity for milk production, and that milk production should be one of the criteria for selecting breeding stock when developing genetic lines for high prolificacy.

Participating personnel in this research were: Sorta Silitonga S., S. Ginting, and Ismeth Inounu for the Research Institute for Animal Production in Bogor; J. E. van Eys for North Carolina State University; and Eric Bradford for the University of California at Davis.

CITRUS PULP AND SUGARBEET PULP IN DIETS FOR GROWING LAMBS

Citrus pulp and sugarbeet pulp are two agricultural by-products available in ample supply in Morocco, which have potential for improving diets for growing lambs. To evaluate this potential, a series of experiments was initiated at the Hassan II Institute of Agronomy and Veterinary Medicine, Rabat.

Both by-products proved to be relatively good energy sources for sheep, with a low fiber content and a high digestibility. Beet pulp was found to be a better source of crude protein, with about 10% (dry matter basis) compared to less than 6% in citrus pulp. Both of these values are low enough to require including a better protein source in any diets which have one or both of these products.

Crossbred D'Man X Sardi lambs were fed diets containing either 40 or 75% beet pulp or citrus pulp, with alfalfa hay making up most of the remainder of the diets. The diets were equalized in crude protein content by using urea. The yearling lambs gained close to 200 grams per day with 40% of either by-product or with 75% beet pulp. On the 75% citrus pulp diet daily gains were only about 150 grams; the reason for the lower rate of gain on this diet was not readily apparent, but may have been related to the quality of protein in the dietary ingredients. A follow up experiment is planned to see if adding a bypass protein which will escape rumen digestion and be available to the lambs in their lower digestive tract, will correct the problem.

In the meanwhile it is recommended that citrus pulp not be used in diets for lambs at a level higher than 40%, while sugar beet pulp can be used at higher levels if its price is competitive with alternative high-energy feeds.

Participating personnel in this research were: Nacif Rihani, Ali Berrami, Moussa El Fadili, and Fouad Guessous for the Hassan II Institute of Agronomy and Veterinary Medicine in Rabat; and W. L. Johnson for North Carolina State University.

GROWTH POTENTIAL, CARCASS YIELD, AND ENERGY REQUIREMENTS OF MOROCCAN SHEEP

The Timahdit is one of the common breeds of Moroccan sheep, herded continuously on the Atlas mountain rangelands for many centuries. Although it is probably one of the oldest of the world's sheep genotypes, little is known about its potential productivity and nutritional requirements. Animal nutritionist Ahmed Kabbali of the National School of Agriculture in Meknes, Morocco, is conducting research to learn more about these important sheep. Collaborating with him are scientists from two land grant universities in the U.S.

In a recently completed trial Mr. Kabbali and his students fed a diet of 100 grams of chopped wheat straw (in plentiful supply from nearby farms) plus a pelleted concentrate fed to the appetite of the animal. The young Timahdit ram lambs receiving this diet gained more than 200 grams per day. Total daily dry matter intake was 3.6% of body weight. Upon slaughter at about 25 kg body weight, these lambs yielded carcasses of 14.6 kg or 58% of empty body weight.

The lamb carcasses were then analyzed for protein, fat, water and ash content. Together with information about the energy content and digestibility of the diets, Mr. Kabbali was able to estimate the daily energy requirements of these animals for maintenance and growth. Surprisingly, his estimates were very close to published values for sheep breeds of European origin.

This new information about nutrient requirements for Moroccan sheep will be useful for shepherders, extension specialists, teachers and students who are concerned about improving the nutritional status of sheep in Morocco.

Participating personnel in this research were: Ahmed Kabbali, Mohamed Essaadi, Hassan Hafidi, Djibril Semkega, Latifa El Majarzi, Nadia Legdali, and Fatima Oumzai for the National School of Agriculture in Meknes; C. E. Allen and D. W. Johnson for the University of Minnesota in St. Paul; and W. L. Johnson for North Carolina State University.

WASTE PALM DATES IN DIETS FOR GROWING LAMBS

Palm dates are an important cash crop from the irrigated valleys of Morocco southeast of the Atlas Mountains and bordering the Sahara. A portion of the dates cannot be marketed for human consumption; after being dried and ground, they are commonly used for feeding livestock.

A series of experiments have been conducted at the Hassan II Institute of Agronomy and Veterinary Medicine, Rabat, to determine the nutritional value of diets for sheep with waste palm dates. It was concluded that diets for growing lambs can contain up to 50% waste palm dates, if an additional source of protein is included.

This conclusion was not affected by breed of the sheep, which in these experiments were Sardi X D'man crossbreds and pure D'man. Daily gains were 135 grams (average for both breed types) when the diet consisted of 50% alfalfa hay and 50% palm date meal (with urea added to equalize nitrogen content across diets). For a diet of 75% alfalfa hay and 25% palm date meal, average daily gains were 99 grams; and another group consuming only alfalfa hay gained an average of only 48 grams per day.

In a separate experiment with Timahdit rams, the digestibility of the organic matter of palm date meal was found to be about 78 percent, which makes it an excellent energy supplement for ruminants.

Participating personnel in this research were: Nacif Rihani, M. Khal, A. Berrami, and Fouad Guessous for the Hassan II Institute of Agronomy and Veterinary Medicine in Rabat; and W. L. Johnson for North Carolina State University.

SEASONAL VARIATIONS IN ALFALFA YIELD AND QUALITY IN A MEDITERRANEAN CLIMATE

In irrigated valleys Southeast of the Atlas Mountains in Morocco, alfalfa has long been a traditional forage crop for sheep. However, little was known about how best to manage this important forage for optimum nutritional value, until Fouad Guessous of the Hassan II Institute for Agronomy and Veterinary Medicine in Rabat started a series of experiments in 1982.

Differences in the proportion of leaves which are more palatable and digestible occurred at different seasons. In the spring (through April) and fall months the proportion of leaves was greater than 50% whereas in the hotter summer months the proportion of leaves fell below 50%. In the cooler winter months (January and February) plant growth declined to the point where shortages could be expected, necessitating the storage of hay harvested in the summer months, or the use of an alternative feed source.

Fouad Guessous sampled the alfalfa at 14 day intervals, during growth cycles at several times of the year. He found that the total fiber content of the samples increased with the aging of the plant, especially in the spring and summer. In summer, compared to spring or fall, the alfalfa had a higher concentration of cell wall fiber at any given stage of physiological growth. Lignocellulose (poorly digested by sheep) was about 30 to 32% in summer, but only 25% in fall, for alfalfa in full bloom. As a predictable result, the digestibility of the alfalfa was found to be lowest in summer and highest in spring and intermediate in the fall.

These results demonstrate that forage quality can vary significantly with the season of the year. In the hottest month of summer, when mean temperatures were above 30 degrees C., alfalfa quality was the lowest of any time of the year. Added to the known depressing effect of hot weather on animal appetite, it can be seen that special care must be exercised to insure an adequate nutrition for sheep during the hottest months of the year in a Mediterranean climate.

Participating personnel in this research were: Fouad Guessous, A. Boualil, and Nacif Rihani for the Hassan II Institute of Agronomy and Veterinary Medicine in Rabat; and W. L. Johnson, and J. W. Spears for North Carolina State University.

TOXIC EFFECTS OF BRACHIARIA BRIZANTHA, A TROPICAL GRASS, IN SHEEP

Tropical grasses of the Brachiaria genus, such as Brachiaria brizantha or decumbens, are increasing in popularity in Indonesia due to their widespread adaptability, potential for erosion control, and ability to successfully compete against the undesirable native cogon grass (Imperata cylindrica). However, health problems have frequently occurred with sheep when Brachiaria brizantha comprises the major part of their diet.

Scientists at the Research Institutes for Animal Production and Animal Health in Bogor have been investigating the problem of brachiaria toxicity in sheep. They have observed that sheep consuming only brachiaria may become unthrifty and suffer from loss of weight and loss of appetite, and eventually die. Clinical symptoms include bile duct hyperplasia, necrotising cholangitis, periportal fibrosis and lymphocyte infiltration. In severe cases a symptom identical to facial eczema can be observed. The toxicity symptoms do not occur consistently and seem to be dependent on location, climatic conditions, and the form in which the grass is fed. Moist, humid conditions appear to precipitate the occurrence of the symptoms. Feeding trials with brachiaria silage indicate a more pronounced toxic effect of the ensiled material. Adding another forage or concentrate at 50% or higher level of the diet appears to eliminate the symptoms and improve animal performance.

The symptoms were previously thought to be caused by the toxin sporidesmin, which is produced by a fungus. However, inconsistencies in the clinical symptoms along with a better understanding of the chemical properties of this particular toxin has caused scientists to doubt the causative role of the fungus. More recent information suggests that the poor performance of sheep on brachiaria may be associated with problems in the metabolism of copper and zinc.

Further studies now in progress are designed to bring a better understanding to the problem of brachiaria toxicity and to develop practical feeding or management recommendations.

Participating personnel in this research were: T.B. Murdiati, Leo Batubara and Wayne Mathius for the Research Institute for Animal Production; D. Stolz and A. Wilson for the Research Institute for Animal Health in Bogor and James Cook University in Townsville, Queensland, Australia; and J.E. Van Eys for North Carolina State University.

GROWTH POTENTIAL OF NORTH SUMATRAN LAMBS AND KIDS ON ALL FORAGE OR FORAGE-CONCENTRATE DIETS

What is the potential rate of growth of animals at various levels of nutrient intake? This is one of the first questions asked by researchers trying to find improved feeding and management systems to recommend to farmers still using long-standing traditional practices. In North Sumatra, where small ruminant research is just getting underway, a collaborative team of animal nutritionists asked exactly this question about the native breeds of sheep and goats of the region. The answer not only will help in evaluating the genetic potential of the native breeds, but also provide a benchmark against which to compare current village practices and new innovations.

At the Sungei Putih (North Sumatra) station of the Research Institute for Animal Production in Indonesia, a study was conducted to compare the performance of lambs and kids fed either a free choice diet of native grasses or a free choice diet of the same forage plus locally available concentrate feeds. For this study, Indonesian scientists collaborated with nutritionists from North Carolina State University, as part of the Small Ruminant CRSP. The feeding trial lasted 20 weeks.

The native lambs on the pure forage diet had average weight gains of 37 grams per day, while the kids averaged only 17 grams per day. Adding the concentrate to the diet increased weight gain to an average of 93 grams per day for lambs, and to 78 grams per day for kids. The faster growth rates of native sheep than native goats is consistent with observations made on similar animals in West Java, especially on the pure forage diet. However, the weight gains observed with the forage-concentrate diet were lower than those observed with similar diets in West Java. It is not clear whether this difference is due to the genetic potential of animals in the two regions, or to differences in feed quality.

Further experiments now underway in North Sumatra are designed to determine how best to improve performance of these native breeds: by adjustments in feeding, breeding, or general management practices.

Participating personnel in this research were: W. Sinulingga, Pius Ketaran and Marwan Rangkuti for the Research Institute for Animal Production; and Alice A. Reese, J.E. Van Eys and W.L. Johnson for North Carolina State University.

ANHYDROUS AMMONIA-TREATED FORAGES IN DIETS FOR SHEEP

Low quality forages and crop residues, in general, suffer two disadvantages as livestock feeds: their poor digestibility, making them a poor energy source, and their low protein content. Studies carried out by Ray Harvey and associates at North Carolina State University have shown that both of these problems can be partially solved through an ammoniation process.

The researchers conducted two feeding trials with crossbred wether lambs to evaluate diets containing wheat straw, coastal bermuda grass hay, fescue hay, or switchgrass hay, either treated with anhydrous ammonia or untreated. Large round bales of the experimental forages were treated in an ammoniation chamber for 24 hours, with 3% anhydrous ammonia under pressure.

The chemical composition of the forages was improved by ammoniation. Crude protein concentration increased from 3% (without ammoniation) to 7.5% in wheat straw; from 11% to 15% in coastal hay; and by even larger amounts in the other forages: from 6% to 14% in switchgrass hay, and from 9% to 17% in fescue. Hemicellulose content was reduced slightly in most of the forages; cellulose, however, was unchanged.

Dry matter digestibility was improved by ammoniation, by 10% in wheat straw, 20% in fescue, and 30% in switchgrass.

In the animal trials, intakes of the ammoniated forages were generally higher than intakes of the corresponding untreated forages. As a result, animal performance was improved. In the case of fescue or switchgrass, lambs lost weight on diets of untreated forage, but were able to maintain body weight with the treated forage. In the case of coastal bermuda grass average daily gains were increased from 45 grams, untreated, to 85 grams with treated forage. (In all of the above diets lambs received about 200 grams of corn per day after the first two weeks of the trial.) In the case of wheat straw, gains were 45 grams per day with the ammoniated straw alone; 85 grams per day with untreated straw plus corn; and 170 grams per day with treated straw plus corn (in an amount equal to the diet with untreated straw).

In many situations in the tropics or subtropics where sheep are raised, ammoniation of low quality forages could improve animal growth. However, the use of anhydrous ammonia may not be technically or economically feasible in all such locations. The search for a safe, practical, low-cost ammoniation procedure using a chemical agent that is readily available to livestock producers in lesser developed regions is being pursued by several research laboratories around the world.

Participating personnel at North Carolina State University were: J. Parris, R.W. Harvey and J.W. Spears.

DO SHEEP AND GOATS USE DIETARY FIBER WITH EQUAL EFFICIENCY?

Nutritionists of the Small Ruminant CRSP have observed that sheep and goats given the same diet do not always respond with the same level of performance. This phenomenon has been observed with native goats and hair sheep in the semi-arid Northeast of Brazil and with the native sheep and goats of the humid tropics of West Java, Indonesia. In both cases the intake and growth capacity of the local sheep exceeds that of the goats.

There are conflicting conclusions in existing literature about the relative efficiencies of these two small ruminant species. Some researchers report a higher efficiency of forage fiber utilization by sheep, others by goats; while a third reports very little difference between the two.

Animal nutritionists at North Carolina State University who participate in the Small Ruminant CRSP have conducted studies designed to look in depth at how sheep and goats use the forage fiber in their diets. Two early experiments conducted at the Raleigh campus showed a consistent trend: on diets low in fiber content (relatively high levels of concentrate) there were no detectable differences between the sheep and the goats in voluntary intake (corrected for differences in body size) or in digestibility of the fibrous portion of the ration. When the diets contained relatively high levels of fiber, however, two differences were noticed: the goats consumed relatively more than the sheep (again, corrected for body size), but the digestibility of the feed consumed was lower by the goats than by the sheep. The net result was an approximately equal daily intake of digestible dry matter. These results were observed with wheat straw diets as well as with tall fescue or bermuda grass fed as hay.

At this point the researchers began to suspect fundamental differences in how the two species process dietary fiber in their digestive tracts. Their next experiment was therefore designed to measure not only the rate of passage of undigested fiber through the rumen and lower digestive tract, but also intake and digestibility. In this experiment, when the diet was changed from a high quality (low fiber) alfalfa hay to a low quality (high fiber) wheat straw, the following observations were made: fiber and dry matter digestibility decreased by the same amount in both sheep and goat; voluntary intake decreased, but more in the sheep than in the goats; and retention time in the rumen increased, more in the sheep than in the goats. Passage rates of fiber particles through the lower digestive tract, after exiting the rumen, decreased by the same amount in both sheep and goats.

In all of the above experiments, differences in selectivity of the diet offered were negligible. It is known that particle size of ingested forage must be reduced to a certain threshold size before undigested particles can pass out of the rumen. Given the above results, it appears that goats, when consuming high fiber forages, may chew them more efficiently than sheep (either during the initial ingestion or during rumination) or else they are better able to pass larger particles of forage out of the rumen and through the lower

digestive tract. Future experiments may shed more light on these processes.

All of these conclusions apply mainly to confined animals with limited opportunity for selection of diet. For free ranging animals with ample selection opportunities, it is known that goats can take advantage of a wider range of dietary options than sheep. They are aided in this by the structure of their mouth parts, by their ability to reach tree branches by standing on their hind legs or by climbing, and perhaps by their natural curiosity. The net result seems to be that free ranging goats can partially compensate for poor pasture or range conditions by selecting a higher quality diet (lower in fiber, higher in crude protein) than is possible for either sheep or cattle.

A better knowledge of how sheep and goats differ in their strategies for selecting and utilizing dietary ingredients will help animal nutritionists in their quest for more efficient feeding systems for these important domestic livestock.

Participating personnel at North Carolina State University were: W.L. Johnson, Rex Gaskins, Lynn E. Brown, Jean-Marie Luginbuhl, Roberto Quiroz, Budi Haryanto, Kevin Pond, E.A. Tolley, J.D. Pettyjohn, and Anne Sprinkle.

FEEDING PRACTICES FOR SHEEP RAISED IN RAINFED WHEAT PRODUCING AREAS OF MOROCCO

When initiating applied or adaptive research aimed at a specific agricultural production system, the first step must be to find out as much as possible about the existing system, including present productivity levels and current practices. Thus, when a team of animal nutritionists of the Small Ruminant CRSP decided to extend their research to a rainfed mixed farming area of Morocco, they first designed a survey activity to study the target farmers and their practices.

The first study area chosen was the Beni Oukil rural community, located in an area which receives 300 to 400 mm of rain in an average year and which has no developed irrigation resources. Mr. Driss Ismaili conducted the study in collaboration with the Tadla regional livestock extension office. The study had two phases: first, a general survey of 80 farms chosen as representative of the region, and second, an intensive follow up with several visits over 5 months on 15 of these farms.

The study region has a seasonal rainfall pattern, with the months between October and April receiving most of the rain and the May to September period being quite dry. Mean monthly maximum temperatures range from a low of 18°C in January to a high of 40 degrees in July; minimum temperatures average 2 to 4 degrees in January, 20 degrees in July.

Mr. Ismaili found that sheep production was the main cash generating activity on these farms. Wheat is the major crop of the area, with barley and forage peas also being planted. The cereal grains are generally stored for family consumption. Forty-three percent of the farms of the region are less than 5 hectares in size; only 3 percent are larger than 50 hectares.

Flock sizes varied widely. About one-third of the farms kept 20 ewes or less, one-third kept from 20 to 50 ewes, and one-third kept more than 50. Less than one flock in ten had more than 100 ewes. Almost half the farms surveyed also kept a few cows, usually less than six head. One farm in four kept goats; half of the goat herds numbered less than six animals.

Almost 100% of the ewes were reported to have lambed during the year of the study, which was a good year in terms of feed resources. Twinning, however, was not at all common. Lamb mortality was about 7% up to 3 months of age on the 15 farms that were monitored intensely.

Feeding practices follow a pattern dictated by weather and cropping practices. About half of the land of the region is designated as "parcours" or community grazing land. During the rainy months, livestock graze either the "parcours" or on fallow cropland. Then when the rains stop and the grain has been harvested, the animals are moved to graze the wheat and barley stubble areas for 10 to 12 weeks. At other times their diet may include wheat or barley straw, wheat bran, beet pulp, pea vine hay, barley grain, or alfalfa hay. Some farmers

also use the first vegetative growth of barley for grazing, letting the regrowth mature for grain.

Animal weights were monitored on the 15 intensively-visited farms. Ewes weighed an average of 33 kg right after lambing, dropping to about 29 kg at the time of weaning. This loss of weight is not unreasonable for lactating ewes. The lambs themselves gained about 100 grams per day during the suckling period, reaching a weight of more than 18 kg at five months.

In a later year a second survey and monitoring program was initiated further north in the El Hajab region near Meknes. As in Beni Oukil, this region is important for rain-fed wheat and sheep. A total of 111 farms of the region are being monitored by a team of students of the Meknes National School of Agriculture, supervised by animal nutritionist Ahmed Kabbali and economist Mohamed Hassib.

Information from these surveys will be useful for researchers and extensionists who want their programs to be relevant to the needs of their target farmer population. When students can participate as in these surveys in Morocco, they also benefit from their first-hand experience, learning about the practical problems of agriculture directly from the farmers who must live with these problems every day.

Participating personnel in this research were: Driss Ismaili and Fouad Guessous for the Hassan II Institute of Agronomy and Veterinary Medicine in Rabat; Ahmed Kabbali, Mohamed Hassib, Mohamed El Haddani, Boudour Ben Rahal, and Leon Koyandondri for the National School of Agriculture in Meknes; and W.L. Johnson for North Carolina State University.

MINERAL SUPPLEMENTS IMPROVE FORAGE UTILIZATION AND PERFORMANCE OF SHEEP AND GOATS

Scientists of the Small Ruminant CRSP have been studying the mineral status of sheep and goats in West Java since 1981. The Indonesian Research Institute for Animal Production in Bogor, and North Carolina State University in Raleigh have collaborated in these studies.

In the early diagnostic stages of these studies, tissue samples were taken from the carcasses of sheep raised in village flocks. Analyses of these samples indicated marginal deficiencies of the trace minerals copper, zinc and manganese, all of which are essential for efficient growth and reproduction.

Samples of commonly used feedstuffs were also analyzed. In many of the feed samples, the major minerals sodium and phosphorus were below the critical recommended level, as were the trace minerals copper and zinc.

Mineral supplementation experiments were therefore conducted. In a trial with growing lambs, feeding a complete mineral mixture improved dry matter intake of napier grass (a common, high-yielding tropical grass) by 25% and average daily gain of the lambs by 70%, compared with napier grass alone. In another trial napier grass was replaced by a mixture of native grasses similar to the diet commonly fed in Indonesian villages. Again, feeding the complete mineral mixture increased forage intake and digestibility and average daily gains, although the effect was less pronounced than that observed when napier grass was the basal forage.

The next step was to test these results in village flocks. Several treatments were tested in small village sheep and goat herds, in a trial designed in such a way that the farmer did not know which treatment he was giving his animals. The most striking result was a reduction in lamb and kid mortality, from 16% when no mineral supplement was fed, to 2% for the flocks receiving minerals.

Growth rates of lambs and kids were also greatly improved, both before and after weaning. Average daily gains for animals receiving the complete mineral mixture were 113 grams preweaning (to 90 days of age) and 72 grams postweaning (90 to 180 days). These gains were almost twice those registered by animals receiving the placebo treatment with no mineral supplement. Two additional treatments of salt alone or salt plus calcium phosphate gave intermediate results, with little difference between them. A final treatment tested the addition of urea to the complete mineral mixture; lamb and kid gains on this treatment were inferior to those on complete minerals without urea.

There were site differences in this trial; animal gains were higher in an upland village than in a lowland village. These differences may be a reflection of greater heat stress or a less nutritious basal diet in the lowland village, or to the fact that only sheep were included at the upland site while both sheep and goats were monitored at the lowland site. The growth rate of sheep usually exceeds that of goats.

The on-farm trials are continuing in order to measure the long term effects of mineral supplementation on animal reproduction and overall flock productivity. The next step of this collaborative research will be designed to find out which one or combination of the many essential minerals is responsible for the improved performance.

Participating personnel in this research were: Achmad Prabowo, Sorta Silitonga S. and Wayne Mathius for the Research Institute for Animal Production in Bogor; and J.E. Van Eys and W.L. Johnson for North Carolina State University.

SULFUR FERTILIZATION OF TROPICAL GRASSES GROWN ON A WEST JAVA SOIL DOES NOT IMPROVE THEIR YIELD OR DIGESTIBILITY

A recent study by animal scientists in Indonesia has indicated that fertilizers high in sulfur content should not be used for forage crops on the oxic dystropept soils of West Java. Scientists were somewhat surprised by these results, since many previous studies conducted in Southeast Asia, Australia or the U.S. have reported positive effects of sulfur fertilization on crop and animal production. Positive responses to sulfur fertilization have also been reported from parts of Indonesia, in spite of the volcanic origin of most Indonesian soils and the continued volcanic activity in the area.

Two factors which determine whether sulfur should be amended as a fertilizer are the availability of the soil sulfur (difficult to measure) and the specific requirements of the crop.

The present experiment was conducted as part of the Small Ruminant CRSP, with collaborative participation of the Research Institute for Animal Production, Bogor, and North Carolina State University. Several common tropical grasses were established in small plots and given complete fertilizers with and without sulfur. Results showed yield responses to sulfur only during the dry season and only for napier grass and centrosema. Sulfur fertilization had no effect on dry matter yields of guinea grass, signal grass or setaria. Fertilization increased the average concentration of sulfur in plant tissue by about 25%, but had no significant effect on the nitrogen, cell wall fiber, or minerals other than sulfur.

Digestibility of dry matter and cell wall fiber of several of the grasses was actually depressed by sulfur fertilization. The negative effects were observed in laboratory tests for rate and extent of cell wall fiber degradation. The fiber of forage leaves was degraded at a 30% slower rate with sulfur fertilization than without, and 48-hour total fiber digestion was only 8%.

Intake of the sulfur fertilized grasses by ruminant livestock could be much lower than intake of similar forages not fertilized with sulfur because of the known depression of intake which occurs when forage fiber is slowly or poorly digested.

A predominantly negative effect of sulfur on the nutritive value of forages is suggested and it is suggested that fertilizers with high levels of sulfur should not be used for forage production on oxic dystropept soils similar to those of West Java.

Participating personnel in this research were: S. Ginting and Hamzah Pulungan for the Research Institute for Animal Production; and J.E. Van Eys and W.L. Johnson for North Carolina State University.

Breeding and Management of Sheep and Goats to Maximize Meat
and Milk Production in Arid and Tropical Environments

J. M. Shelton

Texas Agricultural Experiment Station

THE USE OF CULTIVATED FORAGE SPECIES TO ENHANCE ANIMAL PRODUCTION IN NORTHEAST BRAZIL

Northeast Brazil is characterized by wet and dry seasons. The area is largely covered by a mixture of brush or browse species called "caatinga". A substantial part of the offtake from this area is in the form of livestock products, particularly from small ruminants. Occasionally little forage is available in the dry season of six months or more duration except for fallen leaf litter, and this constitutes a stressing time for the animal. However, in most years and in much of the Northeast, rainfall during the rainy season is adequate to produce feed or forage for use by the animals during the dry season. A number of agronomic species have been shown to be adapted to the region. Feeding and digestibility trials have been conducted with a number of these species which confirm their value as feedstuffs and the potential for their utilization in the region. Most of the feeding studies have been conducted with milk goats at Fazenda Pendencia (EMEPA) in Paraiba. Digestibility studies have been conducted at the National Goat and Hair Sheep Research Center at Sobral (EMBRAPA-CNPC). Some of the forage species studied to date include legumes (Cunha - Clitoria ternatae), grasses (forage sorghums or Buffel grass) and shrubs (Algaroba) and succulents (thornless cactus). Available information concerning species which can be produced in the area, cultural methods, and the feeding value of the end product is generally adequate to permit the exploitation of these resources, but it should be pointed out that this information may not be available at the producer level. Limitations to greater exploitation of this potential means of increasing livestock production may well rest with information transfer and the socio-economic constraints at the small producer level. Another problem which has not been adequately addressed with some forage species is that of methods of preservation or storage; rainfall often limits the ability to make hay, and equipment is a serious constraint to silage making. These questions need to be addressed in future research.

Several Brazilian scientists associated with EMEPA (W.H. Sousa, P.R.M. Leite, W. da Silva Correia) and EMBRAPA-CNPC (L.C. Freire, F.A.V. Arruda, J. Ambrosio, H. Carneiro and M. Bezerra) have contributed to this program in collaboration with the SR-CRSP scientists C.A. Zometa and Jorge Kawas.

FEEDING FOR MILK PRODUCTION FROM GOATS

Milk production from goats offers an important means of providing animal protein for home use or sale for small-holder farmers. However, under most conditions some type of supplemental nutrients are required by lactating does for some part of the year.

Research work recently completed under USAID Title XII Small Ruminant Collaborative Research Support Program in Brazil has suggested means of economizing in ration formulation for supplementing milk goats in the northeast region. This work was conducted under the Texas A&M University Management Component in collaboration with CNPC (Centro Nacional de Pesquisa de Caprinos) and EMEPA-Pb. (Empresa Estadual de Pesquisa Agropecuária da Paraíba) at Fazenda Pendencia near Soledade, Paraíba in Brazil. In these studies, ground Algaroba seed pods (*Prosopis juliflora*) were compared with ground yellow corn in ration formulation for milking does. These studies indicate that satisfactory rations can be formulated using Algaroba. From an energy standpoint, the Algaroba seed pods do not appear to equal that of corn since the seed pods have a higher fiber content. However, Algaroba can be produced satisfactorily on the farm under the arid conditions of the Northeast of Brazil. Efforts are being made to encourage the production of Algaroba; but since it is a shrub or tree, a few years are required for it to reach the production stage. Even in the absence of on-farm production, Algaroba can generally be purchased much more economically than corn or other feed grains. It is more efficiently utilized in mixed rations if ground, which may present problems to small holder agriculturists. In another part of the same study, urea and other non-protein nitrogen (NPN) sources were used to replace 75% of the cottonseed meal protein in formulated rations. When used as a supplement to rations based on corn as an energy source, urea produced results comparable to that of cottonseed meal. Urea appeared to be less satisfactory when used as a supplement in Algaroba based rations. These studies suggest that NPN can often be used to good advantage by goats, and that it would in most cases be more economical than natural protein supplements such as oil meals. Field trials have also been conducted under farmer conditions using NPN based rations with favorable results.

These studies were conducted with local or native Anglo Nubian and Alpine does. The latter were substantially heavier milk producers. This experience suggests that exotic types of milk-type goats can adapt and perform satisfactorily to conditions of Northeast Brazil when fed adequately.

Scientists collaborating in these efforts included Aldomario Rodrigues, Wandrick Haus de Sousa and P.R.M. Leite, EMEPA (Empresa Estadual de Pesquisa Agropecuária) and C.A. Zometa, Texas A&M University.

USE OF EXOTIC DAIRY GOATS IN NORTHEAST BRAZIL

A number of studies have been completed at Fazenda Pendencia in the State of Paraiba in Northeast Brazil in which both local (native or Crioula) goats have been compared with introduced exotic types for milk production. The exotic types which have been used are the Alpine (of European origin) and Anglo Nubian. The area is characterized by wet-dry seasons of varying length. The introduced types have survived and adapted well from the standpoint of disease problems utilizing the normal prophylactic measures already employed in the area. The introduced types have responded well to improved care and feeding, with milk production levels ranging from two to three times that of local types. However, their level of milk production have not approached that of the same breeds in temperate regions. It is not entirely clear what are the limiting factors. No attempt has been made to maximize production disregarding the cost of inputs. Representatives of the Anglo Nubian breed have been successfully introduced into producers' flocks which were being utilized as meat or dual purpose goats. No data or experience is available where the Alpine has been evaluated at the producer level under unimproved conditions, and the use of this exotic breed under unimproved conditions cannot currently be recommended until further research results are available.

Data on this project derives from collaborative efforts of Texas A&M University personnel working with scientists from EMBRAPA (CNPQ) and EMEPA, which are the National Research Organization in Brazil and the State Research Agency in the State of Paraiba. Collaborating scientists included Elsio Antonio P. de Figueiredo, W.H. Sousa, P.R.M. Leite, C.A. Zometa and Maurice Shelton. The research has been sponsored under the Small Ruminant CRSP.

PRODUCTION OF HAIR SHEEP IN NORTHEAST BRAZIL

Data have been collected on 1338 ewes (ewe years) and 989 lambs under production conditions which are typical of much of that in Northeast Brazil. Production and genetic parameters have been calculated from these data which were collected over 5 breeding seasons. Over this period of time, the average lamb crop weaned was 102 percent, even though many of the sheep were of young age. This suggests that with this species reproduction is not a major limiting factor. Even though the ewes were often in poor condition and light weight, most mated and lambed successfully. A number of environmental variables were studied as to their effect on reproduction. Most of these, including the presence of visible lesions of caseous lymphadenitis, were without a significant effect on growth or reproduction. Although reproductive rate (to weaning) was reasonably satisfactory, growth rates and post weaning survival of the lambs were generally poor with the result that few animals were being marketed or were available to be marketed to advantage at a young age. This suggests that high priorities for future research initiatives should be concerned with management schemes to improve growth rates, post weaning survival and to develop appropriate marketing strategies.

Genetic parameter estimates suggest that it should be possible to practice effective selection for the performance traits studied.

These data suggest that technological limitations are not as great a constraint to production as are those imposed by the environment and by the socio-economic limitations. However, the latter are not particularly amenable to research, and it may still prove that production oriented research offers that greatest promise for instituting change.

These studies were conducted by the Texas A&M University component of the Small Ruminant CRSP and in collaboration with workers at EPAGE in Quixada and the CNPC scientists. The data on which these comments are based derived from a thesis entitled "Genetic and Environmental Factors Affecting Growth and Reproduction Characters of Morada Nova Sheep in Northeastern Brazil" presented by Antonio Amaury Orio Fernandez in partial fulfillment for the requirements for a MS degrees at Texas A&M University.

GENETIC INFLUENCE ON DIET SELECTIVITY OF RUMINANTS

The increasing human population will no doubt continue to place pressure on the world's resources. One result of this will be that the grazing animal will tend to become, even more than present, relegated to the use of land not suitable for the production of crops. In this connection, it will become increasingly important to select between or within animal species for those genotypes which utilize available forage resources to best advantage. The existence of important species differences in diet selectivity or forage utilization is well documented, but one still observes instances of failure to utilize the available information in planning agricultural systems. In addition, work recently completed in collaboration with EMBRAPA as a part of the Texas A&M University component of the USAID Title XII Small Ruminant CRSP Program has shown that differences exist within species and within breeds in diet selectivity and grazing behavior. Differences between breeds or genotypes could be of considerable significance in attempts or proposals to move these between various countries, environments or resource areas. In these studies, it was shown that meat-type goats browse more extensively than the Angora. Likewise, hair sheep (Black Bellied Barbado) browsed more heavily under some condition than other breeds, such as the Rambouillet, with which they were compared. Likewise, significant sire differences were observed within meat-type goats for the level of intake of a number of plant species. This suggests that it might be possible to select animals which feed more heavily on certain plant species. This might be done with the goal of exploiting an existing resource or controlling an invading or problem plant species. A good example of a problem plant is honey mesquite (*Prosopis glandulosa*), which is an invading species in many areas, including the Southwest U.S. Results to date do not provide an explanation for mechanisms involved in differential selectivity by various animal genotypes, although the underlying mechanisms are being studied. Differences in dexterity between the breeds may be part of the explanation.

A more complete report of this work can be obtained from USAID Small Ruminant CRSP Technical Report #32.

LIMITED SUCKLING MAY IMPROVE REPRODUCTION IN GOATS

Only a relatively small part of the world's goat population is exploited for milk production, even though human food of animal origin is produced much more efficiently by means of milk as contrasted to meat. It is generally accepted that, at least for growing children, food of animal origin contributes to improved development. This may be especially critical in developing countries. The milking of a limited number of goats to provide a household milk supply can be rather universally encouraged, whereas commercial exploitation of milk production from goats requires more careful study. Recent research completed in collaboration with EMBRAPA as a part of the Texas A&M University Breeding and Management Component of the Small Ruminant CRSP suggests that milking or partial milking, or more appropriately limiting suckling, could contribute to improved reproduction by reducing the post-partum anestrual period. It has been shown with other species that the nursing stimulus interacts with the hormone balance with the result that post-partum estrus is delayed. These studies confirm that the same is true with goats. Fortunately, the management systems necessary to exploit this phenomena integrate well with exploitation of the goats for milk production and especially that of the dual purpose goats. Examples of where this can be exploited are Cabrita production where the kid is early weaned and the doe subsequently utilized for milk production, or where the kid is removed from the doe for a few hours per day in order to practice limited milking.

Further details concerning this experiment can be obtained from a paper entitled "Reproductive Response to Suckling Manipulation in Spanish Does" by J.L. Lawson, D.W. Forest and M. Shelton published in *Theriogenology*, Vol. 21, pp. 747-755.

THE CONTRIBUTION OF FAT-TAIL OR FAT-RUMP SHEEP TO FOOD AND FIBER PRODUCTION IN UNFAVORABLE ENVIRONMENTS

Perhaps the most prevalent type of sheep in the world is the fat-tail or fat-rump sheep found largely in the arid region of the tropics or sub-tropics. This also coincides with the area where many of the developing countries are located, including those that depend more heavily on sheep and goats for a livelihood. There are many breeds, sub-types or genotypes which tend to have in common the traits of fat accumulation, a mixed coat producing carpet wool (or no merchandisable fleece), low twinning rate, and many have traditionally been milked to make a major contribution to the human food needs. Some work has been conducted in Texas as a part of the SR-CRSP effort to evaluate the unique characteristics of this animal and the significance of these to the contribution made by them. At this point, the significance and phylogeny of the fat accumulation in the tail remains to be elucidated. However, current work has shown that these animals are voracious feeders when forage is available and that a large part of the surplus energy is converted to body fat. The end result is that the total body fat content or fat reserve is great compared to other types with which they have been compared. Their habit of having single, as contrasted to multiple births contributes to the ewe maintaining condition and vigor, the lamb making sufficient early gain and fat accumulation to survive periods of stress, and the opportunity to take surplus milk for human use. Their type of wool cover contributes to their adaptation to both low and high temperatures often encountered in arid regions. These unique adaptations to adverse environments and to serving man's needs for meat, milk and fiber have developed over thousands of years. Societies and the animal industries which support them in the Western hemisphere (North and South America) are of comparatively recent origin, and the animal industries in developing countries cannot afford the luxury of this long time period. There is observational information, but not research data, to indicate that the truly fat-tail types are not well adapted to the humid tropics. However, an alternative type is the fat-rumped sheep, for example the Blackhead Persian, which do not encounter the problems associated with the fat-tail type in humid areas and have been shown to be well adapted to areas of sparse feed conditions. A related type, known as the Brazilian Somali, has been studied in Brazil. The animals involved show some evidence of degeneration due to genetic drift, small population size or mixing with other tropical breeds. Even with this alteration of form and function, the data suggest that they are well adapted to the wet-dry conditions of Northeast Brazil. A substantial gain could be realized from further research to introduce new genetic resources to this population and by devising a crossbreeding system to exploit the adaptability of the small and hardy Somali female breed to a larger sire breed.

The work discussed here was conducted by Eisio Antonio P. de Figueiredo and Francisco de Assis Melo Lima (EMBRAPA-CNPC) in Brazil and Maurice Shelton in the U.S. as a part of the collaborative effort involving the SR-CRSP.

A SUCCESS STORY IN TRAINING

Often, the most important residual benefit from international efforts is that of a trained corps of people which can carry on for the time necessary to bring about a change. Most often, this takes the form of advanced graduate studies at U.S. institutions which will usually be limited in number. Another level of training has been utilized to advantage in Brazil. In the last three years, 21 young people have received training and limited support in sheep and goat production under the supervision of Dr. C.A. Zometa with the Texas A&M University Management Component of the Small Ruminant CRSP. The students spent approximately six months in residence at the Fazenda Pendencia Research Station in Paraiba. The trainees, or more properly Estagiarios, all had B.S. degrees in Agriculture prior to the start of their training. Over half the young people involved were women. The students came from six states in Brazil (Paraiba, Pernambuco, Alagoas, Bahia, Rio de Janeiro and Rio Grande do Norte) and have returned to these areas. Presently, 9 students are involved in research, 2 in extension, 4 college teaching, 1 in development projects and the whereabouts of 5 are unknown at present. While in training, the students assisted and later assumed responsibility for care and data collection with experimental animals. Much of these efforts were related to the production of a home milk supply from goats, and this was one of the reasons for their participation in the project. In addition to the training provided, the trainees assisted immeasurably in the conduct of research studies. Students were selected and assigned to the program by EMEPA, the research agency in the state of Paraiba. However, the requests to provide the training came from similar agencies in the other states as well as Paraiba. The administrative structure and facilities were also provided by EMEPA.

GOAT BREEDS FOR USE IN NORTHEAST BRAZIL AND SIMILAR AREAS

Much of the Northeast region of Brazil is covered by a dense brush referred to as caatinga, which is best suited to utilization by goats. Meat is the primary product obtained, with skins or hides as an important secondary product. The most frequent intervention in livestock programs in developing countries is through attempts to make genetic improvement, often through introducing new or exotic breeds. The appeal to this approach is that it can be a one-time event, and does not require the extensive and repeated changes often required by other types of interventions. Perhaps the most important and far reaching assignment of the SR-CRSP would be to provide valid recommendations on this point. Goat production or an established goat industry in this region of Brazil is comparatively recent in contrast to some other areas such as the Near East or Asia. The end result is that no breed or type has evolved which is uniquely adapted to the region and to serving man's needs. There are a number of recognizably distinct types which are distinguished largely by color. There is also a larger amorphous population similar to those found in many regions of the world which is referred to as the SRD (Sem Raca Definida) or 'without well defined' type. In addition, some exotic breeds have been introduced for exploitation for meat production. Two of the latter are the Anglo Nubian and the Bhuj. The latter is of Indian origin, although it is apparently not known by this name in India. A number of studies have been completed in the U.S. and Brazil having to do with characterizing and evaluating these genotypes and identifying the most appropriate strategy for bringing about further improvement. Data from Brazil suggests that the local or native types do not differ significantly and may represent largely color variations. Of the two exotic types tested, the Anglo Nubian adapted satisfactorily and, in respect to growth, performed better than native types. In Brazil, size of the slaughter animal is of some importance in determining price, and thus some increase in size is desirable. This data tends to confirm the widespread practice of using the Nubian as an improved breed. The use of the Nubian for this purpose is being evaluated in both the U.S. and Brazil. Work in the U.S. and Brazil has shown that the goat leaves much to be desired in terms of carcass characteristics, and that their widespread use traces to their hardiness and survivability or adaptability and not to any superior meat producing qualities. Limited genetic studies in the U.S. do not lead to much encouragement about making rapid genetic improvement of the meat production traits of goats by selection within existing breeds or genotypes. Some important differences do exist within the available genetic resources on a world basis, but there are serious limitations on the ability to move these around for evaluation or exploitation. The end result is that selection within synthetic or crossbred populations for improved meat production seems to offer the greatest promise in the near future. This is being practiced in both the U.S. and Brazil.

This work has been conducted by Elsie Antonia P. de Figueiredo, A.A.O. Fernandez, F.H.F. Machado in Brazil and Maurice Shelton and G. D.

Snowder in the U.S. Additional details can be obtained from SR-CRSP Report No. 45 and from papers published in IGSR 1:258-268 and in Pesq. Agropec. bras., Brasilia 20(1):109-114 (Jan. 1985).

Systems Analysis and Synthesis of Small Ruminant
Production and Genetic Improvements of Dual Purpose Goats
Under Small-Holder Farming Systems

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SHEEP AND GOAT COMPUTER SIMULATION MODELS DEVELOPED FOR PRACTICAL APPLICATION IN DEVELOPING COUNTRIES

The most critical problems of developing countries are producing more food and improving diet quality. Sheep and goats are well suited for a major role in this task if flock productivity can be increased without using costly outside inputs, without reducing food crop production, degrading the environment and increasing risk. But developing countries have limited physical resources, operating funds and trained personnel to devote to sheep and goat research and development projects. Research results from one country are useful but the technology developed is not directly applicable to another country especially if the technology was developed for a temperate climate and application is for the tropics. Developing countries have a more limited infrastructure and often are not capable of accommodating and successfully adapting to single changes in the production chain. Even though sheep and goats are often kept in small family flocks, introduction of a new practice to improve one aspect of production may create unexpected problems in another.

The objectives of the Texas Agricultural Experiment Station Systems Analysis project of the Small Ruminant Collaborative Research Support Program (SR-CRSP) in collaboration with scientists in developing countries are, first, to organize and summarize in useful form the accumulated basic research knowledge about sheep and goats; basic knowledge is applicable to every country whereas technology is not. The second objective is to examine, via simulation models, constraints to production and the effects of new practices on the total inputs and outputs of sheep and goat systems, including risk factors. The third objective is to develop sets of practices for practical application to specific localities. These packages will contain information from the other SR-CRSP projects such as nutrition, health and economics, and will be designed to enhance the production objectives of the small farmers, whether it is more milk for the family or more products for cash sales.

The simulation model is the framework that unifies the basic knowledge from different disciplines and uses it for analysis and synthesis, in this case, of sheep and goat production systems. Such computer experiments save time and money and speed the basic research to practical application. Sheep and goat models that simulate through time have been developed by the SR-CRSP Systems Analysis project. Carefully designed along biological, cause and effect principles, the models can be adapted to any given set of production conditions with appropriate local input data on the type of sheep or goats, the forage resource and management practices employed. One use of these models is to simulate an experiment rather than actually conducting it with real animals. For example, an experiment may be simulated to test the production of an introduced breed vs an indigenous breed in good rainfall and poor rainfall (drought) years.

However, these models are useful only to the extent that they closely simulate the important aspects of real flocks, so the model must be validated. The goat model, for example, was validated against a set of research data carefully collected at the International Dairy Goat

Center at Prairie View University in Texas where two breeds of dairy goats were fed rations combining high- or low-energy feed with high- or low-protein content. The same experiment was simulated and the computer simulation results compared with the actual experimental results over this wide range of nutritional factors. The comparisons were very similar for the various outputs including feed consumption, milk production and doe weight. The "basic" validation run must be performed for each new location to ensure proper adaptation to local conditions. For example, the goat model is being used to examine constraints to dual purpose (milk/meat) goat production in western Kenya. Another example is the use of the sheep model to examine nomadic production in the arid area of northern Kenya. Simulations were run to compare the output with local data and local experience. In each case, after adjustments required for local conditions simulated results closely corresponded with actual data.

There is now sufficient experience with these models in Kenya to encourage reliance on the models and more extensive uses are under way. The models are currently being extended to Peru, Brazil and Indonesia.

Application of systems analysis to sheep and goat production may seem to be inappropriate for a developing country, but just the opposite is the case. Computers are now available in all countries, and with this equipment, systems analysis provides a way to accelerate needed research and also provides a basis for developing a balanced, practical approach to enhancing sheep and goat productivity in developing nations.

Collaborating scientists in this research were: F. Ruvuna, A.B. Carles, T.C. Cartwright and H. Blackburn.

GENETICISTS COLLABORATE TO DESIGN AND BREED A PRACTICAL MILK/MEAT BREED OF GOATS FOR SMALL FAMILY FARMS IN KENYA

A dire need exists for improved nutrition of families subsisting on their small farms in the higher rainfall areas of Kenya. The team of scientists of the Small Ruminant Collaborative Research Support Project (SR-CRSP) working with Kenya Ministry of Agriculture and Livestock Development scientists and USAID agreed, after a careful survey, that dairy/meat goats added to crop farming could economically improve nutrition without detracting from food crop production. But there was a missing link: a breed of goat that could produce sufficient milk and meat, utilize crop residues for feed, and be hardy enough to withstand the diseases, parasites and other rigors of the tropics.

The team of scientists provided data on the basic resources and constraints, such as the amount and quality of forage a one hectare farm could produce, and the amount of health care that could be expected to be delivered. Geneticists of the Texas Agricultural Experiment Station Breeding Project of the SR-CRSP and Kenyan scientists then collaborated with the Systems Analysts project to "computer design" a breed of goat to fit the constraints, yet produce sufficient milk and meat. These specifications imposed a rather critical balance between robustness and genetic potential to produce milk and grow efficiently. The geneticists utilized two indigenous goat breeds (Galla and East African), and two exotic dairy breeds from the United States via artificial insemination, to develop a synthetic composite breed designed to maximize and retain hybrid vigor.

The new breed, called the Kenya Dual Purpose Goat, is being tested for hardiness and productivity through various developmental stages at a Kenya experiment station and in the field with selected farmers. The dual purpose goat, in its early developmental generations, is very popular with the farmers. In the early stages of development, geneticists received feedback from production scientists that higher milk production was needed in the milk/meat balance. Because hardiness had to be retained, the geneticists decided to obtain greater genetic potential for milk by screening the population of adapted indigenous Galla and East African breeds for higher milking strains rather than by increasing the exotic influence. This screening has now been successfully completed, but has delayed arrival of the ultimate product that will be labeled the Kenya Dual Purpose Goat. Nevertheless, the results from early generations clearly show that the new breed can complement crop production to help fill the critical nutritional needs of the people in the tropical areas of western Kenya.

Already there are requests for the Texas A&M geneticists to expand the dual purpose goat program to produce suitable goats for areas of intermediate rainfall and for other countries with similar conditions. The program is demonstrating that high technology and collaboration with researchers in the developing country can have practical benefits in helping small farmers in those countries improve their health and their way of life.

Collaborating scientists in this research were: F. Ruvuna, D. Kimunye and T.C. Cartwright.

THE ROLE OF THE KENYA GOAT SIMULATION MODEL IN THE DEVELOPMENT OF VIABLE PACKAGES OF PRODUCTION PRACTICES FOR SMALL FARMERS

The Systems Analysis component of the Small Ruminant Collaborative Research Support Program (SR-CRSP) in Kenya was designed to identify and quantify constraints to viable dual purpose (milk/meat) goat production by small farmers. Then, after assessment, scientists will be able to balance inputs to overcome these constraints and enhance dual purpose goat production utilizing the available resources of the small farmer.

The Kenya Goat Model was first used to identify and quantify the characteristics of a goat suitable for both meat and milk production, using the feed and breed resources at hand. The second step was to determine the milk and meat production from family flocks of the dual purpose goats, given different flock sizes, amount of forage available and the farmers' management practices. The third step, conducted in collaboration with other SR-CRSP projects was to devise ways to overcome the constraints of the present goat production system through new animal management practices, shifted forage production emphasis, etc. We then retested the effects of these changes on milk and meat production. The final step is to put the inputs and practices together into a low-risk optimal package of recommendations to enhance meat/milk productivity within the limited resources of the small farmers in Kenya.

Using the breeds of goats available in Kenya and imported semen, it is possible to develop a breed of dual purpose goats with the genetic potential for mature body weight from 30 kg to 50 kg and to combine that with a genetic potential for milk production from 2.0 kg up to 6.0 kg for milk per day at peak lactation. Systems analysis simulations tested four genotypes for production under local conditions and management practices. Results revealed that the 30/2.0 (mature weight/milk production) was not viable. Production of the 45/4.5 and 35/3.0 genotypes were similar, but the results indicated that the 35/3.0 was more likely to survive under small farmer management and the forage resource base. Further simulations identified the 40/4.0 genotype as an optimal combination of productivity and body condition to ensure the small farmer a balance between milk and meat production and a hardiness to provide a buffer against the rigors of its environment.

Once the specifications for an optimal genotype had been determined, the SR-CRSP Breeding Project designed and initiated a program to produce the optimal dual purpose goat. But it became apparent that the flock size for each small farmer with only a few acres was an important component of a new goat production system. Flock sizes of 2, 4, and 6 mature does were then simulated and a goal of 1/2 pint of milk per man, woman and child in the family was set as the desired dairy production. A flock size of six mature does was required to satisfy the 1/2 pint goal but this flock size has been questioned on the grounds of its higher investment of human capital and other resources.

Systems analysis simulations also revealed that the forage resource base was adequate in amount but deficient in quality. This deficiency

in quality results in dairy milk production approximately 25% lower than the potential. Supplementation with high quality forages during very limited, but critical, phases of production increased dairy production by about 40% and also increased fertility and growth, while decreasing mortality. The amounts and kinds of supplementation needed were determined in the simulations, along with the required feeding practices. Developing a method to produce this high-quality forage for supplementation is now the target of the SR-CRSP Feed Resources project. Several promising forages have already gone through initial testing.

Another component of the Dual Purpose Goat package designed to increase milk production was a new management practice tested on the new breed via simulation. Traditionally, families take 1/2 of the doe's milk for human consumption and let her kid have the remainder. Under the proposed management practice does would be milked out fully, and then the kid would be fed only a prescribed amount, thus diverting milk from kid production to human nutrition. In simulations, the amount of milk per kid per day was tested at 1/2 doe's milk, 500 and 300 grams. The results showed a trade-off between the number of days of dairy production and the amount produced per day.

In a small farmer situation, kid growth was not sufficient with a high mortality rate at 300 grams of milk per day, but the growth of the kids receiving 500 grams of milk per day was very acceptable. The practice of feeding each kid 500 grams per day doubled the daily dairy production. The costs and benefits of this new practice are currently under analysis by the SR-CRSP Economics project.

The successful implementation of new technology depends on the interaction of the various research components of the development package. Constraints to dual purpose production in Kenya have been identified and targeted for further research and questions of implementation examined through the use of computer simulation models. The application of today's high technology techniques to develop a Dual Purpose Goat production system package for Kenyan small farmers has shortened the time horizon for moving from the current subsistence cropping agriculture to a future of a less restricted cropping-livestock agriculture.

Collaborating scientists in this research were: S. Tallam, F. Ruvuna, A. Mukhebi, M. Onim, T.C. Cartwright, H. Blackburn and P. Howard.

UTILIZING HIGH TECHNOLOGY METHODS TO COPE WITH DROUGHT EFFECT ON SHEEP PRODUCTION IN THE ARID LANDS OF KENYA

Nomadic pastoralists in northern Kenya depend heavily upon their livestock for subsistence. The problems associated with livestock production are similar throughout the Sahel. Increasing livestock production without abusing the natural range has been the thrust of the Integrated Project for Arid Lands (IPAL) and Kenya's Ministry of Agriculture and Livestock Development. IPAL project scientists had collected forage and sheep data in northern Kenya, but needed to extend their data in order to make meaningful recommendations for the pastoralists. Texas Agricultural Experiment Station scientist in charge of the Systems Analysis project of the Small Ruminant Collaborative Research Support Program (SR-CRSP) has developed a simulation model to quantify sheep production restraints and seek ways to overcome them. IPAL scientist requested the SR-CRSP to conduct a systems analysis study using this model with their data.

In these arid environments, the livestock producers have limited options due to the low level of infrastructure and other resources. One option, which requires a low degree of backstopping, is the introduction of more productive breeds. Genetic resources from other arid areas of Africa may improve flock production. A useful new breed must have the environmental adaptation of the present breed and it must surpass the current breed in milk production and growth. But breed evaluation is time-consuming with no assurance that the tested breeds will survive the extreme hardships which can occur. The recurring problem of drought cannot be avoided. However, strategies may exist which can lessen the impact of drought on the people living in a drought-stricken area. Evaluating different breeds during a drought and their recovery from the drought provides a comparison between breeds in a stressful situation. Little is usually known about nomadic flock structure and performance before a drought occurs, so re-establishing flock productivity after a drought is extremely difficult. This lack of information increases the tactical problem in planning relief programs.

Using systems analysis and the Sheep Production Computer Simulation Model, an experiment was conducted, by simulation, to examine the potential for introducing new sheep genotypes and how the genotypes would respond to a changing northern Kenya environment. The four environments simulated were the 1979 base year, in which actual diet quality data had been collected by IPAL; a drought year, in which the quality and quantity of forage were reduced to levels usually occurring in a drought; and two recovery years utilizing the same forage input parameters as in the base year. Nine genetic combinations were tested, combining three sizes, 30, 35, and 45 kg at maturity, and three milk potentials, .90, 1.30 and 1.75 kg per day. The 35/1.30 (mature size/milk potential) was representative of the genotype currently used in the area and was considered a control. By exploiting the simulation model's capability to examine sheep productivity over time, it was possible to trace the performance of the different genotypes through the series of simulated years.

The reproduction, growth and milk production of all genotypes were affected by the drought, as expected. But unexpectedly, drought altered the cycle of births from a continuous distribution to one of births occurring in a very narrow time span. As the flocks moved into the drought recovery phase, the distribution of births began to spread out and by recovery year 2, a pattern similar to the base year was re-established. These results raised the question: are sheep in this environment more productive with a continuous breeding season or with a controlled breeding season? The results from additional simulations clearly showed that these flocks were more productive when allowed to mate on a year-round basis than when subjected to a short controlled breeding season. A continuous breeding season is the manner by which the flock re-establish themselves after a drought. This practice is contrary to experience in temperate environments.

The rate of recovery for other characteristics was examined. Ewes quickly re-established body condition in recovery year 1 and lamb mortality, which increased greatly in the drought, decreased in recovery year 1. The impact of the drought on lambing rate (lambs born/ewes bred), weaning weight, yearling weight and average offtake of lamb and cull ewes was not seen until recovery year 1. The delayed response was primarily caused by a disruption in the reproductive pattern of the flocks in combination with poor ewe body condition and high lamb mortality during the drought. Shifting environmental conditions separated productive from non-productive genotypes. Generally, sheep with a mature size of 30 kg were less productive than the 35 and 45 kg groups. Two genotypes suffered severe reductions in flock size and productivity and did not recover from the drought; these were the 30/1.75 and 35/1.75 genotypes. This brings into focus a problem of arid lands: a breed can have the potential to produce more milk than its body size and environment will support. The result is a genotype which does not thrive and serve its intended functions.

Consistently, the most productive genotypes were the 35/1.30 (the breed currently used) and the 45/1.75. Computer analysis showed the 35/1.30 is well suited to the environment and is capable of surviving and recovering from environmental stresses. The 45/1.75 flock did rank higher in milk and meat production than the 35/1.30, suggesting that if a new genotype is to be introduced to the area, it should be similar to the 45/1.75. These data demonstrate how simulation can be utilized to answer questions that would be difficult if not impossible to address using live animal experimentation. Because of these results, officials with the Integrated Project for Arid Lands have reconsidered their recommendation to set up a controlled breeding season, a practice they had previously assumed would improve production.

Collaborating scientists in this research were: C.F. Kales, W. Lusigi, H. Blackburn and T.C. Cartwright.

IMPROVED FIBER TESTING CAPABILITIES IN PERU

South American camelids, particularly the alpaca in Peru, represent a unique resource to the highland farmers who are predominantly ethnic Indians and descendants of the Incas. While the sure-footed llama serves as the main pack animal for the narrow mountain trails and the vicuna is now a totally protected species, the herds of alpaca, intermediate in size, provide a basic and vital role in supplying small farmers with meat, hides, and fiber for their livelihood.

Alpaca fiber is among the finest and most sought after animal fiber in the world. It is produced in quantity by alpaca before shearing and comes in colors ranging from shades of brown and red to black. The fiber is skillfully woven into garments by local artisans for use in the bitterly cold Andean altiplano.

Commercial prices to the small farmer for alpaca fiber destined for export markets are generally rock bottom and exclude bonuses for quality. Much of the fiber ends up in European markets where "middle men", capable of grading and processing the fiber, can make substantial profits by further export to the United States and elsewhere.

Recently Texas A&M University scientists, Tom Cartwright and James Bassett, working under the auspices of the Small Ruminant Collaborative Research Support Program (SR-CRSP), began a cooperative effort with scientists at La Molina Agricultural University. The aim of this effort is to improve the quality control and testing of fiber in Peru so that savings can accrue directly to the small farmer. Texas A&M, which is a center of excellence in this field, has installed new and modern equipment to test the length, strength, and quality of camelid fibers in order to establish luster grading schemes so that small farmers can be paid bonus prices for better work. Not only is it hoped that an immediate impact will be felt on the income of the small rural family, but also that higher prices will provide an incentive for application of improved husbandry techniques leading to better quality fiber in greater amounts.

Collaborating scientists in this research were: Ben Quijandria, Alberto Pumayalla, T.C. Cartwright and J.W. Bassett.

**Improving Small Ruminant Nutrition, Management,
and Production through Proper Management of
Native Range and Improved Pastures**

F. C. Bryant

Texas Tech University

ANDEAN STOCKING RATES NEED ADJUSTMENT

In the Andean regions of Peru and Bolivia, sheep have gradually replaced camelids (llamas and alpacas) as the most numerous domestic animal. International and national market pressures have strongly influenced this shift, even though sheep are poorly adapted to grazing high elevation ranges (10-15,000 ft.). Little is known about how this species affects nutritional ecology of camelids. Moreover, much needs to be learned about how the grazing habits of sheep may influence high altitude rangelands.

Of particular concern is the question of stocking rates. Early research has indicated that penned alpacas, for example, eat 20-50% less forage per unit of body weight than do sheep. No estimates of the forage intake by either alpacas or native sheep grazing Andean ranges were available until range researchers from Peru's Veterinary Institute of Tropical and High Altitude Research (IVITA) teamed up with personnel from Texas Tech University through support from the Small Ruminant Collaborative Research Support Program (SR-CRSP).

Several years of research in the central Andes of Peru has pinpointed an optimal stocking rate for sheep at 3-4 ewes/ha on the best rangeland available. Production figures, like lamb crops and birth weights, indicate that if sheep are stocked above this level, sheep production and range condition will suffer. The highest stocking rate tests was 6 sheep/ha. After 3 years of grazing at this level, only 15% of the ewes produced a lamb, compared to the optimal level where ewes had lamb crops near 90%. Keeping in mind that 3-4 ewes/ha is optimum only on the best range, stocking rates on degraded range should be well below that level.

Research into forage intake of alpacas and sheep has shown that free-grazing alpacas consume 1.4 - 1.6% of their body weight per day. In contrast, native sheep consume forage equivalent to 2.4 to 4.5% of their body weight daily. These values indicate that currently recommended stocking rates for alpacas and sheep need to be re-examined with these differences in mind. The much lower forage intake by alpacas per unit of body weight strongly indicate that present replacement ratios of sheep for alpacas may be very detrimental to range condition and animal performance.

Results from this cooperative study indicate the devastating influence of high stocking rates on animal nutrition and production. Convincing campesinos to maintain herd numbers within established guidelines is the greatest challenge faced by extension specialists.

Collaborating scientists on this research were: Arturo Flores, Jorge Gamarra, Fred Bryant, Jim Pfister and Carlos Fierro.

UNRAVELING CAMELID NUTRITION

Research scientists with the Peruvian Veterinary Institute of Tropical and High Altitude Research (IVITA) and the Small Ruminant Collaborative Research Support Program (SR-CRSP) are working together to try and understand what nutritional problems camelids (alpacas and llamas) encounter in the High Andes of Peru.

The high altitude grasslands in Peru and Bolivia are grazed by millions of sheep, llamas and alpacas. However, the native camelids are much better adapted to the altitude and cold stress encountered at 10-15,000 ft.

Small holders rely on the llama and alpaca for meat and fiber. Selling in Europe for almost \$U.S. 5 per lb. (grease weight in Peru), alpaca fiber also has become especially valuable in world markets. Proper nutrition is very important to fiber production. Alpaca fiber yields have been observed to increase from 6 lbs. to 17 lbs. annually under optimum pasture conditions.

Research has focused on what these animals eat under free-ranging conditions. Range researchers from Peru and from Texas Tech University have been the first to surgically alter llamas and alpacas through a technique known as "esophageal fistulation". Trained surgeons create an outlet from the animal's esophagus to the skin surface which is then plugged with a special closure device. With the "plug" in place, research animals ingest and swallow feed as normally as do their grazing partners. However, when the "plug" is removed and a special bag is attached to the animals neck for 30 min., researchers can collect forage actually selected by the animal. Scientists examine the collected forage for adequacy of such nutrients as minerals, protein and energy. This grazed material is also useful for identifying specific plants and then assessing competition among sheep, llamas and alpacas. The technique has been used successfully in about 20 llamas and alpacas.

Results to date indicate that llama and alpaca nutrition is poor during much of the year. Protein levels during the dry season (June to Nov.) were 2 to 5% lower than the 10 to 12% levels recommended by nutritionists. Animals grazing in the Andean grasslands also appear to be deficient in energy at times. Management schemes designed to overcome these nutritional problems are currently being explored in ongoing research in central and southern Peru.

Collaborating scientists on this research were: Ramiro Farfan, Juan Astorga and Rich Reiner.

GAINING ON ALPACA PRODUCTION

Mention Peru, and invariably one thinks of Machu Picchu, site of the ancient Inca Empire, and of majestic llamas being herded by native women in colorful dress. Important as the llama is as a beast of burden and meat for Andean pastoralists, the alpaca, a cousin of the llama is an important source of high-quality fiber for the world textile markets. Alpaca fiber recently was selling at \$U.S. 5 per lb. (grease weight in Peru) to European buyers. To Andean pastoralists who own small herds of livestock, income from alpacas is crucial for economic survival.

Alpacas are traditionally grazed in high altitude Andean pastures (10-15,000 ft.) in Peru and Bolivia. Because these pastures have been overgrazed for many years, animal production is severely hampered.

Range scientists from Peru's La Molina University and Texas Tech University are working together under the Small Ruminant Collaborative Research Support Program (SR-CRSP) to integrate alpaca use of small fields of irrigated pastures with native rangeland. Because the potential for irrigated pastures is very limited in the Andes, these cultivated pastures cannot support large numbers of alpacas year long. However, strategic use of irrigated pastures can be of great benefit to alpaca production by reducing nutritional bottlenecks during the dry season (June to Nov.).

Under this program, newborn female alpacas are grazed for their first year of life on irrigated pastures. Then these females are shifted permanently to native range. The results of this research indicate a real potential for improving alpaca production. Female alpacas grazed on cultivated pastures reached breeding weights of about 110 lbs at one year of age; in contrast, alpacas grazing only on native range reached this breeding weight at 2 years of age!

Not only was an extra year of alpaca production achieved with the use of cultivated pastures, but fertility increased over 20%. Also, the newborn alpacas (tuis) from cultivated pastures were heavier at birth than their range-born counterparts.

The use of irrigated pastures is no panacea, but does offer Peruvian pastoralists an opportunity to gain a year of productivity from alpaca females. The extra offspring over the productive life of the alpaca could be a boon to smallholders with few alpacas.

Collaborating scientists in this research were: Arturo Flores, Fred Bryant and Jim Pfister.

STRATEGIC SUPPLEMENTATION OF SHEEP

Cultivated pasture or improved native range? Well intentioned but misguided scientists have argued this question as the way to alleviate the chronically low animal production in the Peruvian Andes. Establishing irrigated pastures has been viewed by non-U.S. expatriots as the panacea. However, range scientists at Peru's La Molina University, in collaboration with Texas Tech University personnel, are demonstrating the proper role of cultivated pastures in Andean livestock production systems. The key, according to these range specialists, is not replacement of rangelands with cultivated pasture, but integration of the two.

Joint research done under the Small Ruminant Collaborative Research Support Program (SR-CRSP) is proving that integration can be very effective. In one recently concluded study, ewe lambs were allowed access to cultivated pastures for periods ranging from 1 hour per day to 24 h per week. Access to the irrigated pastures for only 1 hour per day increased total gain during the dry season (June to Nov.) by about 15%. One day per week was less successful, but animals still outgained their range-grazed counterparts by 5%. Such management for strategic supplementation is not difficult or expensive in Peru, since animals are constantly being herded, very often by women or small children.

Because only 4% of the Andean region has the potential for cultivation and irrigation, such pastures can best be used by integrating them with the basic forage resource which is native rangeland. Research on strategic supplementation indicates the potential exists for improving livestock performance with proper management of these two forage resources in the Andean region. Collaborating scientists in this research were: Carlos Fierro and Juan Astorga.

Rangeland Research for Increasing Sheep and Goat Production
in Northeastern Brazil
J. C. Malechek
Utah State University

UREA AND MOLASSES PROVIDE NEEDED NUTRIENTS FOR YOUNG GOATS IN BRAZIL'S DRY TROPICS

Loss of weight and body condition during the annual dry season is a chronic hindrance to animal production in most tropical areas of the world. If ways could be found to reduce this loss, animals could be brought to market at younger ages and with a lower overall investment of feed per unit of animal liveweight.

Researchers in the semiarid tropics of northeastern Brazil are finding promising results by using urea and molasses as dietary supplements for young growing goats. Walter Schacht, an associate of the Small Ruminant CRSP working with the Centro Nacional de Pesquisa de Caprinos¹ has been conducting this work.

Molasses, a good source of dietary energy, is cheap and readily available in northeastern Brazil. Urea, used as a source of dietary nitrogen and a building block for protein, is needed in only small quantities for this purpose (5 grams per animal, daily). Schacht fed urea and molasses supplements separately, and in combination to different groups of young goats grazing the local native rangeland ("caatinga"). For the first eight weeks of the trial all animals gained weight at the same rate, about 50 grams per day. However, as the dry season advanced and native forage conditions deteriorated all animals stopped gaining and simply maintained their weight except those receiving the combination of urea and molasses. The overall result for the 3-month trial was that goats receiving the combined supplements gained an average 47 grams per day, compared to only 25 grams per day for the other groups.

This research suggests that the native caatinga range forage is deficient in available protein and energy during the dry season, even under circumstances where there is an abundance of dry matter available. Locally available products (urea and molasses) can be used to off-set these deficiencies for young growing goats. The next step is to analyze the economic feasibility of the practice, especially as it might apply to small farmers with limited access to capital.

Collaborating scientists in this research were: Walter Schacht, Luiz Carlos Freire and Jorge Kawas.

¹ Centro Nacional de Pesquisa de Caprinos is the national goat research center of EMBRAPA, the Brazilian national agricultural research agency, and is a collaborator with the Small Ruminant Collaborative Research Support Program funded through USAID.

UNDERSTANDING TRADITIONAL PRODUCTION SYSTEMS: A KEY TO EFFECTIVE RESEARCH

Technical assistance programs operate on the premise that introduced technology will induce beneficial changes in traditional agricultural settings. Recently it has become apparent that many well intentioned technical assistance programs have failed because recommended technological packages were incompatible with the complex, risk-avoiding production systems.

This problem can be greatly reduced by first understanding how local agriculturalists manage their resources. Only by considering the constraints and concerns the small farmer faces, can researchers identify ways to make improvements without jeopardizing the long term survivability of the enterprise.

A research team composed of Brazilian and American scientists associated with the Small Ruminant Collaborative Research Support Program (SR-CRSP) studied 28 farms producing sheep and goats in the semiarid region of northeast Brazil. A soil-plant ecologist from Utah State University and an agricultural economist from Winrock International, performed an inventory of farm endowments and described present management schemes in detail. The study revealed that these farms produce a variety of goods; along with cattle, sheep and goats the production of cash (cotton) and subsistence (beans and corn) crops is ubiquitous. Good soils are intensively cropped every year whereas marginal ones are subjected to slash-and-burn cultivation or they are simply grazed. Supplemental feed is provided primarily to cattle whereas goats are forced to derive sole sustenance from the native caatinga vegetation. Crop and livestock production are intricately associated. During the dry season, cattle and to a lesser extent sheep, graze the crop aftermath. The lack (or high cost) of adequate fencing was regarded as a major constraint to goat production because without good fences goats invade crops before they are harvested.

Animal inventories before and after a severe drought showed that farmers reduced cattle numbers while increasing the size of goat flocks over the course of the drought. This strategy reflects the relatively high inputs (feed supplements) required to maintain cattle vis-a-vis goats during adverse periods.

The results of the study suggest that researchers attempting to enhance animal production in northeast Brazil (and other risk-prone areas of the developing world) must take into account the mixed production strategy pursued by the local agriculturalists. It is this multifaceted approach that enables production systems to cope in the unpredictable environment. To focus all research and development activity on only one commodity or one part of the system is to insure that recommended practices will not be accepted by producers.

Collaborating scientists in this research were: Joao S. Queiroz of Utah State University and Nestor Gutierrez of Winrock International.

SHEEP AND GOATS ARE EFFECTIVE USERS OF COMPLEX AND VARIABLE HABITATS IN THE DRY TROPICS

Environmental conditions in the dry tropics of the world, are subject to enormous variability. Rainfall is typically distributed in highly seasonal periods of extreme wet and dry and extended droughts are not unusual. This variability presents serious hazards to effective animal production causing loss in weight and body condition during the annual dry season. When drought strikes, there are few alternatives short of selling part or all of the producing herd, usually at depressed prices.

Such environmental conditions are typical of a large region of northeastern Brazil where sheep and goat production is being studied through combined efforts of US and Brazilian scientists, sponsored by the Small Ruminants Collaborative Research Support Program. These researchers are discovering that small ruminants are admirably suited to deriving an existence under these harsh conditions. Additionally there appear to be cheap and simple technologies available to local producers for reducing risks while improving animal off-take.

Researcher associates James Pfister and Robert Kirmse¹ recently completed studies of the seasonal nutrition of sheep and goats foraging on native rangelands of Brazil's drought-prone "Northeast". They were interested in how the animals' food supply and nutritional welfare varied from wet season to dry season and how it was affected by complete removal of the native tree and shrub cover. Land clearing is a common cultural practice in northeastern Brazil for purposes of cropping and harvest of wood products, but little was known about how it may affect livestock production.

The yearlong nutrition of sheep and goats on intact, uncleared woodland (called "caatinga" in the area) was apparently good, even during the dry season. Protein levels and digestibility of diets selected by the free-grazing animals were generally within limits considered necessary for adequate growth and reproduction. However, other work suggests that all nutrients in the diet may not be available to the animals because chemicals such as tannins (common in many tropical browse plants) may prove to be toxic. Animals appeared sensitive to their environment and responded immediately to minor changes that, collectively, contributed to their nutritional well-being. For example, on one occasion, a minor rain shower during the dry season caused several of the tropical shrubs to initiate small, ephemeral leaves. Sheep, and particularly goats, shifted their diets to include a major component of these species, even though they were considered by local producers to be unpalatable. As a result, protein intake improved noticeably, and the response endured for several weeks.

¹ Pfister and Kirmse were associates of Utah State University when this research was done. They were collaborating with the Centro Nacional de Pesquisa de Caprinos, the sheep and goat research center of Brazil's national agricultural research agency, EMBRAPA.

Removal of the tree and shrub canopy increased the yields of broad-leaved herbs in the plant community by a 6-fold factor. However, this made no substantial improvement in the animals' nutrition or rate of production. Clearing removed the option for the animals to consume fallen tree leaves during the dry season. These leaves were an important feedstuff for animals on uncleared range and can be depended upon to furnish some forage, even in drought years. However, clearing presented a new feed option in the form of succulent green browse on shoots regenerating from the cut stumps. This suggests that some combination of clearing (or thinning) and intact woodland might provide the optimum environment.

Small ruminants, particularly goats, are highly discriminatory and eclectic in choosing their diets from the smorgasbord of plant types available on rangelands. These traits help to make them the ideal type of animal to extract a livelihood from the complex and unpredictable environments presented by the arid and semi-arid tropics. The research in Brazil is beginning to define the character and dynamics of such an environment as it relates to livestock production and how man might manipulate two of the components (plants and animals) to best suit his needs. Presently, actions that insure complexity of the plant cover seem to be the best for sheep and goats. This is contrary to some popularly held notions that wholesale land clearing is desirable. Research continues on this important question.

COPPICING FOR FORAGE PRODUCTION

Trees and shrubs are generally under valued for the vital roles they play in the arid and semi-arid tropics. They are important sources of forage for livestock and wildlife, wood for fuel and construction, and numerous species provide commercial extracts for a variety of uses (e.g. waxes, gums, insecticides, lubricants). However, because woody vegetation obstructs crop production and many species are not useful as a source of palatable browse, "management" has traditionally taken the form of wholesale clearcutting or chemical and mechanical eradication. Land use in northern Brasil follows this pattern, but with increasing population pressure, clearing rotations are being shortened, leading to accelerating soil erosion and, in the mind of some experts, an overall decline in land productivity.

An alternative to this traditional approach is to learn more of the unique characteristics of woody plants so they can be better utilized to meet the needs of people in developing countries. Researchers in northeastern Brazil, working through joint efforts of Brazilian and US agencies¹, are using this approach to improve the production of sheep and goats in tropical woodlands. The results achieved will likely have applications in many other parts of the developing world.

Five woody species are being studied by researcher Linda Hardesty of Utah State University. Sabia (Mimosa caesalpinifolia) is preferred forage for sheep and goats year round as well as being a valuable wood producer. Catingueira (Caesalpinia pyramidalis) is browsed only very early in the growing season, but supplies important forage in the form of fallen leaves during the dry season. Jurema Preta (Mimosa acutistipula) is a spiny evergreen browsed year round. Marmeleiro (Croton hemiargyreus) is an aggressive invader of disturbed sites and has negligible wood or forage value. Pau Branco (Auxemma oncocalyx) produces excellent timber, but has no forage value.

Stumps of all these species regenerate rapidly and prolificly after cutting and produce masses of new shoots called coppice. This coppice growth is being studied to determine its quantity and quality as potential dry season forage in stands subjected to different tree-cutting methods. Treatments include cutting during different seasons; and browsing, or slashing the coppice growth produced.

Initial results are highly encouraging that forage conditions can be improved through simple variations of the traditional land clearing practices. Most striking was the delay in leaf-fall of coppice growth caused by goat browsing during the rainy season. Moreover, stumps were able to resprout repeatedly following heavy defoliation by animals. This flush of leaves remained green throughout the dry season, providing a potentially valuable source of nutritious forage during the period

¹ Brazil and the US are working jointly through the Small Ruminant Collaborative Research Support Program, sponsored by USAID, and the Centro Nacional de Pesquisa de Caprinos, the sheep and goat research center of Brazil's agricultural research agency EMBRAPA.

normally viewed as a nutritional stress period. Goats browsing coppice growth during the rainy season made heavy use of species not normally browsed, including Pau Branco, Marmeleiro, and green Catingueira. Thus coppice growth is not only more accessible, but apparently more palatable than foliage of intact trees. Investigation into the nutritional quality and quantity of forage that can be produced by these methods is continuing.

Collaborating scientists in this research were: Linda Hardesty and Joao A. Araujo.

A LAND CLASSIFICATION SCHEME USEFUL IN AGRICULTURAL EXTENSION

Understanding the productive potential of land in a local area is fundamental to any agricultural research or development scheme. This information is absolutely critical in tropical regions of the world where soils are often infertile and can impose severe limitations on crop and livestock production.

Intensive soil surveys have been done for most areas of the developed world, but in many developing countries, such information simply does not exist or is so general in scope that its usefulness is nil on a local planning level. It matters little if one is talking about subsistence crop production, large irrigation schemes, or livestock production from animals grazing rangelands; soils limit and determine the kinds and amounts of crops or native vegetation that can be produced, and in-turn, the economic yields possible for a particular area. Land classification schemes that are understandable and applicable by local practitioners and extension specialists are especially needed for developing countries where sophisticated laboratory back-up is not available.

Researchers working in the semiarid tropics of northeastern Brazil have devised a land classification scheme that promises to meet the criteria mentioned above. Their aim is to develop ways to better utilize the native rangeland of the area (a woodland locally known as "caatinga") for production of sheep and goats and to better integrate the shifting subsistence cropping practiced by small holders into the animal production scheme.

Joao S. Queiroz, a soil-plant ecologist from Utah State University and an associate of the Small Ruminants Collaborative Research Support Program has been working with scientists of Brazil's Centro Nacional de Pesquisa de Caprinos in this effort. Using a combination of traditional and space-age technologies (on-the-ground mapping and LANDSAT satellite imagery), Queiroz has developed the structure of a land classification scheme that, with modifications to fit local conditions, might be extended to wider areas of Brazil and other tropical regions of the world. He first modified conventional soil classification procedures to fit the needs of northeastern Brazil. Queiroz then described in detail the vegetation present on each of his newly defined "soil units". Through statistical procedures called cluster analysis, he was able to assure that the soil-plant associations were valid, and that soil features easily seen in the field could be used as reliable indicators of chemical properties that determine plant distribution and growth.

This analysis revealed that most of the soils in the area studied could be placed in three broad categories. These were distinguishable primarily on the basis of soil color or the presence of a sub-surface clay pan that impeded drainage. Red clays were relatively fertile, well drained, and were productive for either cultivated crops or range forage. Clay-pan soils were infertile, often poorly drained, and were limited primarily to range forage production on a limited basis. Undeveloped soils were low in water holding capacity and intermediate in

fertility and could be cultivated or used productively for native forage production.

The real potential of this land classification scheme resides in its simplicity. As developed in Brazil, it uses terminology common to local producers and extension agents, yet it is sufficiently accurate to be useful to researchers.

Researchers working on problems of animal agriculture must continue to ask themselves how best to translate their findings from the experiment station to the conditions of the producer. A reliable land classification method is essential in this transfer.

Collaborating scientists in this research were: Luis Viera Vale and Joao Ambrosio Araujo.

MULTIDISCIPLINARY RESEARCH PROGRAM
UNDERWAY IN NORTHEAST BRAZIL

A collaborative multidisciplinary research project has been initiated at the CNPC Sheep and Goat Laboratory in Sobral in collaboration with the SR-CRSP. The basic structure of the project, whose aim is to investigate the relationship between the reproduction of the female goat and its diet, is completely flexible, allowing the controlled input of research ideas around a common experimental design, thus attaining an efficient utilization of the available resources. As originally formulated and approved, the emphasis was placed on nutritional and reproductive questions, but soon researchers from other disciplines recognized the opportunity provided by the broad span of the basic experimental design. In less than a year, health related, immunological and range management components have been added to the experimental objectives, while animal management observations are continuously accumulated. The project has an on-site team of thirteen resident scientists pursuing several inquiries and is a vital axis of activity for the scientific community at Sobral. True to its name, the project now involves all the disciplines carried at the CNPC, tied by the collaborative spirit of the EMBRAPA and CRSP teams. The effects of the extreme fluctuation of biomass availability on the animal and its productivity, which were evidenced in previous diagnosis concerning herd size growth as correlated to climate, and thus biomass, and the correct interpretation of the recorded and observed reproductive parameters in the animal, are now being quantified. The final aim of this research is to determine the convenience and feasibility of supplementing the animal diet during the drought periods. The project is capable of accommodating new inquiries without disturbing the original experimental design and is the first of a series leading toward the practical modernization of goat production in Northeast Brazil, under a production system approach.

The project was originally formulated by Jorge Kawas, the ME representative, who also acts as coordinator and main nutritionist, and Omar Sanchez, responsible for the reproduction component of the project. Eugene Johnson and Joao Ambrosio act respectively as team leaders in the areas of health-immunology and range management.

Improving Reproductive Performance of Small Ruminants

W. C. Foote

Utah State University

NEW AID FOR BETTER MANAGEMENT OF YOUNG GOAT MALES

The knowledge of age at puberty and fertility in male goats and how to detect it is extremely important, especially in traditional production systems. Research scientists, extension service agents, university professors, animal science students and the producers frequently ask about the maximum age that kids must be separated from the breeding flock to prevent their indiscriminant breeding. On the other hand, they wish to know the youngest age at which males can be used to breed as a tool for decreasing generation interval to increase genetic improvement. A normal prepuberal trait is the attachment of the penis within the sheath. One of the requirements of puberty and resulting fertility is the detachment or freeing of the penis within the sheath.

The collaborating scientists in reproduction recently have shown that penis detachment from the prepuce or sheath is an indication of puberty and the presence of sperm cells in the ejaculate. In goats, the average age and weight observed at penis detachment are 130.6 days and 12.0 kg, respectively. The single born kids attained this stage two weeks younger and 2 kg heavier than twin born kids. Further observations have shown that the ejaculated volume, sperm concentration and sperm motility are stabilized when the animals, on the average, approached 174 days of age. These results provide answers to the questions and serve as a tool for better goat flock management, selection and improvement. The relatively simple procedure of examining older or larger male kids for penis detachment provides a measure of when the offspring have reached functional puberty. The same relationship also appears to exist in sheep.

Scientists of the SR-CRSP/Utah State University Reproduction project and EMBRAPA/CNPC, Northeast Brazil, have been collaborating in this research.

Personnel collaborating in this research were: Aurino A. Simplicio, Jose F. Nunes, Antonio Emidio F.D. Silva, Jose U. Alves and Angela M.X. Eloy for EMBRAPA/CNPC; Warren C. Foote and Gerardo S. Riera for Utah State University; and Edward A. Nelson and Edward S. Fonda for Cal State Polytechnic University.

GOAT SEMEN QUALITY BASED ON SCROTUM MORPHOLOGY

As many as 30% of male goats in tropical and subtropical areas have a divided scrotum (each testicle in a separate scrotal pouch). This is true of goats in Northeast Brazil. It has been suggested that this represents an anatomical adaptation to their environment to increase surface area and enhance heat loss of the testicles in relation to body temperature. The producers appear to prefer males with this characteristic because they believe they are more fertile than those with a non-divided scrotum. Because of this belief a major emphasis is often placed on selecting for this trait at the expense of other traits known to influence reproduction and production. It is therefore important to determine if a relationship exists between a divided scrotum and fertility.

A two year study conducted at the EMBRAPA/National Research Center for Goats in northeast Brazil by national and AID Title XII, SR-CRSP/USU reproduction scientists has shown that bucks with a divided scrotum produced semen with higher ejaculated volume (0.82 ml) and lower proportion of pathologically abnormal sperm cells (7.7%) compared to bucks of non-divided scrotum (0.56 ml and 23.2%, respectively). No differences were found between these two types of bucks in mass motility and sperm cell concentration in the ejaculate. During the dry season, characterized by the hottest temperatures, bucks with a divided scrotum produced semen with significantly less proportion of abnormal sperm (5.4%) compared to goats with non-divided scrotum (32.9%). The results of this study show that the bucks with a divided scrotum provide better semen. Additional research is being conducted. If these results verify the positive results of the initial studies, this characteristic could be used effectively in selecting breeding males for higher reproductive efficiency in goats.

Scientists of the SR-CRSP/Utah State University Reproduction project and EMBRAPA/CNPC, Northeast Brazil, have been collaborating in this research.

Personnel collaborating in this research were: Aurino A. Simplicio, Jose F. Nunes, Antonio Emidio F.D. Silva, Jose U. Alves and Angela M.X. Eloy for EMBRAPA/CNPC; Warren C. Foote and Gerardo S. Riera for Utah State University; and Edward A. Nelson and Edward S. Fonda for Cal State Polytechnic University.

RESEARCH IN REPRODUCTION AND PRODUCTION OF PRIVATE GOAT FLOCKS IN NORTHEAST BRAZIL

A three year study has been completed to estimate reproduction and production performance and to identify the constraints under traditional goat production systems in producer owned flocks in northeast Brazil. Approximately 4,000 goats from 17 farms and five municipalities were used. A close working relationship between scientists and producers indicates the willingness and interest of producers in collaborating to resolve the goat production constraints and incorporate proven, practical, innovative goat management practices. The producers are easily motivated and cooperate in helping to identify their problems and to establish objectives to solve them. Preliminary analysis of data indicates that congenital abnormalities exist which are considered to be detrimental to reproduction or production. These include supplementary teats (35%) implicated in problems of nursing, kid nutrition and hand milking, and polledness (12%) genetically linked to modification of reproduction systems in both sexes, therefore interfering with fertility.

The flock composition at the initiation of the study was 51.5, 19.0 and 6.5% of adult, yearling and kid females, and 4.0, 13.3 and 5.7% males, respectively. These proportions do not indicate the death loss, disposition by sale or family consumption. However, the low proportion of kids indicates the existence of serious constraints in goat production. These include low fertility and/or prolificacy, a high proportion of fertilization failure or embryo/fetal loss in female goats of the flock and high kid mortality. Goat production could be substantially increased by providing low cost management practices in the small producer flocks. A two year study introducing selected practices demonstrated this potential. A traditional practice is to breed throughout the year. A restricted breeding season may not increase fertility but reduced the abortion rate (1.1%) and mortality rate (3.2%) compared to the control flock (5.9 and 25.7%, respectively). Disinfection of the navel at birth also lowered mortality rate (25.7% in the control flock compared to 4.0% in the flock where the practice of navel disinfection was applied to newborn kids). The effort and cost of these two practices were low and within their resource capability compared to the provided benefits to the producer. This study has also shown that the producer owned goats have a high reproductive potential such as 83 to 92 percent of fertility with 1.6 prolificacy. Innovative management practices applied could significantly improve the kid crop and consequently improve the income of the small goat producer in tropical regions. Further data analysis will provide information about growth rates, actual fertility rate, frequency distribution of kiddings and mortality, proportion of multiple births, kidding interval, age at first kidding, effects of polledness on reproduction, live body weight variation throughout the year, and off-take rates.

Scientists of the SR-CRSP/Utah State University Reproduction project and EMBRAPA/CNPC, Northeast Brazil, have been collaborating in this research.

Personnel collaborating in this research were: Aurino A. Simplicio, Jose F. Nunes, Antonio Emidio F.D. Silva, Jose U. Alves and Angela M.X. Eloy for EMBRAPA/CNPC; Warren C. Foote and Gerardo S. Riera for Utah State University; and Edward A. Nelson and Edward S. Fonda for Cal State Polytechnic University.

REPRODUCTIVE CAPABILITIES OF SHEEP IN THE PERUVIAN HIGH ELEVATION ALTIPLANO

Scientists from the National Agrarian University (working at CONSAC, SAIS-Tupac Amaru, 3800 m.a.s.l. *) and National Mayor San Marcos University (at IVITA La Raya Experiment Station, 4200 m.a.s.l.) in collaboration with Title XII SR-CRSP/Utah State University Reproduction project, have found that the incidence of ovulation was higher during January to August (32-76%) with an average mean ovulation rate of 1.08 (1.0 to 1.27). The higher incidence of estrus for the same sheep was during February to September (35-74%). This performance varied also due to breed, with the Criollo tending to have a longer breeding season than the Corriedale or Junin. Additional studies showed 74.5 percent fertility with a lambing rate of 1.01. By crossbreeding with prolific breeds of sheep (in cooperation with USAID Title XII SR-CRSP/Montana), the ovulation rate was enhanced to 1.30, and using hormone therapy, the ovulation rate was increased to 2.45 and the lambing rate to 1.32. The analysis of ovulation and lambing rate of ewes showing estrus demonstrate fertility rates of 45% and potential lamb loss through fertilization failure and embryo/fetal loss to be 74.5%. These data demonstrate that the reproductive performance is limited by the naturally low incidence of estrus and ovulation and the large proportion of fertilization failure and/or embryo-fetal loss. Potential reproduction is limited by genetics (occurrence of estrus and ovulation and ovulation rate) but increases in realized reproduction performance where this potential is increased through changes in genetics or use of hormones remains low implicating limiting environmental factors such as altitude and/or feed availability.

Four Peruvian institutions (Instituto Nacional de Investigacion y Promocion Agraria, INIPA; Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, IVITA-UNMSM; Universidad Nacional Agraria - La Molina, UNA; Universidad Nacional Tecnica del Altiplano, UNTA) and Title XII, SR-CRSP/Utah State University Reproduction Project are collaborating in this research.

Collaborating personnel in this research were: Cesar Novoa, Julio Sumar, Walter Bravo, and Jose Camacho for IVITA-UNMSM; H. William Vivanco for UNA-La Molina; Maximo Gamarra for SAIS Tupac Amaru Consac and UNMSM; Warren C. Foote and Gerardo S. Riera for Utah State University; and Edward A. Nelson and Edward S. Fonda for Cal State Polytechnic University.

* m.a.s.l. = meters above sea level.

SHEEP REPRODUCTION AND PRODUCTION CAPABILITIES IN PRIVATELY OWNED FLOCKS IN THE COMMUNITIES

The sheep population in Peru is approximately 15.3 million, 92% of which are located in the central (35.9%) and southern (56.1%) sierra. Eighty percent of the sheep population are Criollo and the remaining 20% are varying degrees of improved stock primarily with Corriedale and Junin breeds. The majority (80%) of the sheep belong to small producers in the communities and the remaining (20%) are kept by large, associative organizations.

A team of scientists from the National Agrarian University, La Molina, Peru; San Marcos University, Lima, Peru; and the USAID, Small Ruminant Collaborative Research Support Program (SR-CRSP) is working with small producers in the Central Sierra whose primary products come from sheep. These producers have demonstrated a willingness and ability to help identify reproduction/production constraints and develop practical management practices within their resource capability to minimize these constraints and increase meat and wool production.

Levels of general reproduction (77.2%) and consequently production are low (26.9% mortality) due primarily to the rigors of the harsh environment, lack of adequate nutrition, occurrence of disease and the lack of information on required management practices to reduce or eliminate these stresses and resources to provide for changes in management practices.

The fertility level varies from 48.4 to 83.5 percent indicating that significant variation exists among producers. The prolificacy rate of ewes in three farms observed was 1.0. The peaks of lambings and lamb mortality observed were from May to September (87.2%) and May to October (83.3%), respectively. This trend shows that matings for most of the ewes occur during the rainy season, when the availability of forage is the best. The higher incidence of mortality observed was during the dry season, which is characterized by shortage of food and consequently lower lactation which contributed to increased lamb losses.

These findings establish the importance to develop innovative management practices, such as the use of a selected restricted breeding season, to enhance fertility rate, to provide adequate newborn lamb management, to synchronize the food available in relation to the reproduction/production stages of the sheep, to improve fertility, lactation, lamb survivability and to increase the lamb crop.

Four Peruvian institutions (Instituto Nacional de Investigacion y Promocion Agraria, INIPA; Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, IVITA-UNMSM; Universidad Nacional Agraria - La Molina, UNA; Universidad Nacional Tecnica del Altiplano, UNTA) and Title XII, SR-CRSP/Utah State University Reproduction project are collaborating in this reproduction research.

Collaborating personnel in this research were: Cesar Novoa, Julio Sumar, Walter Bravo, and Jose Camacho for IVITA-UNMSM; H. William

Vivanco for UNA-La Molina; Maximo Gamarra for SAIS Tupac Amaru Consac and UNMSM; Warren C. Foote and Gerardo S. Riera for Utah State University; and Edward A. Nelson and Edward S. Fonda for Cal State Polytechnic University.

FERTILITY IN ALPACA

There are approximately 3.1 million llamas and 3.6 million alpacas in the world. These are found primarily in the Andean region of South America and represent the primary resource for 200,000 peasant families. These species have adapted to the harsh and inhospitable extensive high altitude Andes, converting poor quality native pasture to valuable human consumption commodities.

The reproductive efficiency of alpacas is low (approximately 50%). Numerous reproductive management practices were examined to improve levels of reproduction. Several factors seem to be involved and no single factor is positively indicated as responsible. Male related infertility may account for much of this problem. Thousands of male alpaca reproductive tracts have been inspected by IVITA-La Raya Experiment Station scientists, giving information about a high proportion of abnormal testicles (11.5%). The alpaca producers are not using male selection procedures to improve flock fertility. The ovulation, fertilization, embryo and fetal failures in alpaca are high. Peruvian scientists from San Marcos University/IVITA at La Raya experiment Station, Walter Bravo and Julio Sumar in collaboration with AID Title XII, SR-CRSP/Utah reproduction project, used a hundred alpacas and found 83 percent total reproductive failure using a single mating technique. This reproductive wastage was broken down as follows: 41% ovulation failure; 32% fertilization/embryo failure from conception up to 30 days postbreeding; 10 percent fetal failure from 30 to 90 days of gestation. From 90 days of gestation to parturition, no more losses were observed. The alpacas as well as llamas are copulation induced ovulators (ovulating in response to copulation). The incidence of ovulations seem to be closely correlated to intensity and repetitive coital stimulus. To increase the incidence of ovulation, conception rate, and probably normal corpus luteum function, multiple matings to each female are necessary. These results indicate the usefulness of multiple matings and the need to develop and test other reproduction related management practices to minimize their constraints.

Four Peruvian institutions (Instituto Nacional de Investigacion y Promocion Agraria, INIPA; Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, IVITA-UNMSM; Universidad Nacional Agraria - La Molina, UNA; Universidad Nacional Tecnica del Altiplano, UNTA) and SR-CRSP/Utah State University Reproduction project are collaborating in this reproduction research.

Collaborating personnel in this research were: Cesar Novoa, Julio Sumar, Walter Bravo, and Jose Camacho for IVITA-UNMSM; H. William Vivanco for UNA-La Molina; Maximo Gamarra for SAIS Tupac Amaru Consac and UNMSM; Warren C. Foote and Gerardo S. Riera for Utah State University; and Edward A. Nelson and Edward S. Fonda for Cal State Polytechnic University.

Kenya Animal Health Research Component

T. C. McGuire

Washington State University

COLLABORATIVE RESEARCH IN KENYA LEADS TO IMPROVED VACCINE AGAINST CONTAGIOUS DISEASE

Research scientists with the Kenyan Ministry of Agriculture and Livestock Development (MALD) and the Small Ruminant Collaborative Research Support Program (SR-CRSP) have made phenomenal progress toward the control of contagious caprine pleuropneumonia (CCPP), through research jointly sponsored by USAID, MALD and U.S. universities.

CCPP is caused by a mycoplasma organism termed F-38 and occurs in outbreaks resulting in high mortality that constrains goat production. This organism has been isolated from outbreaks of CCPP in Kenya and in other African and Arabian Peninsula countries.

The most important research results are the complete protection of contact challenged goats by an inactivated and lyophilized vaccine. These developments are an extension of research begun several years ago by the MALD and a German agriculture team. The present program is now being supported by Washington State University under a subgrant from USAID's SR-CRSP program.

The new vaccine has a shelf life of at least three months and it has provided protection from contact challenge by experimentally infected goats when animals are vaccinated with two doses. Once scientists determine the duration of immunity, they will begin large field trials with the vaccine.

In addition to development of the vaccine, researchers have identified and isolated a mycoplasma surface protein that will induce neutralizing antibodies and a protective immune response in vaccinated animals. This protein is a candidate antigen for a vaccine produced by new biotechnology such as gene cloning into Escherichia coli with subsequent protein expression for vaccination.

The research team has also isolated a carbohydrate antigen from the causative mycoplasma that will form the basis for a rapid field diagnostic test for CCPP. Tests are now being conducted in large centralized laboratories.

As soon as current studies are completed, the diagnostic tests and vaccine can be used in other countries where CCPP is a major problem for goat producers. These countries extend from West Africa into Asia. Plans are now under way to link up with private industry to develop the vaccine in quantity for widespread future use. Also importantly, it is felt that the same procedures developed in this research could be applied toward control of contagious bovine pleuropneumonia which is an even more economically devastating disease.

Collaborating personnel in this research were: Fred Rurangirwa and Alfred Kibor of the MALD along with Travis McGuire of Washington State University.

GLOBAL SURVEY OF SEROLOGICAL EVIDENCE OF
CAPRINE ARTHRITIS-ENCEPHALITIS VIRUS INFECTION

A recent publication in the Veterinary Record (115:493-495, 1984) by SR-CRSP scientists and collaborators from various countries on caprine arthritis-encephalitis (CAE) virus infection indicates where the infection is prevalent in the world and gives insight into the major method of virus transmission.

Serum samples from Canada, France, Norway, Switzerland and the United States had 65% or greater reactors. Fiji, Great Britain, Kenya, Mexico, New Zealand and Peru had 10% or fewer positive samples; most of the positive samples could be traced to importations of goats from countries with a high prevalence of CAE virus reactors. No reactors were found among serum samples from Somalia, Sudan and South Africa.

The high occurrence of CAE virus infection among dairy goats in countries with intensive dairying practices and the low occurrence in countries with little or no dairy goat industry may have an explanation. Virus is transmitted in colostrum and milk and it is common practice in some countries to pool colostrum and milk from several does to feed it to kids. This practice would allow a rapid increase in the percentage of infections once an infected animal was introduced into the herd. Other factors also may make transmission under dairying conditions more efficient than under pastoral conditions.

Collaborating personnel in this research were: Scott Adams of the United State Department of Agriculture and Travis McGuire of Washington State University.

TRANSMISSION AND CONTROL OF CAPRINE ARTHRITIS-ENCEPHALITIS VIRUS

Studies on the epidemiology of caprine arthritis-encephalitis (CAE) virus infection by the SR-CRSP scientists in the United States and in collaborating institutions overseas, have resulted in methods to control spread of the virus.

CAE virus occurs in goat colostrum and milk and is transmitted to kids when they nurse or drink colostrum and milk. Sustained contact for over 12 months between weaned virus-free goats and virus-infected goats was necessary before horizontal transmission could be demonstrated. Horizontal transmission from infected bucks to negative does during breeding is very inefficient and perhaps nonexistent.

The high frequency of transmission to kids by ingesting colostrum and milk and the relative difficulty of horizontal transmission led to a program of eradication. The program includes removing kids from their dams at birth, feeding virus-free sources of colostrum and milk and complete isolation from other goats until weaning. Results from following the eradication program indicate that CAE virus-free herds can be established.

Collaborating personnel in this research were: Scott Adams of the United State Department of Agriculture and Travis McGuire of Washington State University.

**Economic Analyses of Small Ruminant Production
and Marketing Systems**

A. J. DeBoer

**Winrock International Livestock
Research and Training Center**

MULTIDISCIPLINARY TEAM RESEARCH AT CNPC-EMBRAPA, SOBRAL
RECEIVES SR-CRSP SUPPORT

Understanding production systems in Northeast Brazil is a vital first step in designing appropriate, targeted research programs. In collaboration with CNPC-Sobral scientists the SR-CRSP is helping to sponsor a good example of this approach in the periodical survey of small ruminant producers in Ceara state which started in 1980. This served as the main source of information to conceptualize the production systems and start the diagnosis of the main bottlenecks at the producer level. The survey involved economists, veterinarians, and animal breeders. Some of the findings and recommendations were summarized in early 1985 by the breeding and economic groups.

An evaluation of the on-farm performance of small ruminants indicated that the Bergamacia sheep breed was significantly larger than the Santa Ines and Crioulo breeds. No difference in size was found between the latter two breeds. A crossbreeding program using Santa Ines breeding rams could possibly increase uniformity in the sheep flock. If superior animals could be properly identified, a selection program in sheep flocks for increased body weight might also be successful.

Goat weight comparisons did not show the Anglo-Nubian to be superior to the Sem Raca Definida (nondescript, SRD). The relative superiority of the former breed under experimental conditions is masked under traditional farm-system management.

It appears that producers will use goat herds to make better use of the poorest grazing areas on their farms. Thus, goats will always be subject to the worst environmental conditions. As a result, superior animals for genetic improvement will be nearly impossible to identify, which makes a breeding program based on selection for body weight or crossbreeding impractical under present farming conditions in the surveyed areas.

A further analysis of the same periodical information by the same group of researchers showed interesting results on the composition and dynamics of the herds and flocks in the studied region. The relative importance of sheep declined over the monitoring period, probably because of the onset of a drought. Goats were the preferred species during the drought. Herd and flock population distribution were then assessed for the potential to respond to selection programs.

Frequencies of normal and abnormal phenotypic traits and their probable effects on sheep and goat weights at the farm level was also estimated. These results are summarized below.

Sheep flocks are largely formed by hornless, white-wooled animals. It was found that 9% were horned and 7% had rudimentary horns. Even though the majority of animals were white, coat colors such as spotted (30%), red (14%), black (6%), and gray (6%) were also identified. About 36% of the population were hair sheep and 87% had no wattles.

Goat herds are basically formed by horned, spotted, and dark-colored animals. Other coat colors such as all gray and all white were also

identified, but they formed only 22% of the herd population. Only about 14% of the goats were hornless. Ninety-two percent of the goats had no wattles.

None of the studied phenotypic characteristics (hornedness, coat color, wool coverage in sheep, and wattles) were found to influence dry-season body weights of adult females of the Crioulo sheep breed or the Sem Raca Definida (SRD) goat breed.

Of the abnormal phenotypic traits studied, only accessory teats and prognathism were frequently reported for both sheep and goats. Nonprognathic goats were heavier than prognathic ones. Selection against accessory teats and prognathism should be taken into consideration in breeding programs for the region.

The incidence of a probably adaptive trait for testicular thermoregulation is reported as well as the observation of a male milking goat.

Collaborating personnel in this research were: Nestor Gutierrez and John DeBoer.

UNDERSTANDING RELATIONSHIPS BETWEEN LAND ENDOWMENT AND ANIMAL MANAGEMENT PRACTICES OF SMALL RUMINANT PRODUCERS

Scientists from the CNPC-EMBRAPA and the SR-CRSP in the Range and Economics projects conducted a detailed field survey in 1984 to study interrelationships between soil types, vegetation, economic characteristics of producers, and animal management practices. The latter aspect focused on species mix, stocking rate, and grazing dynamics for each land type. These interrelationships were then studied to ascertain how different groups of producers responded to a prolonged period of drought.

Small ruminant producers in this area engage in a variety of crop production strategies, which reflect the farm resource base and the need for diversity due to an unpredictable environment. Different levels of effort are associated with the production of the different livestock species and in the cultivation of different soil types. Thus, cattle are intensively managed compared to small ruminants and good soils are intensively cultivated relative to less productive soils. It is also apparent that traditional farmers consider both activities (livestock and crops) essential for the persistence of the system and welfare of their family. They are unlikely to sacrifice one for higher short term returns on the other.

By considering only major features of the grazing systems used, it was possible to isolate 16 different management strategies that are structured in accordance to the ecological environment, grazing resources, availability of crop residues, and farm infrastructure. In each of the 16 grazing systems, a priority by livestock species has been established. Cattle are always assigned to fields with the best grazing conditions followed by sheep then goats. The latter species will invariably be assigned to graze native caatinga.

A second aspect studied by the same group of researchers for the same sample of producers was oriented to compare producer's strategies for coping with the drought in regard to the herd composition, stocking rates, animal condition, supplementation, and water supply in both 1980 and 1983. These two years marked the beginning and the end of the drought.

It was observed that during the drought period (1980-1983), producers readjusted their stocking rates by reducing the number of total animal units and changing the livestock mix of their farms. However, this is accomplished mainly by reducing cattle and increasing goat animal units, with sheep flocks having minimal changes.

It was observed that farms that had cattle, sheep, and goat herds survived relatively better during the drought than farms with cattle and sheep only. The latter farms started to incorporate goats at a later stage of the drought period, probably as a strategy for survival. It should also be kept in mind that sheep and goat flocks can be increased in numbers at a much faster rate than cattle herds. This fact also adds flexibility to the system when drought conditions disappear and cattle herds are built up again and small ruminants often gradually replaced.

Collaborating personnel in this research were: Nestor Gutierrez and John DeBoer.

FARMER PARTICIPATION BECOMES AN IMPORTANT COMPONENT OF INDONESIAN LIVESTOCK RESEARCH

One of the problems of farming systems research (FSR) is to maintain motivation of farmers and scientists to collaborate in on-farm research. The livestock component of farming systems tends to be neglected for various reasons. Moreover, specific factors such as mobility of animals, long-life cycle of animals, lack of synchronization of experimental units, nondivisibility and size of units, multiplicity of outputs and high statistical variability differentiate livestock-oriented FSR from crop-oriented FSR and aggravate the problems of livestock on-farm research.

The SR-CRSP team of animal and social scientists introduced regular research field hearings (RRFH) to overcome some of the above problems.

The general objectives of the RRFH are:

- Enhance dialogue between farmers, researchers, and extension personnel. Lack of understanding by any participator results in lack of motivation.
- Discuss specific situations, problems, and technologies in breeding, reproduction, feeding, health, management, and marketing of livestock.
- Develop field recommendations for village farmers concerning breeding, feeding, and farm management, among others, by increasing the probability of "new discoveries" at the farm level.
- Contribute to the farmer's knowledge of different animal husbandry practices and to researcher's understanding of small ruminant production problems and constraints in the village.

In livestock research, RRFH have two additional specific objectives. It increases the willingness of the farmers to submit animals to testing. Most of a farmer's savings is in his livestock, and it is obvious that he is reluctant to submit his animal to any risk. Indeed, it is less risky for a farmer to try out a new foodcrop variety on a corner of his land than to submit his animal to crossbreeding. This risk factor has two implications. On-farm livestock experiments need to be very carefully screened and thoroughly discussed. The RRFH can serve as the appropriate forum of discussion (ex ante evaluation) of the new technology. Also, an "insurance" provision that guarantees farmers' compensation for losses is warranted.

The last and possibly most important justification of RRFH is the need for farmers' assessments of the results of the field experiments. Lack of sufficient replications and large variability in farmers' management and animal performance, as well as environmental conditions, will cause large statistical variability of results. In such a case many trials might show differences between treatments that are not statistically significant. Individual farmers however, evaluate interventions not by comparing results between farms or treatments, but in relation to his production experience built up over his farming career. Greater use of farmer cooperators in assessing intervention must be made than has been the case in cropping systems research.

These goals are pursued by a series of monthly meetings between scientists and farmers which have the following features:

1. Feedback. The emphasis of the meetings is on feedback. The scientists come to the field to discuss and listen, not to preach and (or) teach. On one hand this orientation increases the awareness of the scientists about the farmer's environments and motives; on the other, the farmers realize their own important role and responsibility.
2. Regularity. The willingness of farmers to submit their animals to the testing of new technologies depends upon their understanding of the interventions, as well as their trust in the collaborating scientists. One or two meetings are not sufficient to create a trusted relation between scientists and farmers.
3. Multidisciplinary. Farmers are multidisciplinary, therefore the meetings have to be conducted by multidisciplinary teams of scientists, where each team member provides his own unique expertise.

The Indonesian Experience

On West Java, RRFH have been held over a full year period with nearly monthly intervals at the three locations chosen as the SR-CRSP study sites. These sites represent three different ecosystems but are also characterized by major differences in cultural and social backgrounds, farming systems, animal raising methods, and agricultural and physical backgrounds. Research results are reported in a series of Working Papers.

As the audience reached by the English language Working Papers (also resulting in a number of journal articles and abstracts) was restricted to the scientific community, some scientists in the program realized that the target group was not being reached. The objective of the first meetings was to convey to the farmers some of the early survey results. This series of meetings (four meetings at three sites) resulted in such animated discussions, that participating scientists were quick to realize its qualitative information and evaluative value.

Nevertheless, it was feared that as the "newness" of the RRFH wore off, less effort would go into the preparation of the RRFH, and the interest of the farmers would wane. Therefore, the responsibility for the conduct of the RRFH was clearly defined, and rotated by disciplinary subprograms, i.e., breeding/reproduction, nutrition and socioeconomics. Animal health is under the mandate of a sister research institute, the Research Institute for Veterinarian Sciences. This component is being added to the RRFH in the form of "guest speakers".

During the nine series of meetings in the first year (1983-1984) records were kept on attendance, number of comments and questions, and type of discipline leading off the RRFH with the introductory report. The data show that in each village the farmers interest toward the meeting were relatively similar, although certain differences existed, particularly between locations.

There was no significant effect of the topic discussed on the attendance, the frequency of comments and the number of questions. Topics on breeding, nutrition, or socioeconomics also attracted the farmer's interest. Attendance remained high during the full year cycle of RRFH.

A positive result from the RRFH was the increasing involvement of the village staff employed by the research institute at the different locations. Apparently, attendance by local extension agents increased too, as well as that of local administrators. In some cases, these participants turned the meeting into a promotion rather than a debate. At several occasions even the chairing scientist slipped into the role of teacher, one too easily accepted by the farmers accustomed to play theirs, i.e, that of passive listeners. It is clear that a heavy responsibility lays on the shoulder of the person leading the RRFH to maintain its "hearing" character.

On two occasions field trips were organized as a result of RRFH discussions. The first time a group of farmers visited two large-scale commercial farmers who used a high level of paid inputs and obviously fared well by it. The second time a group visited a village where a number of high yielding grasses and shrubs had been introduced. Both trips were daylong and highly animated. The total cost of both occasions was less than \$100 as farmers brought their own food. The cost of RRFH is limited to the purchase of refreshments, always less than \$10 per meeting.

Presently two trials are underway: a reproduction trial in the coastal area, and a nutrition trial in the upland area. More are expected. The RRFH obviously have contributed to the farmers' willingness to participate in livestock experiments.

Collaborating personnel in this research were: Hank Knipscheer and John DeBoer.

INDONESIAN COLLABORATIVE RESEARCH WITH THE SR-CRSP
LINKS UP WITH AID DEVELOPMENT PROGRAMS

The SR-CRSP in Indonesia pursues linkages with existing development programs that have an important sheep or goat component. This is done for two reasons. First, the development programs such as transmigration, watershed, and (or) regional development programs are an expression of the priority that the Government of Indonesia allocates to those areas where they are being implemented. Secondly, these programs often offer the appropriate type of support services required to test and implement improved technologies.

During the last year, the SR-CRSP has participated in two large development programs, both sponsored by the AID Mission in Jakarta. For the Provincial Development Project (PDP), a broad survey was conducted in three different provinces in Indonesia -- Aceh, South Kalimantan, and East Java (Madura). In these provinces, animals (goats, cattle, water buffalo, and poultry) were "dropped" to small farmers who then bred the animals and repaid the project by returning a number of offspring within a specified period of time.

Since 1979, when the first of these projects was initiated, no evaluation of production performance of these "dropped" animals had taken place. The SR-CRSP study was therefore designed to determine reproduction and production performance over time, and to measure farmers' perception of production constraints (such as disease and other problems). Data were collected from local government officers and directly from recipient farmers.

In general, the survey showed high mortality rates and low reproduction rates during the first year(s) after the distribution of animals. The findings indicate the need for improved transportation facilities and gradual changes in animal diet. Production rates at a later time among surviving animals were generally satisfactory although variation between type of animal and location was found.

Another project to which the SR-CRSP activities have been linked is the Citanduy II project, now being expanded to the Indonesian Upland Agricultural and Conservation Project. The SR-CRSP participated in a broad review of watershed projects on Java. Some of the findings were:

- The fundamental issue of erosion is one of "overuse" of land because of population pressures. Development of the livestock sector in upland area in general deserves attention. For farmers with minimal landholdings, livestock may offer the best employment opportunity. Rather than solely emphasizing food production in upland areas of low soil fertility, the possibility of livestock development as a first source of income should be seriously explored.
- Seemingly, the cultivation of high yielding grasses had not been adopted spontaneously by farmers surrounding the demonstration areas. This might have been due to a lack of extension efforts, or to the lack of economic viability of the package. This aspect

deserves further research. It should be understood, however, that the success or failure of the introduction of new grass varieties is only partly dependent on their yield production and ability to control erosion. Other important criteria for screening are palatability and digestibility. These aspects were overlooked.

- At most project sites, the livestock expertise was limited to the planting and growing of grasses. As animals are a crucial component of the total package, the availability of livestock management expertise at the project site on a day-to-day basis is essential.
- The general focus of the projects was on goats and sheep rather than other species. The advantage of small animals are among others, their divisibility, the rapid turn-over of capital and their marketability. However, other livestock species such as poultry and cattle each have their own benefits. Depending on the comparative advantage of each project area in terms of farmer objectives, water, labor and other input requirements, productivity, marketability and income equity, each of the species should be assessed. In some cases a combination of livestock species, rather than a single kind, might be desired. In view of the importance of soil maintenance, the quantity and quality of the produced manure might also be an important criteria for species selection.
- Field grasses generally are considered a public good. Improved grass varieties are owned by the landowner and (or) the person planting the grasses. Attention was not yet given to the availability of improved grasses to landless farmers. Arrangements of contract by which landless farmers might be allowed to cut high yielding grasses in return for manure is a way to use the rural labor resources fully while preventing the selling of manure by landless livestock holders outside the area.
- Public land and forest land were found to be important feed resources. The planting of high yielding grasses or shrubs in these area is possible if aspects of ownership and use can be solved.
- The link between fuelwood and fodder requirements deserved further investigation. Although progress is made everywhere in the screening and introduction of grass varieties, at most of the sites only a few shrubs and trees were established. The slower growth rate of this kind of vegetation should not prohibit its inclusion at the testing and (or) demonstration sites.
- In some instances, the profitability of the livestock enterprise could be raised by improving the marketing conditions for the farmers. In particular, in isolated project areas or in project areas where the livestock population is relatively low, markets for animals may be dominated by only a few traders. Better accessability to markets and market information will improve the

chances of expanding the livestock component of the farming systems, hence the economic viability of grass/shrub cultivation.

Besides the two above studies, the SR-CRSP organized a workshop on animal sharing systems with special focus on the Provincial Development Project and the Citanduy II Watershed Project during November 1983. During the same month the SR-CRSP host institution in Indonesia, the Center of Research Institute for Animal Sciences (CRIAS), could count 25 participants from these two

projects among the 200 persons attending the Sheep and Goat Scientific Meetings at Bogor (Ciawi), November 23-25.

Collaborating personnel in this research were: Hank Knipscheer and John DeBoer.

RESEARCH BRINGS INDONESIAN AND US SCIENTISTS CLOSER TO FARMERS IN INDONESIA

Sheep and goats are important for a large part (20%) of the Indonesian rural population, not only for the generation of income, but also for reasons such as manure production, social status, and risk avoidance. Sheep and goat research has been neglected for a long time. Present management techniques are little different from those 50 years ago, yet the SR-CRSP research indicates that the present productivity of sheep and goats is still far below their genetic potential, mainly because of inefficient management techniques.

Last year, a sheep and goat management training exercise brought research results closer to the farmers during a successful workshop on meat and milk production in Indonesia. Thirty participants, all extension workers, took part in this course; two from Malaysia and all the others from Indonesia. About half the participants were active in Private Volunteer Organization (PVO) projects, the other half consisted of government extension agents. Together they covered as many as thirteen provinces in Indonesia. The course was co-sponsored by Winrock International under the USAID matching grant No. PDC-0182-G-SS-1086-00 and the Center of Research Institute for Animal Sciences (CRIAS), which is also the host institution for the SR-CRSP in Indonesia.

All the interactions and demonstrations during this 2-week course, which lasted from July 8-22, 1984, were prepared and presented by the SR-CRSP research collaborators. It was the first time that this Indonesian research institute organized a course with the specific purpose of dissemination of research results.

At the end of the course, an anonymous evaluation survey was conducted among the participants and their reaction was overwhelmingly positive: 86% present felt that they now were able to instruct other extension agents or farmers. Nearly all participants (90%) agreed that supporting materials for personal uses, class notes, and other related publications were very useful and important for their tasks. Despite a general complaint about lack of time during the training because of the overloaded program, the majority (76%) felt that they had sufficient time to do their work in class, practical sessions, and reviews. Most important, nearly all participants (95%) felt that they would make a great change in their work at home as a result of their additional knowledge in small ruminant production gained from the training, particularly in record-keeping, diet formulation, and housing systems.

An additional result of this collaborative effort of two USAID-funded programs was the translation of the "Goat Health Handbook" into the Indonesian language. This translation appeared a few months after the sheep and goat management course. This book has been widely distributed in both Indonesia and Malaysia.

Collaborating personnel in this research were: Hank Knipscheer and John DeBoer.

PARTIAL BUDGETING PROVEN USEFUL EVALUATION TOOL
FOR DUAL PURPOSE GOAT TECHNOLOGIES IN KENYA

The development of new technologies is a continuous process of redesign and reevaluation. At each stage of technology development, new systems are screened and the most promising ones selected for further research. Social scientists should participate in this ex ante evaluation of new farming systems or new technologies.

In the Kenyan SR-CRSP, partial budgeting has proved to be very useful for the screening of new dual purpose goat technologies.

The partial budgeting model is based upon the idea that only a minor (partial) change rather than a major (complete) change in farm operation is contemplated. The analysis therefore focused on that minor change in isolation, ignoring the rest of the farm operations. In similar ways, the partial budgeting of biological trials data can also be carried out. The technique analyzes data from individual traits about particular farm practices in isolation. It does not take into account comprehensively the inter-relationships that exist among the results of feed resources, nutrition management, health and breeding projects. Such inter-relationships can only be adequately dealt with through whole farm modeling at a later stage of technology development. (Therefore, input-output coefficients are being compiled for subsequent whole farm [linear programming] modeling.)

The partial budget analyses of technical biological data involved quantification of costs and benefits of various production and management practices conducted by biological on-farm and station trials and identification of economically feasible practices. Common methods for summarizing and analyzing farm management data were applied such as frequency distributions, tabular analysis, and accounting techniques; mainly partial budgeting and gross margin analysis. The partial budget model is outlined below.

DEBITS

- a. additional costs
- b. reduced receipts

Incremental costs
Marginal net benefit

CREDITS

- c. additional receipts
- d. reduced costs

Incremental benefits
b:c ratio or absolute marginal
rate of return

One of the treatments of a biological practice was taken as a control, i.e., the technology closest to the current or most likely production or management practice of target farmers. The rest of the treatments are then evaluated against the control through partial budgeting.

Incremental costs are the sum of additional (extra) costs and reduced (foregone) receipts. They are the direct and indirect costs that would be incurred over and above the costs of the control practice. Incremental benefits are the sum of additional (extra)

receipts and reduced (saved) costs. They are the direct and indirect benefits that would be generated over and above the benefits of the control practice. Marginal net benefit (or cost if negative) is the difference between incremental benefits and incremental costs. The benefit cost ratio (BCR) is the ratio of marginal rate of return (or loss if negative) to incremental costs. It is the absolute marginal rate of return (or loss if negative) to incremental costs. BCR is the criterion for ranking and choosing among the several treatments of a trial. The higher the (positive) BCR, the more economically promising the treatment is and vice versa. Negative BCR implies that the control practice is an economically superior practice.

Some of the results of the economic evaluations of technical and biological data are highlighted below.

The economic analysis of the performance of dual purpose goat kids under different preweaning feeding practices was completed in 1984. The analysis quantified economic costs and benefits of the following preweaning kid milk feeding practices with and without forage supplementation: feeding milk ad libitum, feeding mother's milk only; and feeding half mother's milk. The analysis also assessed the impact of forage supplementation and identified economically most promising feeding practices. The major results of economic analysis were: 1) feeding kids milk ad libitum is economically inferior to the rest of the practices considered, with or without forage supplementation, 2) when forage supplement is not provided the practice of feeding the kids does milk only is the most promising economically, followed by feeding 50% does milk, 3) when forage supplement is provided, feeding 50% does milk is the economically most promising practices, and 4) overall, it is uneconomical to supplement milk with forage in preweaning kid feeding practices, except when the practice of feeding 50% does milk is adopted.

Another economic analysis was geared to quantify economic costs and benefits of intercropping selected forage crops (Sudan grass, Sesbania, and pigeon peas) with maize, the staple crop, to assess the economic impact of applying fertilizer to maize both in pure stand and intercropped with the forage crops, and to identify economically most promising maize-forage intercrops for the Kaimosi cluster type of farming systems.

The major findings were: 1) intercropping forage crops with maize yields greater economic returns (as much as Kshs 4,100 per hectare [1 USD = 16 kshs, January 1985]) than pure stand maize, with or without fertilizer application, 2) applying fertilizer to maize in pure stand or intercropped with forage crops yields greater economic returns (as much as Kshs 6,600 per hectare) than the same crops unfertilized, 3) when fertilizer is not applied, the maize-pigeon pea and maize-Sesbania intercrops fertilizer in that order are the economically most promising maize-forage intercrops, 4) when fertilizer is applied, maize-Sudan grass and maize-pigeon pea intercrop in that order are the most promising intercrops.

Economics of internal parasite control among goats has been assessed. The analysis quantified economic costs and benefits of

controlling Haemonchus contortus worms among three breeds of goats -- East African (EA), Galla, and East African x Toggenburg Cross (EA x T); and assessed the performance of the three breeds of goats under controlled and uncontrolled worm infestation conditions.

The main findings revealed that: 1) substantial economic benefits are generated from drenching EA (Benefit Cost Ratio [BCR] = 3.4), Galla (BCR = 5.5), and EA x T (BCR = 5.8) against internal parasites; 2) EA goats are economically superior to the Galla and EA x T goats under uncontrolled internal parasite conditions and superior to the Galla goats even under controlled internal parasite conditions; and 3) the EA x T goats are economically superior to the Galla goats both under controlled internal parasite conditions and superior to the EA only under controlled parasite situations.

In all of the above cases, the biological scientists in the SR-CRSP are now able to concentrate their future research efforts on the technologies and treatments that have the highest probability of successful application. These studies are valuable illustrations of the input of social scientists during the development of new technologies -- making the efforts of biological scientists more relevant!

Collaborating personnel in this research were: Adrian Mukhebi and John DeBoer.

EFFECTS OF LAND REFORM ON LARGE SHEEP ENTERPRISE PERFORMANCE IN PERU

In 1968 the Government of Peru instituted a series of land reforms. Many units most affected by this were the large sheep grazing units in the Central Sierra. The government attempted to introduce the reforms to maintain production incentives. The Agrarian Society of Social Interest (SAIS) was a cooperative farm set up that included not only former workers of the haciendas but also families of peasant communities that became stockholding members of SAIS and received dividends and technical assistance. A Peruvian researcher, Corinne Valdivia, carried out a detailed case study of one large SAIS in the Central Sierra and found that there had been a long term trend for the SAIS to reinvest in the unit. The total increase (after adjusting for inflation) in net capital assets was 23% over the period 1973-1979. The SAIS showed that it was capable of using sound business practices and balancing the conflicting demands made against the net surplus of funds accumulated from the sale of sheep and wool. Wages and purchasing power of the SAIS members had been maintained, but the SAIS had not been able to employ substantially more labor, a reflection of the capital intensive nature of large scale, extensive sheep rearing units.

Collaborative research projects between INIPA and the SR-CRSP have been able to tackle some of the fundamental organizational and institutional questions that have such a major impact on the ability of Peruvian producers to utilize research results. According to the above study, there is adequate incentive to invest, produce, and adopt improved technology on the large scale units that were expropriated during the land reforms.

Collaborating personnel in this research were: Domingo Martinez, Corinne Valdivia and John DeBoer.

RANGE AND ECONOMICS PROJECTS IN PERU WORKING TO
DEVELOP PROFITABLE GRAZING OPTIONS
FOR SMALL RUMINANT PRODUCERS

Grazing trials carried out during 1980-1984 at three different sites on the Puna (high altitude Andean grasslands) were analyzed by a collaborative team of Peruvian scientists from La Molina University, Texas Tech University and Winrock International under the sponsorship of the USAID SR-CRSP program.

The study used relative input and output prices found in Peru during the third quarter of 1984 and then estimated the profitability of introducing experimental treatments into the traditional production systems. Based on technical and profitability criteria, a series of "dominant practices" were identified as the most likely to be adopted by producers. These were superimposed over a series of hypothetical mixed-production systems that make strategic use of the valuable irrigated pasture at critical stages of the annual weather cycle and physiological stage of the animals.

The results are consistent with other studies indicating the near perfect equilibrium that exists between the traditional systems of production and the harsh, yet fragile, environment of the Puna. They indicate no incentive for producers to use irrigated pastures unless their resources allow them to set up alpaca-sheep-mixed systems of production such as one that uses the irrigated pasture during the dry season (April-November) to raise young alpacas and young ewe lambs, and in the rainy season to make hay to supplement breeding ewes the rest of the year.

Collaborating personnel in this research were: Domingo Martinez, Corrinne Valdivia and John DeBoer.

Dual-Purpose Goat Production Systems for
Smallholder Agriculturalists
H. A. Fitzhugh
Winrock International Livestock
Research and Training Center

UNDERSTANDING THE QUESTIONS BEFORE PROVIDING ANSWERS

The opportunity seemed good...use dual purpose goats to give milk as a protein supplement to the family diet and to sell young goats to generate income. Protein and cash income are two major needs of families on small farms in western Kenya.

Scientists on the SR-CRSP team in Kenya stood ready to provide answers on how best to feed, breed, manage, and market goats. But first priority was given to careful analysis of the actual needs and resources of farm families and of the production and market conditions which the goats would encounter.

To this end, the Small Farm Systems Survey was conducted in western Kenya. The survey was a collaborative effort of the Ministry of Agriculture and Livestock Development, University of Missouri, and Winrock International. Enumerators, who were local school graduates fluent in the language, lived in the villages with the farmers surveyed. The survey included both rapid appraisal of the basic characteristics of families and farms as well as continuing monitoring of crop and livestock through their extended production cycle. The design provided both the quick answers needed to set early research priorities as well as continuing feedback required to modify experimental designs to fit better the actual conditions faced by dual-purpose goats on small farms.

Some key findings were that typical farms averaging only 1 ha of land were supporting 5 to 8 family members. Clearly, there was little or no crop land to dedicate to producing goat feed; thus, emphasis has been on multiple purpose crops (food/feed) and intercropping systems to supply goat feed without reducing food crop yields.

Human population growth rate has averaged over 4% in Kenya in recent years. In the survey region, population densities are high, between 200 and 900 persons per square km with the variation between locales largely determined by the agricultural capacity of the land. Families are poor with few tangible assets other than their land and livestock. The early assumption was that these were subsistence operations primarily meeting family needs from farm production.

The survey revealed, however, that most families had cash flow through the year with some income from farm produce sales, but primarily from remittances from one or two family members finding off-farm employment. Thus, just as in the United States, many families subsidize their farms with off-farm income. The difference is that in Kenya this off-farm income may spell the difference between paying school fees or not.

Experience from the survey indicated that major emphasis should be placed on research in feed production and preservation, in development of herd health management, and in development of a dual purpose goat that had the lactation potential of 350 to 400 liters of milk under the conditions of small farms. Even though more of the farmers surveyed were milking goats, almost all seemed genuinely receptive to trying

these systems. Many are now participating in the on-farm evaluation of dual purpose goats.

Thus, the Small Farm Systems Survey proved a good investment of time and effort. Research priorities were focused to the actual constraints limiting dual purpose goat systems. Scientists descended from their ivory towers to become better informed about the realities of small farm agriculture. Farmers and scientists are now working together to develop and evaluate dual purpose goat systems.

Collaborating scientists in this research were: Mike Sands and Morgan Job of Winrock International, and Colette Suda and Fanny Nyaribo of the Ministry of Agriculture and Livestock Development.

KIDS VERSUS KIDS SHARING MILK FROM DUAL PURPOSE GOATS

A basic premise for research on dual purpose goat production system in western Kenya is that these systems will provide milk for a protein supplement to diets of farm families, especially the 3 or 4 children in the family. These "kids" should benefit in both physical and mental development from having a regular source of milk in their diet and the SR-CRSP research has shown that these children really enjoy drinking goat's milk.

But what about the goat kids? They too require their mother's milk for healthy development. Because the sale of goat kids can be a major source of income, their survival and growth is no trivial matter to the well-being of the farm family.

SR-CRSP scientists from the Ministry of Agriculture and Livestock Development and Winrock International have addressed this dilemma. On one hand, their research in feed production and feeding strategies is designed to improve doe nutrition so that she will increase her milk yield. To date, highest yields of milk harvested per doe on farms have been about 250 liters per lactation. However, with improved genetic potential and better nutrition, these yields may be doubled in the future.

Research has further indicated that 50 to 60 liters of milk is needed to wean a healthy kid weighing 10 kg. Several schemes for feeding the young goats have been tested, ranging from bottle feeding to controlled suckling of dams. The latter requires less labor and, thus, is more acceptable to the farmer. Usually, the farmer first milks the doe allowing the kid to suckle the remainder. Unfortunately, experience has shown that not enough milk may be left to meet the kid's requirements. This problem is, of course, even greater if there are twins.

Research continues both in the controlled environment of the experiment station and on farms of participating farmers. The on-farm research is especially valuable because the farmers who will ultimately decide the issue of "kids versus kids" are part of the research process.

Collaborating scientists in the above research were: Dan Brown and Ahmed Sidahmed of Winrock International and M.S. Khainga, S.K. Karimi and L. Musalia of the Ministry of Agriculture and Livestock Development.

DUAL PURPOSE CROPS FOR DUAL PURPOSE GOATS

The goal of the SR-CRSP in Kenya is to develop dual purpose goat systems to provide milk for family use and young slaughter stock to generate income. Early analysis of the resources available on small farms indicated that a major constraint to success would be producing enough feed to meet the requirements of dual purpose goats without reducing acreage planted to food crops.

Farms are small (about 1 ha). Most of the land must be used for food crops; maize, beans, and cassava. Local goats browse primarily on communal grazing lands. However, off-farm grazing is quite limited, especially during the extended dry season. These local goats survive but are lowly productive with milk yields adequate only to meet the needs of their kids.

Dual purpose goats (DPG) however, must produce substantially more milk to be harvested for family use. The target is to harvest at least 150 liters in a 4 to 5 month lactation plus raise two kids per doe. At this level, 3 to 4 does kidding on sequenced 10-month intervals could provide a liter of milk per day for family use plus 5 to 6 kids for sale each year.

To meet this target, Winrock International agronomist, Moses Onim, and his Ministry of Agriculture and Livestock Development counterparts, Moses Mathuva and Kenneth Otieno, have focused their research on the challenge of producing and preserving feed needed to support year round production by 3 to 4 dual purpose does. Their efforts are further restricted by the requirement not to reduce productivity of staple food crops.

These food crops, especially maize and sorghum, do provide crop residues which can be used for goat feed. However, these residues do not provide sufficient protein and energy to support lactation. Onim has obtained much better results from his research on sweet potatoes Ipanea batata, also a staple food crop. He has isolated cultivars which yield substantial quantities of fresh vines, relished by goats, as well as the tubers preferred by the family.

Another dual purpose crop, this time the grain legume, pigeon pea Cajunus cajun was introduced to the farmers by the SR-CRSP. Onim, who had previously experimented with pigeon peas in eastern Kenya, felt that this crop had major potential on farms in western Kenya. Results to date support his belief. The relative drought tolerance of pigeon peas further opens the possibility of producing fresh, high quality forage for goats well into the dry season.

As Onim and colleagues worked with farmers, they noticed that some were leaving a few tree legumes standing in their fields. Although the farmers did not understand the details of nitrogen recycling, they did know that their food crops tended to grow better near these trees. Drawing on the experience of local farmers, Onim introduced selections of this indigenous tree legume, Sesbania sesban var. Nubian, into his ongoing experiments with tree legumes, Leucaena and Glyricidia,

introduced from other countries.

Comparisons are now underway, including measurements of quantity and nutritive value of foliage from these tree legumes. Feeding trials indicate that goats readily consume the fresh leaves and even strip the bark from branches cut and carried to them. No ill effects have been observed from mimosine or other antiquality factors in the foliage; however, goats are reluctant to consume the foliage once it has been dried. Laboratory analyses are underway to determine why.

The value of these tree legumes does not end with the production of goat feed and nitrogen recycling. Planted around the farm borders they become an effective living fence to keep stray livestock out of the fields. Perhaps, more important, as population pressures mount is the substantial yield of wood for household cooking.

Thus, research designed to produce feed for goats is providing extra dividends in terms of potentially higher yields and better quality food crops and fuel wood to cook family meals.

Collaborating scientists for the above research were: J.F. Moses Onim of Winrock International and Moses Mathuva and Kenneth Otieno of the Ministry of Agriculture and Livestock Development.

FEED, FERTILIZER AND FUELWOOD

Sesbania (Sesbania seban var nubian), a tree legume in the family papilionacea, is commonly found in western Kenya. Because of sesbania's adaptation and abundance in western Kenya, the Feed Resources component of the Small Ruminant Collaborative Research Support Program (SR-CRSP) decided to study its potential as a protein supplement for the dual purpose goats in western Kenya.

After one year's growth, the trees were 6 m tall with 10 cm thick stems at 30 cm above the ground. The goats relish fresh leaves and young stems and, to a lesser extent, hay made by drying the leaves. Productivity as a forage and a multi-purpose crop are excellent; eg.,

1. Dry matter yield/year is approximately 20 mt/ha.
2. Forage which constitutes about 30 to 60% of the total dry matter, depending on cutting frequency, has the following qualities:

<u>Forage</u>	<u>DE(MJ/kg DM)</u>	<u>CP%</u>
Fresh	12	24
Hay	13	26

3. At a spacing of 90 x 40 cm, fuelwood yield/ha/yr is approximately 160 MT.
4. Sesbania produce effective living fence posts within 6 to 8 months.
5. Nitrogen fixation readily occurs. The nitrogen is passed to the other crops through nitrogen fixation in roots, leaf litter and whole plants used as green manure.
6. Farmers in western Kenya prepare a concoction made from sesbania leaves to treat Kwashiokor in children.

Collaborating scientists in this research were: J.F. Moses Onim of Winrock International and Moses Mathuva and Kenneth Otieno of the Ministry of Agriculture and Livestock Development.

HAY BALING IN A BOX

The success of dual purpose goats from the SR-CRSP in western Kenya is limited by severe feed shortages during dry seasons. The machinery required for baling hay in the modern and conventional methods is far too expensive for most small-scale farmers. However, haymaking is still one of the simplest methods of forage preservation. The need for a simplified method of preserving surplus forages at the village level was addressed by the production systems project through introduction of a baling box.

The baler is a wooden box whose inside measurements are 86 cm long, 55 cm wide and 45 cm deep. Bales made with this box weigh approximately 20 kg. Other sizes could be used depending on the size of bales desired. The box has no lid. The only other required equipment is a grass cutting sickle and a roll of sisal twine.

The farmer cuts the grass and leaves it in the field to dry for about one sunny day. Moisture content of the cut grasses under western Kenya conditions (at the equator and an altitude of 1500 m) drops rapidly from about 80 to 20% within eight hours. Thus, hay can be baled on the same day grass is cut. The dry grass is gathered and neatly arranged in the baling box in which four crosswise sisal twine strings have been previously placed. Farmers pack the bale by jumping on it a few times. Then with the help of an assistant, the strings are tightly tied around the bale. The bale is then lifted out of the box. Depending on the farmer's experience, it takes between 10 to 20 minutes to make one bale.

Capital outlay for the three essential pieces of equipment for this system is modest. The box, sickle and a 1 kg roll of string cost US \$13, \$3 and \$1.50, respectively. Collaborating farmers and Provincial Livestock Officers in western Kenya are enthusiastic about this simple, but effective technology.

Collaborating scientists in this research were: J.F. Moses Onim of Winrock International and Moses Mathuva of the Ministry of Agriculture and Livestock Development.

PART III

THE BUDGET: PAST, PRESENT AND FUTURE

BUDGET: PAST, PRESENT AND FUTURE

AID Funds

Under the terms of Grant No. AID/DSAN/XII-G-0049, Project 931-1328, the sum of \$19,662,043 was budgeted for the period October 1, 1978 to September 30, 1983. This sum includes an additional \$85,000 from the Near East Bureau. Under Grant No. DAN-1328-G-SS-4093-00 an additional \$7,134,988 was obligated to give a grant total of AID support of \$26,797,031 obligated to the University of California on behalf of the SR-CRSP.

September 1, 1978	\$ 4,652,000
August 29, 1979	\$ 2,700,000
August 25, 1980	\$ 3,200,000
January 23, 1981	\$ 615,000
June 25, 1981	\$ 35,000
March 4, 1982	\$ 3,200,000
September 20, 1982	\$ 50,000
April 28, 1983	\$ 1,125,043
September 29, 1983	\$ 2,574,957
February 23, 1984	\$ 1,510,043
September 27, 1984	\$ 3,134,988
March 12, 1985	\$ 4,000,000
Total	\$26,797,031

The University has distributed \$23,825,344 funds under the direction of the Board of Institutional Representatives (BIR) in the manner outlined in Table 1. The balance of \$2,971,687 is allocated toward 1985-86.

Future Funding by AID

In September 1984 USAID signed a new grant instrument providing the SR-CRSP a further three years under a new grant of \$12,000,000 through September 30, 1987; of this \$7,134,988 has been obligated.

US Institutional Funds

Table 2 documents the matching contribution of US institutions towards the work of the SR-CRSP. US institutions through the grant period have more than met their obligation to the SR-CRSP.

Overseas Counterpart Contributions

While still difficult to calculate because much of the contribution is "in kind," host governments have contributed substantially to the partnership in research with US institutions.

In Indonesia, BPT continues to receive more than matching funds from BAPPENAS on a dollar-for-dollar basis which amounts to approximately \$200,000.

In Brazil, support has substantially increased with new funds being awarded for development of RIA facilities, new goat facilities and continued expansion of field facilities valued at \$200,000. Brazil has suffered severe financial stringencies in the recent past.

In Peru, estimates of GOP matching contributions remain at just over \$300,000.

In Morocco, the program has expanded substantially in the past two years with inputs from Morocco estimated at over \$250,000.

In Kenya, estimates of the Kenyan government's matching contributions remain at approximately \$150,000.

Other External Sources of Funds

In the past year, support from several other external funding agencies to the SR-CRSP program were implemented.

In Peru, the Canadian IDRC continued a substantial grant to continue the work on the northern goat project (\$50,000) while the World Bank also provided a grant for the veterinary work in the Central and Southern Sierra (\$120,000).

In Indonesia, RMI via a USAID contract provided three full-time livestock specialist positions valued at more than \$200,000 over two years.

In Kenya, ILCA provided \$5,000 for joint work with the Production Systems Project.

The Range Extension Program has shared some costs of the SR-CRSP Range Project.

In Brazil, implementation of a special personnel contract for approximately \$150,000 over two years was awarded by IICA to facilitate the radio-immuno assay work associated with the sheep and goat research. IICA also provided an immunologist who has contributed generously to the SR-CRSP Health Program.

Management Entity Expenses

The Management Entity has closed its ledgers on the first six fiscal years of the original grant period. Table 3 documents these expenditures. It should be noted that the Management Entity costs include all of the following costs associated with the SR-CRSP operation.

- a. The External Evaluation Panel
- b. The Board of Institutional Representatives
- c. The Technical Committee
- d. The AID-mandated audit
- e. Overseas site visits
- f. Costs of overseas administrators travel to the USA
- g. The Management Entity Office

Site Coordinator Expenses

Early in the life of the SR-CRSP, the site coordinator costs were covered by taxing each subgrant an equal percentage as shown in Table 4. In 1983/84 and 84/85, budgeting the tax on subgrants was eliminated. Budgets based on history and current projections of need were developed with the funds charged as a separate cost of overseas research.

Summary

A summary of the SR-CRSP budget for 1984/85 indicates that a total of some \$6,515,080 was expended, the source of funds being:

USAID	\$4,000,000 or 61%
US Institutions	\$1,160,080 or 18%
Overseas Institutions	\$1,100,000 or 17%
External Grants	\$ 255,000 or 4%

TABLE 1. THE SR-CRSP PROGRAM BUDGET

<u>Institution</u>	<u>Discipline</u>	<u>BOARD Approved Year One 10/78-5/80</u>	<u>BOARD Approved Year Two 6/80-10/81</u>	<u>BOARD Approved Year Three 10/81-9/82</u>	<u>BOARD Approved Year Four 10/82-9/83</u>	<u>BOARD Approved Year Five 10/83-9/84</u>	<u>BOARD Approved Year Six 10/84-9/85</u>
California	Breeding	206,786	266,666	184,104	220,000	200,000	195,000
California	Health	196,145	234,000	175,000	158,333	175,000	170,000
Cal Poly	Physiology	60,000	100,000	91,900	---	---	---
Colorado	Health	150,000	233,333	175,000	190,000	175,000	170,000
Missouri	Sociology	174,992	253,333	200,000	275,000	225,000	220,000
Montana	Breeding	200,000	200,000	149,999	165,000	150,000	145,000
N. Carolina	Nutrition	109,435	266,666	200,000	295,000	250,000	230,000
Ohio State	Forages	166,016	233,000	150,000	---	---	---
Texas A&M	Breeding	160,000	212,800	150,000	240,000	200,000*	185,000
Texas A&M	Systems	184,000	253,333	200,000	240,000	150,000*	145,000
Texas Tech	Range	200,000	266,666	200,000	295,000	250,000	230,000
Tuskegee	Management	104,000	153,000	111,000	---	---	---
Utah State	Range	196,081	266,666	200,000	295,000	200,000	190,000
Utah State	Physiology	99,800	160,599	124,000	220,000	200,000	195,000
Washington	Health	200,000	233,333	175,000	190,000	175,000	170,000
Winrock	Economics	175,000	269,475	200,000	220,000	153,000	220,000
Winrock	Management	<u>100,000</u>	<u>153,333</u>	<u>215,000</u>	<u>240,000</u>	<u>200,000</u>	<u>185,000</u>
PROGRAM SUBTOTALS		2,682,255	3,756,203	2,901,003	3,243,333	2,703,000	2,650,000
Management Entity		598,553	386,740	412,070	535,000	435,000	450,000
Prolific Sheep Proposal		---	---	---	100,000	---	---
Morocco Program Development		50,000	---	50,000	---	---	---
Exchanges between LDCs		---	---	---	100,000	100,000	---
General Contingency Funds		200,000	---	200,000	240,187	522,000	180,000
Site Development		196,000	---	4,000	---	---	---
Overseas Sites		---	---	---	---	<u>325,000</u>	<u>720,000</u>
GRAND TOTAL		<u>3,726,808</u>	<u>4,142,943</u>	<u>3,567,073</u>	<u>4,218,520</u>	<u>4,085,000</u>	<u>4,000,000</u>
Additional Near East Bureau Funds			35,000	50,000			

* Texas A&M in Brazil was changed from "Breeding" to "Management" while Systems was not funded but Breeding of goats was funded.

TABLE 2. MATCHING CONTRIBUTIONS FROM US INSTITUTIONS*

<u>Institution</u>	<u>Discipline</u>	Inception to <u>May 1980</u>	June 1980 to <u>Sept 1981</u>	Oct 1981 to <u>Sept 1982</u>	Oct 1982 to <u>Sept 1983</u>	Oct 1983 to <u>Sept 1984</u>	Oct 1984 to <u>Sept 1985</u>
California	Breeding	\$ 35,828	\$ 108,827	\$ 129,073	\$ 97,997	\$ 98,688	\$ 103,485
California	Health	87,872	88,160	62,871	63,552	59,228	74,701
Cal Poly	Physiology	105,408	110,709	74,770	---	---	---
Colorado	Health	47,897	101,500	58,333	72,561	62,623	56,667
Missouri	Sociology	65,183	81,316	86,268	94,332	92,924	91,071
Montana	Breeding	120,663	171,305	206,622	277,747	329,849	54,907
N. Carolina	Nutrition	46,354	93,882	85,564	98,406	91,926	82,290
Ohio State	Forages	95,231	190,419	114,226	---	---	---
Texas A&M	Breeding	44,021	70,466	45,711	60,506	79,331	61,667
Texas A&M	Systems	62,235	110,877	52,957	32,416	123,495	62,415
Texas Tech	Range	66,192	63,407	73,417	108,990	123,523	109,459
Tuskegee	Management	32,763	41,144	62,507	---	---	---
Utah State	Range	140,878	175,367	121,986	131,226	143,348	84,995
Utah State	Physiology	106,610	112,552	85,549	119,905	268,748	121,949
Washington	Health	58,095	73,161	58,042	74,146	77,721	65,240
Winrock	Economics	40,215	81,097	108,836	80,421	89,707	111,042
Winrock	Management	<u>31,913</u>	<u>65,502</u>	<u>71,178</u>	<u>81,334</u>	<u>132,819</u>	<u>87,024</u>
TOTAL		\$1,187,358	\$1,739,691	\$1,498,010	\$1,393,539	\$1,773,930	\$1,166,912

*As of 8/06/85

TABLE 3. MANAGEMENT ENTITY EXPENSES

	October 1980 - September 1981 EXPENDED	October 1981 - September 1982 EXPENDED	October 1982 - September 1983 EXPENDED	October 1983 - September 1984 EXPENDED
Salaries	\$96,717.26	\$118,021.37	\$135,861.84	\$159,443.05
Benefits	34,945.69	40,505.09	48,445.30	58,449.89
Subtotal	<u>\$131,662.95</u>	<u>\$158,526.46</u>	<u>\$184,307.14</u>	<u>\$217,892.94</u>
Supplies and Expense	35,782.86	42,153.91	41,127.03	47,389.69
Equipment	896.97	0	6,059.74	29,053.17
Travel				
International				
Management Entity	25,110.74	28,725.01	24,859.04	17,040.98
EEP	16,652.21	15,564.57	11,530.61	9,265.43
Board	0	7,427.72	3,777.51	12,005.67
Technical Committee	195.00	0	31,727.09	0
Subtotal	<u>41,957.95</u>	<u>51,717.30</u>	<u>71,894.25</u>	<u>38,312.08</u>
Domestic				
Management Entity	9,799.39	13,820.29	11,615.34	11,086.92
EEP	5,595.49	12,928.59	9,715.74	12,066.03
Board	18,953.05	13,497.69	9,238.81	19,363.47
Technical Committee	11,358.86	12,235.35	6,823.45	3,198.78
Meeting Rooms	583.82	355.64	232.88	1,788.40
Subtotal	<u>46,290.61</u>	<u>52,837.56</u>	<u>37,626.22</u>	<u>47,503.60</u>
Other				
Other consulting		9,165.00	18,876.61	<2360.00>*
EEP Consulting	16,850.00	29,830.00	23,196.50	29,602.50
Audit	38,500.00	0	5,729.00	0
Subtotal	<u>55,350.00</u>	<u>38,995.00</u>	<u>47,802.11</u>	<u>27,242.50</u>
Indirect	<u>60,836.78</u>	<u>67,813.37</u>	<u>75,403.07</u>	<u>77,571.32</u>
TOTAL	\$372,728.12	\$412,043.60	\$464,219.56	484,965.30

* Overcharge in 1982-83 refund resulted in credit for 1983-84.

TABLE 4. SITE COORDINATOR EXPENSES

	<u>Kenya</u>	<u>Peru</u>	<u>Brazil</u>	<u>Indonesia</u>	<u>Morocco</u>	<u>Total</u>
1978/79	56,667	56,666	30,000	56,667	0	200,000
Site Development	56,667	56,666	30,000	56,667	0	200,000
Current Balance	0	0	0	0	0	0
1979/80 7%**	46,550	59,950	49,150	38,650	0	194,300
Actual Expenditures	5,210	19,735	15,426	33,134	0	73,505
Cumulative Balance	41,340	40,215	33,724	5,516	0	120,795
1980/81 5%**	35,536	64,638	70,863	22,837	6,700	200,574
Actual Expenditures	97,227	84,012	97,550	74,151	6,700	359,640
Cumulative Balance	[20,351]	20,841	7,037	[45,798]	0	[38,271]
1981/82 8%**	54,235	69,040	86,862	30,702	4,200	245,039
Actual Expenditures	51,850	59,174	87,848	34,688	4,200	237,760
Cumulative Balance	[17,966]	30,707	6,051	[49,784]	0	[30,992]
1982/83 7%**	57,900	64,200	54,458	25,583	27,459	229,600
Actual Expenditures	38,830	99,049	72,809	59,257	17,284	287,229
1983/84 Budgeted	78,052	129,600	80,000	68,000	38,000	393,652
Actual Expenditures	50,307	133,407	122,370	93,902	27,747	427,733
1984/85 Budgeted	54,000	109,976	61,600	44,000	30,000	299,576

**Percent of subgrants.