THE SMALL RUMINANT
COLLABORATIVE RESEARCH SUPPORT PROGRAM
(SR-CRSP)
ANNUAL REPORT
PROGRAM YEAR FIVE
1983-1984

Prepared by the Management Entity

CONTENTS

PART I

SUMMARY OF ACCOMPLISHMENTS

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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. 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.

Forty percent of the world's sheep and seventy-seven 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:

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

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 will result 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 will contribute 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. 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	Research on reproduction in the male and female
Non-selective breeding	Genetic improvement of local breeds and crossbreds
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 five 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.

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 1,000 research reports, papers, abstracts and verbal presentations related to SR-CRSP activity. Part II of this annual report lists only the most recent publications which have not been included in the 1982/83 Annual Report. A working paper series was commenced within the SR-CRSP whereby research results and experimental data could quickly be documented and disseminated. One or more of these papers 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 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 primarly 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 counterparts became full voting members of the Board in January 1984.

The SR-CRSP Budget

Funds for the SR-CRSP have been committed by AID under the terms of Grant No. AID/DSAN/XII-G-0049 which requires 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 five year planning horizon for participants. The SR-CRSP budget for the initial five year funding period was 15 million US dollars. The overseas collaborators contribute substantial 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:	EMBRAPA	Peru:	INIPA
Indonesia:	AARD	Morroco:	HASSAN II University
Kenya:	Ministry of Agriculture and Livestock Development		

Bibliography of Major Meetings and Reports

Since the last Annual Report in 1982-83, the following reports and minutes have been prepared by the Management Entity:

1.	SR-CRSP Newsletter, Issue No. 8.	Sept 1982
2.	Minutes of the Joint Board and Technical Committee.	Oct 1982
3.	SR-CRSP Newsletter, Issue No. 9.	Jan 1983
4.	Kenya Workshop Proceedings.	Mar 1983
5.	Minutes of the Joint Executive Committee.	Apr 1983
6.	Minutes of the Board Meeting.	May 1983
7.	SR-CRSP Newsletter, Issue No. 10.	July 1983
8.	Fifth EEP Report.	Aug 1983
9.	Partners in Research -- A Five Year Report.	Sept 1983
10.	Minutes of the Joint Executives.	Nov 1983

11.	Indonesia Workshop Proceedings.	Nov 1983
12.	Minutes of the Board Meeting.	Jan 1984
13.	Minutes of the Technical Committee.	Jan 1984
14.	Minutes of the Technical Committee.	May 1984
15.	Minutes of the Joint Executives.	May 1984
16.	Minutes of the Board.	June 1984
17.	SR-CRSP Newsletter, Issue No. 11.	July 1984
18.	Sixth EEP Report.	Aug 1984
19.	SR-CRSP Publications List, 1978-1984.	Sept 1984
20.	Bibliography of SR-CRSP Trainees.	Sept 1984
21.	Kenya Workshop Proceedings.	Oct 1984
22.	Minutes of the Technical Committee Executives.	Nov 1984

Update of SR-CRSP Publications and other Communications

This document lists those publications and other presentations that have been received by the SR-CRSP Management Entity after the publication of the 1981-82 Annual Report. This section is arranged according to the following categories: refereed journal articles, manuscripts submitted or in press, theses, abstracts, book chapters, technical communications, and verbal presentations.

Listings with NTIS access numbers can be ordered by writing to the National Technical Information Service (NTIS), United States Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161, USA. Others may be obtained by writing to the Principal Investigators at their respective institutions.

A published summary of the SR-CRSP program-training, institution-building and research accomplishments is available in the five-year report of activities titled "Partners in Research." Limited numbers of this document may be obtained from the Management Entity.

Refereed Journal Articles

Adams, D. S., P. Klevjer-Anderson, J. L. Carlson, T. C. McGuire and J. R. Gorham. 1983. Transmission and Control of Caprine Arthritis-Encephalitis Virus. Am. J. Vet. Res. v. 44:1670-1675. **Washington-Health**

Adams, D. S., B. M. Mugenya, E. W. Allonby, J. F. Bell, S. Waghela and R. Heinonen. 1983. Observations on Caprine Arthritis-Encephalitis in Kenya. Vet. Record. 112:227-228. **Washington-Health**

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Banks, K. L., D. S. Adams, T. C. McGuire and J. Carlson. 1983. Experimental Infection of Sheep by Caprine Arthritis-Encephalitis Virus and Goats by Progressive Pneumonia Virus. Am. J. Vet. Res. 44:2307-2311. **Washington-Health**

Bryant, F. C. and R. D. Farfan. 1984. Dry Season Forage Selection by Alpaca (Lama pacos) in Southern Peru. J. Range Mgmt., 37:330-333. **Texas Tech - Range**

DeMartini, J. C., K. L. Banks, A. Greenlee, D. S. Adams and T. C. McGuire. 1983. Augmented T Lymphocyte Responses and Abnormal B Lymphocyte Numbers in Goats Chronically Infected with the Retrovirus Causing Caprine Arthritis-Encephalitis. Amer. J. Vet. Res. 44:2064-2069. **Colorado-Health**

East, N. E. 1982. Chronic Weight Loss in Adult Dairy Goats. Compendium on Continuing Education for the Practicing Veterinarian. 4(10):166-167. **UCD-Health**

Edwards, R. L., D. D. Crenwelge, J. W. Savell, M. Shelton and G. C. Smith. 1982. Cutability and Palatability of Rambouillet, Blackface-Crossbred and Karakul Lambs. Int'l. Goat and Sheep Res. 2(1):77-80. **TAMU-Breeding**

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Ellis, J. A. 1983. Ovine Caseous Lymphadenitis. Comp. on Continuing Education. 9:S504-S511. **Colorado-Health**

Ellis, J. A. 1983. Retroviral Diseases in Small Ruminants: Ovine Progressive Pneumonia and Caprine Arthritis-Encephalitis. Comp. on Continuing Education. 5:S173-S180. **Colorado-Health**

Ellis, J. A. and J. C. DeMartini. 1983. Retroviral Diseases in Small Ruminants: Ovine Progressive Pneumonia and Caprine Arthritis-Encephalitis. Comp. on Continuing Education. 6:S173-S180. **Colorado-Health**

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Figueiredo, E. A. P., A. A. Simplicio and K. P. Pant. 1982. Evaluation of Sheep Breeds for Early Growth in Tropical Northeast Brasil. Trop Ani. Health and Prod. 14:219-223. **CNPC/TAMU-Breeding**

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Gilles, J. L. and K. Jamtgaard. 1982. Reconsidering the Commons. Rangelands. 4:51-54. **U.Mo.-Sociology**

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Johnson, W. L. 1983. Strategies for Improving the Nutritional Status of Small Ruminants in Tropical Ecosystems. Preventative Vet. Med. 2(1-4):589-601. **NCSU-Nutrition**

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Lawson, J. L., D. W. Forrest and M. Shelton. 1984. Reproductive Response to Suckling Manipulation in Spanish Goats. Theriogenology. 21:747-755. **TAMU-Breeding**

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Reiner, R. and F. Bryant. 1983. A Different Sort of Sheep. Rangelands. 5(3):106-108. **Texas Tech-Range**

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PART III

ANNUAL REPORTS FROM PARTICIPATING INSTITUTIONS

1. **Project Title:** Evaluation and Genetic Improvement of Small Ruminants in Extensive Management Systems.

2. **Institution:** Montana State University

3. **Principal Investigator:** R. L. Blackwell

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983/84 subgrant: $150,000.00
   Matching contribution from 1983/84 subgrant: $59,767.00

5. **Project Goals:**

   The principal research goal of the Montana State University breeding project is to improve the genetic potential for efficient production of meat and fiber from the small ruminant populations of the Andean region through breeding methods. Sheep are the species of primary interest although the alpaca will be included in the research. The activities to accomplish the principal goal are genetic resource evaluation, investigation of selection criteria and selection responses, introduction of genetic material, clarification and application of the nucleus herd concept, and distribution of improved genetic material to the limited resource farmer. The traits of greatest importance include measures of growth, reproduction, maternal ability and fiber production. An important additional goal is the training and development of personnel who can provide leadership in scientific animal breeding technology and who can aid in the application and transfer of this technology.

6. **Specific Objectives:**

   i. Evaluate breeding procedures and selection practices at SAIS Tupac Amaru.

   ii. Evaluate the genetic differences among local breeds and certain imported breeds for production of meat and fiber.

   iii. Implement and demonstrate ram performance test programs for growth and wool production, conduct ram progeny tests for maternal performance, and generate data necessary for estimation of genetic parameters.

   iv. Determine direct selection response for staple length and growth rate, correlated responses, and estimate genetic parameters in alpaca.

7. **Description of Work:**

   i. The project has concentrated its effort at two locations for sheep research (SAIS Tupac Amaru, in cooperation with Universidad Nacional Agraria (UNA) and the Chuquibambilla station in cooperation with Universidad Nacional Tecnica del Altiplano (UNTA) and one location for alpaca breeding research (SAIS Pachacutec in cooperation with UNA). At all locations experimental populations of breeding animals that

have been established by the project continue to provide data as planned for the various breeding comparisons of parameter estimation. The data generated in the project have been stored in the UNA computer and are readily accessible. The research effort at the Central de Coopertivas near Cerro de Pasco was terminated due primarily to management on the part of the Cooperative that rendered research activity unproductive, however, some useful information was obtained.

ii. Progeny comparisons of merit groups continue. The female progeny will provide data as producing ewes. This aspect of the project will be concluded in 1985. Growth and fiber production data have been analyzed.

iii. The comparison of the different breeds of sire is progressing satisfactorily. Ovulation rates on a sample of the first female progeny were obtained at approximately 18 months of age by William Vivanco working in the Reproductive Physiology project. Ovulation observations will be made again in 1984 on a larger number of animals. Breeding plans have been made that will produce progeny with different percentages of Finn genes for comparative purposes and to maintain this gene pool as a possible future resource.

iv. The major on-going effort is the performance/progeny test projects being carried out at SAIS Tupac Amaru (Central Sierra) and at Chuquibambilla (Southern Sierra). At SAIS Tupac Amaru the project has included the progeny testing of approximately 50 rams in each of two years (1982 and 1983) from different production units of the SAIS. Growth and wool production data were summarized on the 1982 lamb crop. Ram selection was based on the procedures used in classifying rams by the SAIS. The first two years the rams were in the "super" class, indicating they met high standards for composite merit. In the future ram selection will be based on performance test data. At Chuquibambilla a similar program, somewhat smaller in magnitude, is being carried out. One added element there is inclusion of rams from cooperating producers in the performance test.

v. The alpaca project at SAIS Pachacutec is progressing as planned. Data are being obtained from the six sub-groups - selection for staple length, two groups; selection for growth, two groups; and two unselected groups established for a base line from which to measure selection progress. Only preliminary summaries of the data in this project have been accomplished to date.

vi. Participation in all three community projects was accomplished through the shared contributions of Dr. Benjamin Quijandria, and in particular in the extensive range livestock community program at Santa Barbara de Carhuacayan through the collaboration of Manuel Carpio and some of our students at UNA. This project appears to have good potential for applying animal breeding and other technology to a typical range livestock enterprise of a fairly large community in the central Sierra.

8. Technical Accomplishments:

i. Summarization of three years of data from the Central de Cooperativas show that progeny of the breeds of rams differed very little in birth and weaning weight. The fertility of ewes varied substantially between years (88, 73, 41 percent for 1980, 1981, 1982, respectively). Survival rates of lambs from birth to weaning was 89, 75 and 63 percent, respectively, for the three years. This resulted in corresponding lamb crops weaned of 79, 55 and 26 percent. Weaning weights averaged approximately 18 kg.

ii. At SAIS Tupac Amaru the percent of ewes lambing of those mated to the "super", "A" and "twin" class of rams were 76, 77, and 79, respectively. Twinning rate among these ewes was 0.4%. Lamb survival (birth to weaning) was 90% with no difference between the progeny of the three merit groups of rams. Similarly, little difference has been observed in reproductive performance of the mates of Junin, Targhee and Finn x Targhee rams. Small differences exist in early growth and fleece production of progeny of rams of different classes of breed groups. This suggests that breeds may differ in certain other characteristics but not so much in such traits as growth and fleece production.

iii. The fact that merit groups of rams selected for breeding did not differ in progeny merit suggests that the criteria for selecting, or classifying the rams are not effective so far as growth and fiber production were concerned. Probably criteria are used other than objective measures of growth and fiber production in making the selection or classification. At least genetic differences for growth and fiber production are not being detected by the method used. This conclusion is further substantiated by the fact that among 50 progeny tested rams, all of which were classified as "Super", the progeny means varied greatly. The range in the progeny means is shown in Table 1 for the lambs born in 1982, the first lamb crop in this program. Evidence on heritability for these traits under Andean conditions suggests that substantial genetic variability exists. This is also indicated by the variation in the progeny means. Methods and criteria to identify these substantial genetic differences are needed and are being developed.

iv. Some progress is being made in interpreting this information to the management of the SAIS. We believe the performance test procedures will be accepted and incorporated into their breeding programs. This achievement can have even greater significance in Peru because SAIS Tupac Amaru is a leader in Andean sheep breeding, and others will probably accept well documented procedures that have demonstrated value there.

v. The performance testing program at Chuquibambilla is progressing satisfactorily. It is creating great interest among some of the leading producers in the Altiplano region. The project will use both performance test and progeny test information to select rams for further breeding tests. The range in performance among 50 performance tested rams, sired by five rams was: 37 - 24 kg in body weight and 3.5

- 1.9 kg first fleece weight, both at about 16 months of age. The range in progeny group means for these five rams was 27.8-24.8 kg in body weight and 2.6-2.0 kg for fleece weight. Fifteen to sixteen rams are being progeny tested each year.

vi. The ovulation rate among the one-quarter Finn ewes (18 months of age) was higher than among their contemporary females of different genetic background. However, no twin births resulted. Also, more of the Finn ewes ovulated than did ewes from other breeding groups at the time observations were made. The results are too preliminary to make any decisive statements regarding the apparent merit of the one-quarter Finn ewes and whether or not the Finn genes have a place in Andean sheep production.

9. Collaborating Personnel:

Co-Principal Investigator - Manuel Carpio, (UNA)
- Rolando Alancastre (UNTA)

Graduate Students/Technicians - in Peru

- Gladys Huapaya - UNA
- Prospero Cabrera - UNA
- Juan Roque - UNA
- Juan Bueno - UNA
- Diana Chavez - UNA
- Gladys Garay - UNA
- Eugenia Montesinos - UNTA
- Esther Lencinas - UNTA

Peruvian Graduate Student in the U.S:

Juan F. Chavez- Ph.D. study in Biology/Animal Science

Indonesian Graduate Student in the U.S:

Subandriyo - M.S. study in Animal Science

Table 1. Range in mean production performance of 50 progeny groups[a] sired by Junin rams classed as "Super", SAIS Tupac Amaru, birth year 1982.

Performance Trait	Maximum Mean	Minimum Mean
Birth weight, kg	4.1	3.3
Weaning weight, kg	27.7	16.5
8-month weight, kg	30.8	22.3
8-month fleece weight, kg	1.8	0.7
2nd fleece weight, kg[b]	2.2	1.7
Staple length, cm[c]	8.2	4.0
16-month weight, kg[d]	42.3	32.0

[a] The number of progeny per sire group varied greatly as well as being generally different for the various measures of performance at different ages for the same sire group. Mean number of progeny per group at birth was approximately 32 (range 49 - 3) and the mean number at 16-17 months of age was approximately 16 (range 30 - 1).

[b] Fleece weight at 16-17 months of age after 8 months growth.

[c] 8 months of age.

[d] Females.

Technical Accomplishments (Montana)

Three studies of sheep production data from the Montana Agricultural Experiment Station were brought to the pre-publication stage. Brief summaries of the results are presented here as a progress report.

As a portion of his MS thesis research, Subandriyo made a study of factors that affect survival of lambs. The heritability estimates of survivability ranged from .05 to .43 at 60 days of age and from .05 to .30 at 120 days of age. Birth weight was found to be an important factor affecting survival, and was curvilinearly related with survival. Maximum survival occurred at approximately 5 kg birth weight, depending on the breed and type of birth. Low birth weights and high birth weights both tended to be associated with reduced survival. The heritability estimates for birth weight ranged from .25 to .39. Estimates of the genetic correlation between survival and birth weight ranged from zero to .5 with a pooled value of .33.

A second study of the relationship between ewe weights at birth, 60 days and 120 days of age and future lamb production, expressed as the ewe's most probable producing ability (MPPA) provided the following results. The correlations between birth weight and MPPA for birth weight, MPPA for 60-day weight and MPPA for 120-day weight were .23, .09 and .08, respectively; for 60-day weight the corresponding correlations were .14, .13, and .11; and for 120-day weight the correlations were .16, .15 and .16, respectively. Certain environmental components of these relationships, such as year of birth of the ewe, age of her dam, and her type of birth and rearing, tended to be negative. However, the magnitude of the effects were small, and thus it was unlikely that they would have significant influence on subsequent ewe productivity. Repeatability of birth weight, 60-day weight and 120-day weight were .26, .18, and .17, respectively.

Heritability estimates for birth weight, 60-day weight and 120-day weight ranged from .17 to .38, .05 to .22 and .08 to .28, respectively, depending on the method of analysis used. Heritability estimates of direct effects were .28 to .32, .17 to .20, and .22 to .26, respectively, for birth weight, 60-day weight and 120-day weight. The corresponding heritability estimates for maternal effects were .34 to .53, .23 to .33 and .24 to .47, respectively, for the three weights. The covariances between direct and maternal effects were negative. The resulting genetic correlations were -.44 to -.81 for birth weight, -.40 to -1.06 for 60-day weight, and -.59 to -1.07 for 120 day weight.

A third study was concerned with growth rates, maturing rates and mature size of sheep. Genetic and phenotypic correlations between degree of maturity at different ages and mature weight were negative. Heritability estimates of maturing rates, growth rates and weight at different ages were large enough that direct selection for any of the measures of growth or size or degree of maturity should be effective. However, the study indicated that selection for a high degree of maturity at young ages would tend to result in smaller mature weights. and conversely selection for large mature weights would tend to decrease the level of maturity at young ages, and possibly reduce life-time production efficiency.

1. **Project Title:** Genetic Improvement of Sheep and Goats.

2. **Institution:** University of California, Davis

3. **Principal Investigator:** G. E. Bradford

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant: $262,865 including carry forward and supplemental funds.

   Matching Contribution from 1983/84 Subgrant: $ 90,164.

5. **Brief Statement of Project Goals:**

   The first goal of the UCD Breeding Project is to improve efficiency of sheep and goat production in two different ecosystems by providing animals with genetic potential for reproduction and growth which match the needs and resources of these systems. The particular ecosystems are a confinement, cut-and-carry system in the humid tropics, represented by Indonesia, and a mixed grazing-irrigated crop production system in a Mediterranean climate, represented by Morocco (and also by California). In both Indonesia and Morocco, the goal is to understand the production conditions as they exist in the local, smallholder herds and flocks sufficiently well to develop animals which are more productive under present conditions, or under feeding and management conditions incorporating feasible improvements. A second goal is to utilize the unique genetic material available in Indonesia and Morocco, particularly with regard to prolific sheep, for comparative studies in the three locations of the genetics of prolificacy and of management systems for more effective exploitation of prolific sheep. A third goal is to provide training of host country professionals in the genetics, breeding and management of small ruminants, with a view to their providing leadership for sheep and goat improvement work in their countries in the future.

6. **Statement of Specific Objectives for 1983/84:**

   i. Indonesia:

      a. Collect lambing and kidding data on females in which ovulation rate data had been measured to advance knowledge of the mode of inheritance of prolificacy in Indonesian breeds of sheep and goats.
      b. Summarize performance of village data on sheep and goats.
      c. Contribute to training of Indonesian scientists.

   ii. Morocco:

      a. Complete construction of sheep breeding research facilities at Tadla Farm.
      b. Produce contemporary D'Man, Sardi and D'Man x Sardi lambs for Phase I of the research, and initiate evaluations of their performance.

c. Contribute to training of Moroccan scientists.

iii. US:

a. Continue evaluation of lines of Targhees selected for growth rate and multiple births.
b. Continue evaluation of inheritance of length of breeding season in Dorset, Finnish Landrace and Rambouillet breeds and their F_1 crosses.

(Note: Items (a) and (b) are funded primarily by the California Agricultural Experiment station and represent a major portion of the UC matching contribution.)

c. Provide goat semen from a CAE-free herd for the Kenya SR-CRSP breeding project.
d. Provide training and data analysis support for the overseas projects.

7. Description of Work Undertaken:

The activities mentioned under Specific Goals in (6) above were all carried out.

i. Indonesia:

a. BPT staff, with the assistance of Mr. Don Torell, retired UC sheep specialist who spent five weeks in Bogor on the project in September/October 1983, collected lambing/kidding data on all females involved in the May 1983 ovulation rate study. These data were reported at the Small Ruminant Seminar at Ciawi in November 1983, and were also reported at the ASAS Annual Meeting in August, 1984.
b. Data from station and village flocks on total weight of lamb weaned per ewe for ewes giving birth to 1, 2, 3 or 4 lambs were summarized by Bess Tiesnamurti and presented at the Small Ruminant Seminar in November 1983. Ismeth Inounu summarized wool and performance data and presented it at the same conference.
c. Dr. Luis Iniguez, Staff Research Associate on the UCD Breeding Project, was in Bogor in June and July 1984 to assist with setting up data analysis systems and to advance the village data summaries. He took an Apple-IBM connector, to permit transfer of data between the two machines, and several statistical software packages. Mr. Subandriyo is also taking a statistical package which he has used at Montana State.
d. Mr. Subandriyo completed his MS degree at Montana State University, with the UCD Principal Investigator serving as a member of his thesis committee. Data from both Indonesia and Montana were included in the thesis.
e. Miss Tiesnamurti and Mr. Inounu were both put on the list of BPT staff to receive World Bank Fellowships for graduate (MS) studies, and both are completing applications to two or three institutions including the University of California, Davis.

ii. Morocco:

Excellent progress on the project has been made during 1983-84. Specific activities include:

a. Determination of age at puberty on the 70 Sardi and D'Man x Sardi ewes from the first lamb crop of the project (born Jan/Feb 1983).
b. Collection of data on litter size, embryo survival, and postpartum interval on the 250 mature D'Man and Sardi ewes mated June/July 1983.
c. Measurement of ovulation rate on the ewes in (a) and (b) above in Nov/Dec 1983 and Jan '84, and lambing performance and embryo survival in April-June 1984.
d. Selection of D'Man, Sardi and F_1 ram lambs from the Fall 1983 lamb crop, for Phase II of the project.
e. Implementation of a protocol to eliminate the white muscle disease problem encountered in early 1983.
f. Computerization of the 1983-84 lamb crop records.

iii. US:

A major part of the US program is training. One activity was supporting and participating in the MS program for Subandriyo at Montana State University (see (4) above). Secondly, two Moroccan staff members, Ismail Boujenane of the Department of Animal Production and Lahsen Derqaoui of the Department of Reproduction, entered PhD programs at the University of California, Davis during the current academic year. Third, Alfeyo Okeyo of Kenya completed his MS degree at UCD under the auspices of the CRSP.

On the research side, a linecrossing experiment involving lines of Targhees subjected to long-term selection for multiple births and for growth rate was initiated; work on measurement of ovulation rate was continued. Mr. Boujenane is involved in the project. Data from the breeding season study on purebred and crossbred ewes of the Dorset, Finnish Landrace and Rambouillet breeds were analyzed by Mr. Okeyo as part of his MS program. Thus the UCD projects contribute to SR-CRSP training in addition to providing research information which complements that from the overseas worksites.

An additional activity during 1983-84 is directed toward standardizing computing hardware and software, for breeding research data management and analysis, at the four worksites: Bogor, Tadla/Rabat, Davis and Hopland. Thus work is the primary responsibility of Dr. Luis Iniguez, and, for the Bogor site, involves the active collaboration of the Missouri Sociology Project leader.

8. Technical Accomplishments:

i. Indonesia:

The most important accomplishment of the year was the collection of data on Javanese sheep which provide strong support for the hypothesis of a major gene affecting ovulation rate and hence prolificacy. Data

on at least one more generation of animals will be required to confirm this hypothesis, but the 1983-84 data represent a major advance. Knowledge of the mode of inheritance of the unusual pattern of prolificacy of these animals can provide the means of controlling the variability much more precisely than has been possible, and hence utilizing it more efficiently. Other findings of special interest are:

a. A similar pattern of high variability and repeatability for ovulation rate exists in three different strains of Javanese sheep; heretofore this had been suspected only in the Javanese Thin Tail breed;
b. All three types had higher embryo survival than reported for practically all other breeds of sheep.

ii. Morocco:

a. Data collected during the current year support the following conclusions:

(1) The D'Man breed transmits its high ovulation rate and early puberty to F_1 ewes from a cross with a breed of low prolificacy. The preliminary data on this point are most encouraging that this will provide a means of producing a breed of intermediate prolificacy for use in higher potential areas of Morocco, without any importation of germ plasm.
(2) Growth rate and size of the F_1's has been higher than expected, very close to that of the larger (non-prolific) parent breed, providing further encouragement as to the utility of the cross.
(3) In the first lamb crop from ewes on which ovulation rate was measured, embryo survival of the D'Man breed was very high, similar to that in the Javanese sheep. The combined results of the two studies suggests that prolific breeds may differ significantly from non-prolific breeds in this parameter as well as in ovulation rate, which up to now has been believed to be the principal if not the sole source of differences among sheep breeds in prolificacy. Lending further support to the idea of genetic variation in prenatal survival is the fact that twin-ovulating Sardi ewes produced significantly more twin lambs when mated to D'Man than to Sardi rams.

b. Other findings of interest from the postpartum matings in December 1983/January 1984 are that:

(1) The postpartum interval is shorter in D'Man than in Sardi ewes.
(2) Both groups recycled and conceived readily during lactation.
(3) Ovulation rates of these lactating ewes were the highest recorded to date on either breed. This suggests the possibility that breeding during lactation may be a means of increasing prolificacy (possibly through a "flushing" effect of high feed intake during lactation) rather than detrimental to subsequent reproduction, as has been a common view.

iii. US:

In February 1984, 1200 straws of frozen semen from CAE-free Alpine, Nubian and Toggenburg males in the University of California CAE-free dairy goat herd, maintained in collaboration with the UCD SR-CRSP Animal Health Project, were shipped to Kenya for use by the Texas A&M Breeding Project there. This activity was jointly supported by supplementary funds from Management Entity and by the UCD and TAMU Breeding Projects.

Analyses of the California data on breeding season in sheep show large year-to-year variation in date of onset of the breeding season in all breed groups, due to as yet unidentified environmental factors. The Finnish Landrace breed has the latest summer anestrus of the three breeds, and transmits this in a semi-dominant fashion to its F_1 daughters. This will greatly limit the usefulness of the breed for improving prolificacy in areas where summer breeding is important, e.g., in California and Morocco.

9. Personnel Collaborating on Project Activities:

i. Indonesia:

P. Sitorus, Ismeth Inounu, Bess Tiesnamurti, Subandriyo, Sitemorang, BPT; Ian Fletcher, CSIRO; G. E. Bradford, D. T. Torell and Luis Iniguez, University of California, Davis.

ii. Morocco:

A. Lahlou-Kassi, I. Boujenane, L. Derqaoui, M. Bourfia, M. Marie, H. Abledi, M. Radzoui, IAV; D. Johnson, University of Minnesota; Y. Berger, G. E. Bradford, University of California, Davis.

iii. US:
G. E. Bradford, L. Iniguez, T. Adams, G. H. Stabenfeldt, D. Brown, K. Hedrick, N. East, M. Dally, D. Van Liew, University of California, Davis.

1. **Project Title:** Improving Small Ruminant Nutrition, Management, and Production through Proper Management of Native Range and Improved Pastures.

2. **Institution:** Texas Tech University

3. **Principal Investigator:** Fred C. Bryant with James A. Pfister, Ron Sosebee, and Frank Craddock

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant: $250,000
   Matching Contribution from 1983/84 Subgrant: $123,523

5. **Project Goals:**

   i. Work collaboratively with other US institutions involved in SR-CRSP research in Peru.

   ii. Identify and support scientists from Peruvian institutions.

   iii. Provide expatriate personnel in Peru for technical advice and to implement research projects.

   iv. Devise and implement short- and long-term research projects in range management to evaluate and improve the productivity of native range and grazing animals; to integrate management of cultivated forages and native range resources.

   v. Continue long-term training of graduate students.

6. **Statement of Specific Objectives for 1983/84:**

   Objectives have been grouped for emphasis and clarity into 5 major areas: range nutrition, grazing management, irrigated pastures, range ecology and range improvements.

   i. Range Nutrition Objectives:

      a. Determine nutritional levels of sheep diets under rotational grazing at four stocking levels.

      b. Determine botanical composition of goat diets in the arid north coast of Peru.

      c. Determine the botanical and chemical composition of diets selected by alpacas and sheep.

      d. Compare forage intake of Corriedale and Criollo sheep in the altiplano region.

      e. Determine forage intake of grazing alpacas in the inter-Andean valleys of southern Peru.

ii. Irrigated Pastures:

a. Determine proper integration of cultivated pastures and native range for growth of ewe lambs.

b. Evaluate irrigated pasture use for improving alpaca and sheep production systems.

c. Determine responses of cultivated pastures to varying intensities and frequency of defoliation.

d. Determine the optimum use of irrigated Lolium pasture for flushing ewes.

e. Evaluate management schemes for use of irrigated pastures to supplement alpacas and ewes during the dry season.

iii. Grazing Management:

a. Determine the proper stocking rate for sheep grazing in the central Sierra.

b. Determine the proper grazing regime (continuous vs. rotation) for sheep production in the central Sierra.

c. Initiate a long-term (10 yr.) study to evaluate short duration grazing using different grazing intensities and pasture rest schedules; compare short duration grazing to continuous year long grazing.

d. Continue research into flushing and late gestation supplementation of ewes in central Peru.

iv. Range Ecology:

a. Initiate ecophysiology research into the plant-water relationships and biomass production of important grass species in southern Peru.

b. Continue synecological research of 2 major range types in the Southern Sierra.

c. Initiate research into the effects of prescribed burning on Festuca dominated rangelands of southern Peru.

v. Range Improvements:

a. Determine effective control methods for Opuntia flocosa, a noxious cactus species.

b. Initiate studies on interseeding degraded rangelands in the altiplano with grasses and legumes.

c. Determine the effects of fertilization on forage production from degraded ranges in southern Peru.

7. Description of Work Undertaken:

i. Range Animal Nutrition:

a. One year's data have been collected at monthly intervals from esophageally fistulated sheep. Total fecal output has also been determined in order to calculate voluntary forage intake in the 4 treatments.

b. This study was completed and the MS thesis approved for Ing. Hugo Garcia by the faculty at Univ. Nac. Pedro Ruiz Gallo, Peru.

c. Studies at Chuquibambia and La Raya using fistulated alpacas and sheep were successfully carried out. This information will serve in part for the PhD dissertations of Fierro and Reiner.

d. Field sampling completed on this study in late March. Will be a portion of Fierro's dissertation.

e. One year of field information on fecal output has been obtained. This study will be continued at La Raya.

ii. Irrigated Pastures:

a. One year of data has been collected on this study. It will continue for one more year.

b. In the central Sierra, alpaca and sheep are being used in a production system designed to integrate native range and irrigated pastures. Animals in this study are compared to SAIS (control). Study will be continued for at least two more years.

c. Clipping was done at various intervals to determine biomass responses. Periodic biomass production is being monitored; this study will continue into the dry season of 1984.

d. One year of data collection has been completed on this project. Ewes have been evaluated for increased reproductive performance with flushing.

Several studies involving alpacas and sheep were instituted to evaluate use of irrigated pastures for supplementing grazing females. These studies were initiated by Peruvian counterparts and will be continued indefinitely.

iii. Grazing Management:

a. Three years of data collection have been completed for this study. Data are presently being analyzed prior to submission for publication.

b. Three years of data collection have been completed. Analysis of these data began as the reporting year ended.

c. This study was not initiated as planned due to problems in a suitable animal watering system. Plans were revised and the study will begin in the fall of 1984.

d. Data have been collected on these three treatments (native range, flushing, flushing plus late gestation supplementation) for two years. These initial two years of data are being analyzed.

iv. Range Ecology:

a. Peruvian graduate student, Lucrecia Aquirre, made a preliminary trip to Peru from Lubbock to initiate several phases of this project. Texas Tech professor, Ron Sosebee, also visited the potential research sites and discussed the proposed work with IVITA personnel. Data collection will begin on most aspects of the study in the summer of 1984.

b. Continued monitoring of the biomass and plant community successional changes in two exclosures representative of two range sites was done.

c. Research on burning was designed and preliminary trials began in 1983. Burns were conducted on bimonthly intervals and pasture measurements began.

v. Range Improvements:

a. Research was designed and implemented for determining control of this cactus. Periodic treatments include spraying with diesel oil, hand-grubbing, and herbicidal application.

b. Under the supervision of Juan Astorga, interseeding of several grass and legume species into range plots was carried out. These seedings were evaluated for germination and stand establishment by students from UNTA in Peru.

c. Fertilization of rangelands at various rates was also carried out by Juan Astorga and his group near Manco Copac. These treatments have not yet been evaluated.

8. Personnel Collaborating on Project Activities:

i. Post-Graduate Training:

LDC Students in US:

Ing. Enrique Nolte is nearing completion of his PhD degree at Ohio State University. He was fully supported by Texas Tech in this endeavor during 1983-84.

Luis Carlos Fierro, a Mexican national, is presently completing his PhD degree in Range Science at Texas Tech University. He spent nearly a year in Peru before terrorist activity forced his withdrawal.

Lucrecia Aquirre began work on her MS degree at Texas Tech University. Her plant ecophysiology research will be done in Peru in 1984-85.

Felipe San-Martin arrived at Texas Tech University in Jan., 1984, to begin a PhD program in Range Science. San-Martin, a Peruvian veterinarian, will develop a research program in range animal nutrition.

Custodio Bojorquez also arrived on campus in Jan., 1984. He will pursue an MS program in Forages with Dr. J. Matches serving as his major professor.

ii. LDC Students in LDC:

Name	Institution	Dates Funded by TTU	Director
Jorge Gammara	UNA-Lima	1981-1984	Dr. Arturo Florez
Ivan Lares	"	1980-1983	"
Luis Bueno	"	1980-1983	"
Nellie Rodriguez	"	1980-1983	"
Javier Aris	"	1983-1985	"
Edgar Gonzales	"	1983-1985	"
Carlos Guittierez	IVITA-Lima	1981-1983	"

iii. US Students in LDC:

Rich Reiner spent nine months in Peru doing field work for his PhD before terrorist activities forced his withdrawal. He is presently finishing his coursework at TTU and completing sample analysis.

iv. US Students in US:

Jim Carey is currently completing his MS degree in Animal Science under the direction of Dr. F. Craddock. He is analyzing wool samples from grazing treatments in the central Sierra.

v. Management Training:

A symposium on range management in the Andes was held in Puno, during April, 1983. Invited Peruvian, Mexican and American speakers discussed topics in range science of interest to range scientists and agronomists in the southern Sierra region.

Ing. Ramiro Farfan participated in the Latin American Assoc. of Animal Production Meetings in Santiago, Chili.

1. **Project Title:** Basic Supporting Research.

2. **Institution:** Texas Tech University

3. **Principal Investigators:** Fred C. Bryant with James A. Pfister, Frank Craddock and Jerry Matches

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant: $250,000.
   Matching Contribution from 1983/84 Subgrant: $123,523.

5. **Project Goals:**

   i. Provide agronomic data on the management of cultivated forages.

   ii. Continue animal fiber evaluations.

   iii. Develop proposals in range animal nutrition.

   Due to limited funding, only minor emphasis has been given to work in the US. Even though limited in scope and funding, such supporting work has provided some important data for use in conjunction with Peruvian research data.

6. **Statement of Specific Objectives for 1983/84:**

   i. To develop improved forage systems for grazing livestock; to determine optimum management practices for improved water use efficiency by forages.

   ii. To determine effects of stocking rate on wool production by ewes.

   iii. Write proposals for work in range animal nutrition. Proposals include Ph.D. proposal of F. San Martin, and two proposals by J. Pfister to be funded primarily by Texas Agricultural Experiment Station with Angora and Spanish goats.

7. **Description of Work Undertaken:**

   i. Combinations of improved forages are being tested by Dr. J. Matches. Ongoing trials with nearly 100 leguminous forage species are being evaluated. Peruvian MS candidate Custodio Bojorquez also began work on his research proposal in the area of cultivated forages.

   ii. Thesis work by Jim Carey, under the direction of Dr. F. Craddock, is nearing completion. Statistical analyses has been completed and his defense is tentatively scheduled for early June, 1984.

   iii. Research proposals were begun in three specific areas: 1) sheep digestive physiology by F. San Martin (PhD research); 2) nutritional stress and abortion in Angora goats; and 3) regulation of maternal behavior in Angora and Spanish goats.

8. Training:

F. San Martin, Peruvian PhD candidate, arrived in Lubbock in Jan. 1984, and began coursework for his doctorate program.

Custodio Bojorquez, Peruvian MS candidate, began coursework at Texas Tech University in Jan., 1984.

Jim Carey, US student, is nearing completion of his MS program.

1. **Project Titles:** (1) Systems Analysis and Synthesis of Small Ruminant Production and (2) Genetic Improvements of Dual Purpose Goats Under Small-Holder Farming Systems.

2. **Institution:** Texas A&M University

3. **Principle Investigator:** Dr. T. C. Cartwright

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant: $190,578.00
   Matching Contribution from 1983/84 Subgrant: $63,520.00

5. **Brief Statement of Project Goals:**

   i. Breeding.

   The broad objective of the breeding project is to develop a breed or breeds of dual purpose goats for Kenya; especially the western Kenyan small-holder. The approach will be to evaluate the dairy potential within the indigenous breeds. Then selection would proceed based on high performance strains and individuals from this indigenous stock. The selected indigenous stock will be combined with optimal amounts of exotic dairy goat breeding. The F_1 indigenous exotic has now proven well suited and adapted. Therefore the objective is now to create a new breed (synthetic) combining indigenous and exotic breeding in approximately equal portions and that will retain maximal hybrid vigor.

   ii. Systems.

   The broad objective of the systems analysis project is to provide a method for increasing the effectiveness of research by establishing research priorities and by providing a method of effectively evaluating the application of research results and recommend practices in Kenya as well as the U.S. Development of a dynamic, comprehensive mathematical model, based on biological functions, for sheep and goat production systems utilizing the individual animal as the modeling unit was the primary initial objective. This objective has been completed and the primary goal is now to provide simulated input/output data of dual purpose goat production systems for use in forage production, nutrition and health as well as in economic and sociological assessment. Evaluation of alterations or interventions proposed by the Kenyan SR-CRSP cooperators to various aspects of the sheep and dual purpose goat production systems can be examined through simulations in order to develop optimal inputs and practices that tend to produce maximal output within the constraints and objectives of small holders.

6. **Statement of Specific Objectives for 1983/84:**

   i. Breeding Objectives.

   a. To compare indigenous breeds and their crosses with dairy breeds

with regard to variability and level of milk and meat production, health status, and their suitability to different environments under Kenya conditions of a small-holder farming system.

b. To initiate crosses for use in producing a new or composite breed of dairy and indigenous breeds.

c. To establish a recording and evaluation program of dairy production (including progeny testing) and initiate selection within the newly formed composite breed.

ii. Specific objectives are:

a. To evaluate productivity and variability of different breeds.

b. To establish a breeding program to produce and improve a "composite breed" designed to be a dual purpose, milk and meat, goat suitable for the Kenya small-holder.

c. To evaluate milking strains of the Galla breed and to widely sample and screen the East African breed.

d. To up-grade Galla and East African indigenous goats with Toggenburg germ plasm available in Kenya and imported germ plasm of other dairy breeds.

e. To compare different milking procedures and to determine a feasible milking method for research purposes and for use by Kenya small-holders.

f. To conduct cooperative research with breeding inputs with other SR-CRSP projects.

iii. Systems Analysis Objectives.

a. Model Development and Validation.

(1) To develop comprehensive, interacting, biologically based mathematical models to simulate sheep and goat production systems in Kenya.

(2) To validate the general shee and goat models for basic structure and functions with sets of independent data and then to revalidate for each of the different small-holder locales and conditions in Kenya.

(3) To incorporate in the goat model an interacting function for effects of internal parasite load, diseases and other stresses as the need arises and information becomes available.

b. Simulation, Analysis and Synthesis of Dual Purpose Goat Management Systems.

(1) To examine the effect of specific forage production (from forage

project) and management practices (from management project) on goat production and carrying capacity of small holder farms with various characteristics in Kenya.

(2) To examine combinations of practices in order to predict optimal inputs to maximize outputs under given constraints and to provide simulated production data for economic analysis in Kenya.

(3) To simulate small holder production of goats of varying genetic potential for maturing rate, size, and milk production for farms with specific resources and management in order to estimate optimal traits of goats for breeding objectives in Kenya.

(4) To simulate sheep and goat production for use by IPAL in Kenya.

7. Description of Work Undertaken.

i. Breeding.

The major thrust of breeding a dual purpose goat for Kenya, especially western Kenya, was intensified by increasing the number of does of indigenous breeding. The populations of East African and Galla have been characterized on this project and found to possess a greater than usual degree of variability (CV) for milking potential. Thus, the decision was made to place emphasis on screening the existing population in order to accomplish a very high initial selection differential. This screening has taken place, selected does purchases, and the flock now approaches the goal of 1000 does.

The indigenous breeds of does are mated naturally or AI to exotic milking type bucks of the Toggenburg, Nubian and Alpine breeds. The F_1's have proven very suitable for small holders of western Kenya and are being produced to supply the Production Systems project as well as forming a foundation for a planned synthetic or composite breed. The major thrust of this project is to produce an adapted, stable breedtype (synthetic) of dual purpose goat for Kenya.

All of the other stated objectives were pursued. A large intensive milking experiment was conducted in order to (a) determine how to best assess the milking potential of does of indigenous breeding which have restrained milk let down for hand milking and (b) determine a milking procedure satisfactory for employment by small holders to optimize milk for family use and satisfactory developoment of kids.

A number of other experiments, many collaborating with other SR-CRSP projects were undertaken. These included anthelmintic efficacy and breed differences, genetic environmental interaction for trypanosomiasis suspectibility, reproductive performance (puberty, postpartum interval and prolificacy) and AI techniques for goats, disease incidence (Pasteurellosis and CCPP), and grazing behavior and intake.

ii. Systems.

Simulation models for sheep and goats, adapted to specific production settings and regimes, have been developed and validated. The major emphasis was placed on utilizing these models to examine the effects of production options and especially at the present stage of the SR-CRSP to provide simulations that will be useful in designing or redesigning objectives and procedures of projects related more directly to applications by small holders. Production systems in two diverse areas were simulated and the results analyzed. One was simulation of dual purpose goats in two districts of western Kenya to evaluate or examine (a) feed resource capability for supporting dual purpose goats, (b) feed supplementation, (c) management practices and (d) breeding practices. These results relate to specific practices but are initially most useful as perspective simulations to specifically quantify limiting factors (and in fact viability) of DPG production and guide the redesign of experiments to meet the goal of producing the information necessary for DPG production by small holders in western Kenya. Another was the simulation of sheep production by small holders in western Kenya. Another was the simulation of sheep production in a traditional range area of Kenya in collaboration with the Integrated Program for Arid Lands (IPAL) to examine genetic environmental interaction. Validation establishing a baseline, and simulation of options and effects of a drought year were undertaken.

8. Technical Accomplishments.

i. Breeding.

The DPG flocks have been built up by increasing the frequency of widely selected higher producing indigenous breeds. Milk production records have been obtained for almost all does and sire progeny testing record files established. The flock has been discriminately culled for low producers based on these records. Also the various breeds and crosses are being characterized for growth and maturing rates and viability. Semen from U.S. dairy breed buck purchased from the University of California, Davis was cleared for entry for CAE and other requirements and is now being utilized. Goats were made available to the Production Systems and Veterinary projects. The selected flock at Ol Magogo now has an inventory built up to about 1000 does. (The current severe drought is disrupting normal operations and experiments and may affect inventories if it continues).

Results from experiments include:

Title: Characterization of East African, Galla, Exotics and their Crosses.

a. Average daily milk yield for EA, Galla and Toggenburg were 385, 409, and 800 g, respectively.

b. The milk yield range was 0 to 1200 g/day for EA; 50 to 1500 g/day for Galla; and 400 to 1700 g/day for Toggenburg. The Toggenburg

does averaged approximately twice as much milk per day as the indigenous purebreds indicating clearly the greater genetic potential than the local breeds for milk production.

c. The large variation and range of milk yield in the indigenous purebreds suggested there is sufficient variation to warrant continued selection and/or screening for improved milk yield in the indigenous breeds.

d. On average, crosses were approximately 2 kg heavier at 12 weeks of age and gained about 20 g/day more than the indigenous purebreds. There was very little difference between Galla and EA, the slight advantage favoring the Galla breed. Also, there was no significant difference between the Toggenburg and Anglo-Nubian crosses with a slight advantage of Toggenburg crosses.

Title: Milking Techniques.

Six potential milking procedures were compared to determine the most suitable procedure for use by small holders and for experimentally assessing genetic potential. The procedures considered were:

Experiment 1:

a. Milking in absence of the kid (KA) and kid suckles residual milk.

b. Milking in presence of the kid (KP) and kid suckles residual milk.

c. Milking once a week and kid suckles all milk the remaining six days of each week (OW).

Experiment 2:

d. Milking half udder while kid suckles the other half (HUM).

e. Milking in the morning and kid suckles all the evening milking (MMO).

f. Weigh-suckle-weigh (WSW).

Parameters measured included milk yield and growth of kids in each milking procedure. The preliminary findings are summarized:

a. Milking does in the presence of the kids increased milk yield. This was attributed to the stimulation of milk let down by the kids presence.

b. Though milking in presence of kid procedure potentially provided most milk for family consumption, little milk was left to sustain proper growth of kids.

c. Estimates of total milk yield by milking once a week seemed to underestimate milk yield potential of the East African and Galla breeds when compared to milking in absence and presence of kid.

d. Restricting milk available to kids reduced their growth rates thus indirectly affected their maturing rate.

e. No milking procedure proved to be all around superior in all the criteria used to select and appropriate method for the small holder. There is a need to use a type of "index" in choosing a milking method whereby socio-economic weights are used to balance the amount of milk for family use with the amount of milk for family use with the amount of milk to sustain growth of kids, etc.

Title: Puberty and Postpartum Interval Characterization of East African and Galla Breeds.

a. Respective mean gestation lengths of Galla and East African does were 149 and 148 days.

b. The period from parturition to estrus (Postpartum Interval) ranged from 20 to 110 days. The average postpartum breeding interval was 90.8 days for East African and 91.2 days for the Galla.

Title: Disease and Prolificacy Characteristics of the Galla and East African Goat Breeds.

a. The East African showed a higher twinning rate (30%) than the Galla breed (10%). The results suggest that it is possible to screen and/or select within the 2 indigenous breeds for prolificacy (twinning rate).

b. The goats originating from Siaya and South Nyanza districts on average had higher twinning rate (30% and greater) than goats originating from Laikipia, Isiolo and Garissa districts.

c. Pasteurellosis causes high mortality in goats particularly in kids. There was a difference in degree of tolerance to the disease by different goat breeds with the East African showing the highest tolerance as exemplified by its lowest mortality in kids.

d. An outbreak of Contagious Caprine Pleural Pneumonia (CCPP) affected the whole flock within a matter of days or weeks. However, with diagnosis done early, the disease responded well to treatment with terramycine.

ii. Systems.

Simulations setting baselines and examining production levels and constraints and effects of optimal practices and breed types were accomplished for western Kenya small holder DPG production and for the IPAL project. Results from simulations include:

Western Kenya

Simulations were utilized to test for optimal genotypes under two types of management - single purpose i.e., meat production and dual purpose e.e., milk and meat production. Four genotypes of varying

mature size (WMA) and milk potential (MP) were tested under single purpose management for viability. All four genotypes proved viable. When dual purpose management was superimposed upon these same four genotypes the 30/2.0 (WMA/MP) was nonviable. Production lels for the 50/6.0 and 45/4.5 genotypes were similar with the 45/4.5 genotype maintaining a higher body condition score. The 35/3.0 genotype had lower levels of production per lactation but completed more lactations given the same time frame. From these simulations, a 40/4.0 genotype was selected as the target genotype. Simulations showed that the 40/4.0 genotype maintained higher body condition scores (85%) than the previous genotypes without sacrificing added production capacity, e.g., 115 kg of milk per lactation and kid weaning weight of 13.8 kg averaged over 6.1 kiddings in 5 years.

Simulations were completed using the 40/4.0 genotype and forage parameters for Siaya and Kakamega. The forage parameters were supplied by the Forage Resources Project as first estimates of production and quality for these two areas. Discussions with the Forage Resources Project about feed quality and quantity lead to the inclusion of two specific forage interventions appropriate for small holders. These forage interventions consisted of forage storage and growing a high quality supplement. Milk production increased in Siaya by 14% with the use of stored forage, while the use of supplementtion increased milk production by 22%. Milk production increased 27% in Kakamega with the use of supplementation when compared to the use of stored forage. Kid weight sold also increased by 88%. More importantly, the cyclic seasonal pattern of production was smoothed in both Siaya and Kakamega, assuring a greater continuity of milk supply for small holder households.

IPAL

Sheep data collected by IPAL were analyzed and used for model input and validation. The validation indicated close agreement between real and simulated results for mature ewe body weight, lamb growth, milk production and reproduction. With the close agreement in results, a baseline validation was established and a series of experimental simulations performed. An important question in this area is how to increase sheep offtake with the given resource. One possible intervention would be the introduction of different genotypes. Therefore responses of sheep of varying mature sizes (30, 35 and 45 kg) and varying potential peak milk production levels (.90, 1.30 and 1.75 kg) were examined for a relatively godd year, a drought year and a 2 recovery years occuring after the drought. The simulated production characters of lamb weight sold per year, total and dairy milk production, reproduction and the efficiency of production were compared. In all instances the sheep with a mature size of 30 kg in conjunction with all levels of potential milk production were the least productive. These three groups of sheep consistently ranked low in comparison with sheep of the 35 and 45 kg mature size. It was found that within the 35 and 45 kg groups there was the optimal milk production level that resulted in higher levels of productivity: 1.30 kg/d for the 35 kg and 1.75 kg/d for the 45 kg ewes. The 35/1.30 flock is the type of sheep currently being used in northern Kenya.

The results consistently showed the 45/1.75 outperforming the 35/1.30. This would imply that this environment could better support a heavier, higher milking sheep. However, the results also show that increasing body size while not increasing milk production level would not result in an increased level of productivity. Similarly, increasing milk potential to 1.75 for 35 kg ewes was also counterproductive. These counterproductive limits further substantiate that 35/1.30 is an optimal combination. As a result of these simulations, IPAL is initiating experiments to introduce and test the productivity of a heavier, high milking sheep into the nomadic production system. Preliminary simulations concerning continuous vs controlled breeding season have been performed. At this point, controlling the breeding season appears to have a negative impact upon total sheep flock productivity. This is contrary to the initial thinking of the IPAL group; upon examining the simulations, the IPAL staff is reconsidering their recommendation and are proceeding more cautiously before making controlled breeding a recommended production practice.

9. Personnel Collaborating on Project Activities:

Title	Name	Institution	Dates
Co-Investigator	G.M. Smith	Texas A&M	Dec 1978--Aug 1983
Co-Principal Investigators	A.B. Carles, PhD	Univ. of Nairobi	Feb 1980--
	D. Kimenye, PhD	Univ. of Nairobi	July 1982--
Senior Investigator	F. Ruvuna, PhD	Texas A&M	Nov 1981--
Research Associate	Harvey Blackburn	Texas A&M	Oct 1978--
Collaborators	C.R. Field, PhD	UNESCO	Feb 1980--
Graduate Students	P. Howard	Texas A&M	Jan 1982--
	S. Tallam	Texas A&M, MALD	Jan 1983--
	C.O. Ahuya	Texas A&M, MALD	Dec 1983--
	L. Coronado	Texas A&M, Univ. San Marcos, Peru	Jan 1981--Dec 1983

Appendix - Peru

Dr. Luis Felipe Coronado, Univ. Nac. Mayor de San Marcos, Lima, Peru, completed his MS sponsored by the Systems Analysis Project, in December, 1983.

This sponsorship initiated in 1981 at a time that the project was active in Peru. The thesis is entitled: Performance of Purebred and Crossbred Sheep on Accelerated Lambing on Cultivated Pastures in Peru. The abstract of the thesis follows.

Performance data collected on the "Sheep Production" project at the Principal Altitude Station of the Veterinary Institute of Tropical and Altitude Research, Huancayo, Junin, Peru from 1971 to 1973 in the continuous breeding regimen and from 1973 to 1977 in the seasonal breeding regimen were used to characterize growth and reproduction characters of sheep on cultivated pastures. These two breeding management data sets were analyzed separately by least-squares methods for unequal subclass numbers. The growth characters analyzed were birth weight, weaning weight, 6-month weight, 12-month weight preweaning average daily gain from birth to weaning, postweaning average daily gain from weaning to 6 months and postweaning average daily gain from 6 months to 12 months. The reproduction characters analyzed were gestation length, lambing interval and frequency of twins. Environmental factors considered were month or season of birth, year of birth, sex, type of birth and age of dam at lambing.

Breedtype of lamb had a significant effect on all growth characters studied for both breeding regimens, except for postweaning average daily gain from 6 months to 12 months in the continuous breeding regimen. The 1/2 Hampshire-1/2 Junin breedtype of lamb was superior at birth, weaning and 6-month weights to the other breedtypes in the continuous breeding management. For the seasonal breeding data, the 1/2 German Mutton Merino-1/2 Junin breedtype of lamb had the heaviest birth weight. The 1/2 Texel-1/2 Junin lambs were heaviest at weaning and gained fastest from birth to weaning. For the three-breed cross and backcross, 1/2 German Mutton Merino-1/4 Hampshire-1/4 Junin had the highest weight at birth and the 3/4 Junin-1/4 Texel had the highest weaning weight and preweaning average daily gain. Breed of dam had a significant effect on gestation length and frequency of twins in the continuous breeding data. For the seasonal breeding data, breed of dam had a significant effect on gestation length, lambing interval and frequency of twins. The Criollo, 1/2 Texel-1/2 Criollo and 1/2 Hampshire-1/2 Criollo dams exhibited the ability to lamb on a three-times-two year schedule each with 8 4, 8.2 and 8.2 month intervals, respectively.

1. **Project Title:** Economic Analysis of Small Ruminant Production and Marketing Systems.

2. **Institution:** Winrock International Livestock Research and Training Center.

3. **Principal Investigator:** A. John De Boer

4. **Funds Allocated From:**

Grant No. AID/DSAN-XII-G-0049 from 1983/84 Subgrant:	$153,000
Matching Contribution from 1983/84 Subgrant:	$ 85,170

5. **Brief Statement of Project Goals:**

   i. Provide a well-trained group of professional agricultural economists with the analytical skills, research experience, and professional motivation to contribute to the conduct of multidisciplinary research on small ruminants and their producers.

   ii. Develop long-term reliable data bases on cooperating producer farms to provide animal performance data to EMBRAPA researchers and to allow whole-farm economic modelling to be carried out.

   iii. Develop cooperative research projects with biological sciences to gain better understanding of producer rationale for sheep and goat production practices.

   iv. Publication and dissemination of research results representing a wide variety of research and which will contribute to a better understanding within the scientific community of small ruminants and their place in selected rural economies of developing countries.

6. **Statement of Specific Objectives for 1983/84:**

   i. Conduct economic analysis of CNPC experiment station results in nutrition and management.

   ii. Complete the analysis of periodical survey results for 32 farms. A total of 6 papers are being prepared from this data covering production system description, animal performance, genetic abnormalities, resource allocation, and animal management systems.

   iii. Updating the whole-farm linear programming model to incorporate recent experimental results from Range Management research and data from the periodical survey. Documentation and training with the model will be completed at Sobral and Brazilia.

   iv. Complete collaborative project with Utah State Range on "Ecology and Management of Small Ruminant Production Systems in the Sertao of Ceara State." This will provide detailed information on management strategies and land utilization patterns by season for cattle, sheep, and goats and will provide information needed for statistical analysis of farm monitoring data and for the planning and conduct of on-farm

trials.

v. Start feasibility study for establishing a dairy goat production and processing industry in Northeast Brazil in collaboration with the Texas A&M Management project.

7. Description of Work Undertaken:

i. Analysis of research station experiments -- Economic analysis was carried out on one experiment comparing goat breed productivity, two experiments involving feeding levels of mata pasto in goat diets, and one experiment estimating animal responses to mineral supplementation.

ii. The linear programming model was transferred from the computer at the University of Arkansas to the EMBRAPA main-frame computer in Brasilia. Original model results generated by Gutierrez-A. (1983) were validated in Brasilia and modification of the matrix coefficients is proceeding. Table 1 presents model results indicating the simulated influence of weather situations on whole-farm performance.

iii. Analysis of the two years of periodical survey data has been a long and complicated process, particularly as regards on-farm estimates of animal performance. The original data set was entered, cleaned, and reformatted in 1982 at Winrock. The data was subsequently entered in the EMBRAPA computer in Brasilia where most of the analysis has been carried out in cooperation with Dr. Abel Ponce de Leon, an IICA/EMBRAPA consultant. Implications have been drawn which support most of our earlier contentions about the role of small ruminants (particularly goats) in the Sertao region. They are the favored species for home consumption, maintain relative numbers at higher levels than cattle during droughts, require less capital per $ of output than crops or cattle, and are almost always part of a mixed farming system. Another important finding of relevance to the whole area of farming systems research is that estimates of animal performance (particularly growth curves and reproduction parameters) based on repeat surveys of farms show high variance both within farms and among farms. This is despite tagging and careful weighing of large numbers (over 4,000 head in total) of small ruminants over more than two years on farms that we originally perceived as fairly homogeneous. The implication is that monitoring and assessing the potential impact of "improved" technology at the farm level will be very difficult until we can better sort out the sources of variance of animal performance. An alternative may have to be setting up researcher-controlled experiments on the farm with well managed control groups of animals.

iv. A collaborative project with Range Management was designed and the survey phase conducted to (a) help classify farm types, farm resources, and farming systems at a much more detailed level and (b) to assess the impact of the five-year drought on whole-farm performance and adjustments in animal numbers, stocking rates, and management strategies. We are hopeful that accomplishing part (a) will help in the reanalysis of the animal performance data from the periodical survey. A total of 16 specific management strategies were

defined and this was subsequently reduced to 3 for cattle, 4 for sheep and 3 for goats.

8. Personnel Collaborating on Project Activities.

Nestor Gutierrez-A., Agricultural Economist, Winrock International.

Jose de Souza-Neto, Agricultural Economist, EMBRAPA/CNPA.

F. Abel Ponce de Leon-B., IICA/EMBRAPA Consultant in Animal Breeding CNPC, Sobral.

Joao Ambrosio de Araujo F., Professor of Range Management, Federal University of Ceara

Odorico de Moraes Eloy da Costa, EMBRAPA/CNPC

Fatima Moura Fe, Zootechnics Department, Federal University of Ceara.

TABLE 1. Simulated Effect of Three Weather Situations on Whole-Farm Performance Based on Linear Programming Model for Typical Farm.

Performance Variable	Unit	Weather Situation		
		Good	Average	Poor
Net cash income	CR$*	621,210	335,204	177,577
% net cash income of average year	%	185	100	53
Breeding Units	Head			
Cows	46	24	11	
Ewes	43	25	10	
Does	41	31	19	
Livestock Populations	Head			
Cattle	117	74	49	
Sheep	161	67	65	
Goats	126	120	89	

*Cruzeiros 64 = 1 US$ at December, 1980 survey period.

1. **Project Title:** Economic Analysis of Small Ruminant Production and Marketing Systems.

2. **Institution:** Winrock International Livestock Research and Training Center.

3. **Principal Investigator:** A. John De Boer

4. **Funds Allocated From:**

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant:	$153,000
Contribution from 1983/84 Subgrant:	$85,170

5. **Brief Statement of Project Goals:**

   i. Provide a well-trained group of professional agricultural economists with the analytical skills, research experience, and professional motivation to contribute to the conduct of multidisciplinary research on small ruminants and their producers.

   ii. Provide an improved data base for guiding research and providing policy guidelines for improving small ruminant productivity and farmer incomes.

   iii. Strengthen the overall research capacity of selected host country research institutions by providing leadership in conducting interdisciplinary research, conducting training programs and publishing research results.

   iv. Direct the focus of research towards a farming system approach in which relevant research institutes collaborate in attempting to develop new technology to meet farmers' needs.

   v. Publication and dissemination of research results representing a wide variety of research and which will contribute to a better understanding within the scientific community of small ruminants and their place in selected rural economies of developing countries.

6. **Statement of Specific Objectives for 1983/84:**

   i. Complete marketing profile studies to allow comparative analysis between West, Central and East Java and identify successful marketing innovations that may raise small producer returns.

   ii. Earlier field studies have identified some key individuals and organizational arrangements used in village small ruminant production and marketing systems. These include village traders, village women, animal sharing arrangements and labor use patterns. A series of focused studies will identify the positive and negative aspects of these factors and identify key change agents that must be utilized to facilitate improved systems.

   iii. A budgeting model will be used to compare improved vs traditional

systems and to assist in the on-farm technology testing and evaluation.

iv. Agroeconomic profiles will be constructed of selected livestock farming systems. These are used to guide the on-farm trials and select promising areas for technology transfer.

v. Complete work examining the technical and economic potential for transferring commercial small ruminant producer technologies to cooperating smallholders.

vi. Assist in the design of research programs for the new substation at Sei Putih, North Sumatra.

7. Description of Work Undertaken:

i. Market profiles and marketing agent studies -- Studies have focused on analysis of the social and economic links between farmers and middlemen in the goat production and marketing process. A detailed survey was conducted in collaboration with Satya Wacana University in Central Java and a repeat survey for West Java is scheduled for 1984/85.

Marketing profiles of small ruminant markets were conducted in East Java, the Jakarta small ruminant market and these studies, in addition to the earlier studies of the West Java, Central Java and Bandung markets, are being integrated into one comprehensive document.

ii. Follow-up research from initial baseline surveys in West Java -- The original 1981/82 baseline survey data has been more fully analyzed and some additional resurvey work has been conducted to focus more closely on specific resource allocation issues and sex roles related to specific production and marketing activities.

This research has highlighted relationships between animal numbers and specific characteristics of the farms and farm family composition.

iii. Village monitoring research -- The seasonal dimensions of resource allocation and farm family cash requirements is important in designing acceptable technical/management packages for these small producers. Long-term monitoring of selected producers has provided critical information on seasonality of labor use for a variety of enterprises, seasonal variations in feed supply and cash returns from small ruminants, and variations in household cash flow patterns. Research results show considerable variation in labor inputs for small ruminants among villages but not within specific villages. Access to feed supplies is the most critical factor explaining these variations. Seasonal variations in farm-level prices received for small ruminants does not appear to be large enough to use a seasonal production strategy.

iv. A small research project on the potential uses of existing production technologies found on larger, specialized small ruminant production units was completed. These commercial units specialized in the

growing out of immature small ruminants or in fully integrated breeding-growing out units. All used full confinement systems with agro-industrial by-products fed as supplements. Economic analysis of these production systems were carried out and attempts made to assess the potential transferability of these more productive systems to typical smallholder units.

v. Previous interest in sharing (gadohan) arrangements for small ruminant production culminated in a workshop held in Bogor on November 21, 1983. A variety of researchers and project management staff shared their observations and experiences with animal distribution schemes and resource sharing arrangements and made recommendations about how this traditional aspect of Indonesian village life could be further utilized to promote animal production schemes.

vi. The current and potential role of small ruminants in upland watershed projects was reviewed and this information was incorporated into a U.S. AID Project Paper designed to assist the Government of Indonesia in devising viable farming systems for highly erodable upland areas in Java.

8. Personnel Collaborating on Project Activities:

i. Dr. Henk Knipscheer, Agricultural Economist, Winrock International, Bogor.

ii. Tjeppy Soedjana, Agricultural Economist, BPT-Bogor.

iii. Agus Muljadi, Agricultural Economist, BPT-Bogor.

iv. Uka Kusnadi, Agricultural Economist, BPT-Bogor.

v. Karo-Karo, Agricultural Economist, BPT-Bogor, and Sei Putih, N. Sumatra.

vi. Dr. John Ihalauw, Satya Wacana University, Central Java.

vii. John Petheram, Social Scientist, PBT-Ciawi.

viii. Kedi Suradisastra, Rural Sociologist, PBT-Bogor.

ix. M. Sabrani, Agricultural Economist, BPT, Klepu.

9. Training and Workshops/Conferences/Seminars:

i. Agus Muljadi, M. S. in Agricultural Economics, Texas A&M University, August, 1983.

ii. Sugiyanto, M. S. in Rural Economics, Bogor Agricultural University, September, 1983.

iii. Henk Knipscheer and Uka Kusnadi, attended "Goat Development in Asia" Workshop, Southeast Asia Research College for Agriculture, Los Banos, Philippines, October 1983.

iv. Tjeppy Soedjana - Attended World Congress on Animal Production, Tokyo, August 1983 and Food and Fertilizer Technology Center seminar on "Recent Advancements in Soil Fertility," Los Banos, Philippines, May 1984.

v. Co-Sponsored Workshop on Sharing Household Systems, Baguio, November, 1983.

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2. **Institution:** Winrock International Livestock Research and Training Center.

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4. **Funds Allocated From:**

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant:	$153,000
Matching Contribution from 1983/84 Subgrant:	$ 85,170

5. **Brief Statement of Project Goals:**

   i. Develop useful whole-farm economic model of Western Kenya small farms to assist in ex ante evaluation of dual-purpose goat acceptance.

   ii. Economic feasibility analysis of selected component technologies and management practices being developed for use by small farmers. These include forage production, feed production from modification of existing cropping systems, dipping, drenching, alternative confinement systems, and evaluation of economic success achieved with goats distributed to farmers.

6. **Statement of Specific Objectives for 1983/84:**

   i. Whole-farm economic modeling. Implement a simplified linear programming (LP) model of small farms in Kenya, carry out training activities associated with the model, up-date the model parameters based on 1983 long-rains and short-rains experimental results, estimate resource requirements following adoption of dual-purpose goats, and incorporate household economic data into the model.

   ii. Analysis of component technologies. A variety of analytical techniques will be applied to the experimental data generated from trials of the Maseno station and farmers fields. These include partial budgeting, whole-farm budgeting, cost-benefit analysis and incorporation of selected results into the whole-farm LP model. Detailed studies of farm household food purchasing and food consumption patterns will be used to supplement this data and provide a better base for assessment of potential farmer adoption of dual-purpose goats. Finally, detailed studies of farm labor use are being conducted to assist in assessment of acceptability of dual-purpose goats.

7. **Description of Work Undertaken (in cluster areas):**

   i. Small farm household expenditure survey was conducted in April, June, and October 1983. Data were collected and analyzed to explain variations in food consumption and expenditures between reasons and compare these to previous survey periods.

   ii. Household labor allocation to crop activities, livestock activities and household chores was monitored for one crop season covering seven

months, March-September 1983. Data were collected and analyzed to quantitate labor inputs to various crop and livestock including dual-purpose goat enterprises and household activities.

iii. Single farm visits were made to households which had been given dual-purpose goats. Recall input-output data were collected and analyzed to generate annual/seasonal budgets and resource returns by enterprise and by cluster.

iv. Technical input-output data from biological experiments (feed resources, nutrition management, animal health, and animal breeding) were collected in collaboration with other SR-CRSP projects. Economic costs and benefits of prototype technologies and practices were computed.

v. Technical and economic resource and enterprise coefficients generated from SR-CRSP experiments were used in constructing Linear Programming models of small-scale farms in Western Kenya, incorporating farmer risk preferences, seasonal variability in cropping patterns and the interrelationship between the dual-purpose goat enterprise and other enterprises in small-scale farming systems in Western Kenya.

vi. Training counterpart economist on relevant economic theory and analytical models applied in economics project activities.

8. Technical Accomplishments: In Proceedings of the Third SR-CRSP Kenya Workshop 1984-Forthcoming.

i. Nyaribo, F. B., A. W. Mukhebi and R. H. Bernsten. 1984. "Implications of family labor use for adoption of the dual-purpose goat enterprise."

ii. Nyaribo, F. B., A. W. Mukhebi and R. H. Bernsten. 1984. "Implications of family consumption patterns on adoption of the dual-purpose goat enterprise."

iii. Mukhebi, A. W., F. B. Nyaribo, R. W. Bernsten, E. Reynolds, and P. Mbabi. 1984. "Preliminary socioeconomic evaluation of the dual-purpose goat enterprise in the small-scale farming systems in western Kenya."

9. Personnel Collaborating on Project Activities:

R. H. Bernsten, Co-PI for Kenya.

Adrian W. Mukhebi, SR-CRSP resident scientist.

Fanny B. Nyaribo, collaborator, Ministry of Agriculture and Livestock Development.

1. **Project Title:** Economic Analysis of Small Ruminant Production and Marketing Systems.

2. **Institution:** Winrock International Livestock Research and Training Center.

3. **Principal Investigator:** A. John De Boer

4. **Funds Allocated from:**

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant:	$153,000
Matching Contribution from 1983/84 Subgrant:	$ 85,170

5. **Brief Statement of Project Goals:**

   i. Provide a well-trained group of professional agricultural economists with the analytical skills, research experience, and professional motivation to contribute to the conduct of multidisciplinary research on small ruminants and their producers.

   ii. Provide an improved data base for guiding research and providing policy guidelines for improving small ruminant productivity and farmer incomes.

   iii. Strengthen the overall research capacity of selected host country research institutions by providing leadership in conducting interdisciplinary research, conducting training programs, and publishing research results.

   iv. Publication and dissemination of research results representing a wide variety of research and which will contribute to a better understanding within the scientific community of small ruminants and their place in selected rural economies of developing countries.

6. **Statement of Specific Objectives for 1983/84:**

   i. Consolidate earlier research efforts by resident scientists, Peruvian collaborators and graduate students.

   ii. Initiate an economic research component in two of the three community research sites.

   iii. Start second phase of research on Cooperative Sector ranching units focusing on division of profits, reinvestment options, and potential for technology transfer between these units and community producers of sheep and alpaca.

   iv. Finish up analysis of goat project survey work.

   v. Develop monitoring project for northern goat project to assist in analysis of seasonal constraints on goat production in the arid regions.

7. Description of Work Undertaken:

i. A graduate student, Rosario Valer, has started work on description of production systems in northern Peru and in designing a questionnaire for monitoring farm resource allocation, income, expenses, and food consumption.

ii. A US graduate student, Anne Swindale, is working in the Central Sierra farming systems project. Although her major support comes from an Inter-American Foundation grant, the work is closely linked to the SR-CRSP efforts. A model for improving the economic evaluation procedures for assessing new technology in peasant communities is being developed in conjunction with Peruvian collaborators.

iii. Data files have been created and edited for both the Northern Goat Project Survey and the Community survey in Huancavelica conducted three years ago. An experienced computer programmer has been hired to assist in the analysis of these data sets.

iv. Cooperative workplans have been developed with the Range Management/Forages and Sheep Breeding projects and a Research Associate has been hired in the economic analysis and interpretation of experimental results generated to date.

8. Personnel Collaborating on Project Activities:

Domingo Martinez and Corinne Valdivia, Lecturers in Agricultural Economics, Department of Economics and Planning, National Agrarian University, Lima -- Co-Investigators.

Aldo Cruz -- Research Assistant (full-time).

Francisco Gutierrez, Eduardo Garcia, Jamie Flores -- Junior Research Assistants (part-time).

Ed Lotterman, Department of Economics, Dordt College, Sioux Center, Iowa.

Mario Tapia, Leader, Andean Cropping Systems Project.

Maria Fernandez -- Research Associate in Central Sierra Community Research Project.

Trainees:

Anne Swindale, MS candidate, Tufts University.

Roxanna Diaz, candidate for Ing. Agr. degree, National Agrarian University, Lima.

Ruben Velarde, candidate for Licenciatura in Economics, National Agrarian University, Lima.

Luis Millones-O. Completed Licenciatura in Economics degree, National Agrarian University, 1983.

Rosario Valer, candidate for Licenciatura in Economics, National Agrarian University, Lima.

1. **Project Title:** Economic Analysis of Small Ruminant Production and Marketing Systems.

2. **Institution:** Winrock International Livestock Research and Training Center.

3. **Principal Investigator:** A. John De Boer

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant: $153,000.
   Matching Contribution from 1983/84 Subgrant: $ 85,170.

5. **Brief Statement of Project Goals:**

   i. Provide a well-trained group of professional agricultural economists with the analytical skills, research experience, and professional motivation to contribute to the conduct of multidisciplinary research on small ruminants and their producers.

   ii. Provide an improved data base for guiding research and providing policy guidelines for improving small ruminant productivity and farmer incomes.

   iii. Strengthen the overall research capacity of selected host country research institutions by providing leadership in conducting interdisciplinary research, conducting training programs and publishing research results.

   iv. Publication and dissemination of research results representing a wide variety of research and which will contribute to a better understanding within the scientific community of small ruminants and their place in selected rural economies of developing countries.

6. **Statement of Specific Objectives for 1983/84:**

   i. Complete the analysis of feasibility study on economics of locating goat milk processing facility in the Ozark region of southern Missouri-northern Arkansas.

   ii. Help develop a general purpose linear programming model for use in farm planning and research decision making for Kenya and Brazil research programs.

   iii. Provide computer hardware and software support for overseas worksites.

7. **Description of Work Undertaken:**

   i. Ozark Dairy Goat Feasibility Study--This was a cooperative program between Winrock International, the University of Arkansas, the Winthrop Rockefeller Foundation, and the Central States Dairy Goat Marketing Cooperative. The major reference materials utilized in this study are MS theses by Norman (1982) and Howard (1984). The first study reported on a producer survey, which was used to generate dairy goat budgets for different size units operating under different levels

of technology. The second study carried out an assessment of the marketing, processing, and pricing of goat milk for various end uses.

This report merged these two studies to conduct an overall feasibility analysis for establishing further dairy goat processing facilities in the Ozark Mountain region of Southern Missouri and Northern Arkansas. Feasibility is examined from the viewpoint of the investor in new facilities as well as the producer level. Starting at the retail level, costs are calculated at every level of the distribution-marketing-processing chain to arrive at a net price payable to the goat-milk producer for milk delivered to the processing plant. This net price payable is then compared to costs of producing goat milk to arrive at a profit or loss figure per hundred weight of milk produced.

Critical factors influencing profitability were size of dairy goat herd, lactation levels assumed for the does, type of final product produced, retail prices and size of processing plant. The report describes in considerable detail the procedures used to generate the budgeting data. Therefore, this study could serve as a basis for further work in this area where some of our assumptions may be changed.

ii. Research Methodology Support for Host-Country Research Programs. A variety of publications and other research materials were collected at Winrock and sent to the host-country research groups. Microcomputer support was provided in Kenya, Indonesia, and Peru.

iii. Policy Support. The major study was completed for the World Bank and the publication produced by the World Bank Department of Agriculture and Rural Development was widely distributed. The public policy issues raised in this report have been important in focusing attention on the role of small ruminants in mixed farming systems and in rural development programs. Also, papers were presented at international meetings at the International Rice Research Institute and at an FAO expert group meeting in Bangkok. Both dealt with policy issues related to small farm livestock development.

8. Technical Accomplishments:

Ozark Dairy Goat Feasibility Study. Dairy goat producers have established a small goat milk industry in the Ozark mountain region of northern Arkansas and southern Missouri. About 60 to 80 commercial producers supply raw goat milk to a Class C processing plant in Yellville, Arkansas, which produces evaporated and dried milk. A larger group of noncommercial farmers produce goat milk for on-fanm and local consumption.

The amount of milk bought by the Yellville plant is fixed by its capacity; thus significant increases in usage of goat milk in the region will depend largely on expansion of the current plant or construction of additional processing facilities to produce new product lines such as pasteurized milk, ultra-high temperature milk or cheese.

The research reported here was designed to assess the potential uses for increased production of goat milk from this region. The research included (1) a producer survey to gather technical and economic information from a sample of dairy goat farms in the study area; 2) statistical analysis of the data; 3) development of model budgets for three different sizes of dairy goat farms showing annual net returns; 4) identification of goat milk products that might be processed in the study area; 5) definition of three market areas for the processed goat milk products; 6) estimation of the assembly, processing, and distribution costs associated with each of the goat milk products, assuming different market area sizes and different processing plant sizes; and 7) identification of the goat milk products and the appropriate production and marketing assumptions that would result in a milk price to producers that would cover variable and fixed costs.

The model budget for a 50-doe herd with a milk production average of 1,800 lb/lactation/doe was judged to be the most applicable to the commercial producers in the study area at the time of the study. For this budget, income above total variable costs of $13,319 was $2,346. When nonland fixed costs of $5,919 were considered, net returns to land, labor, and management were $-3,573. The researchers noted that 1) if an existing building could be converted to a milk shed, the annual costs could be reduced by almost $2,500 a year, and 2) if pasture could provide a significant proportion of needed forage, costs of purchased hay could be reduced correspondingly.

If a higher lactation level (2,400 lb/lactation/doe) were assumed, total gross receipts would improve significantly because: 1) more milk would be produced and sold and 2) the offspring of these higher producing does are more desirable to buyers and command a higher price when sold as breeding stock. The only combination of doe numbers and production average that came close to covering variable cost, fixed cost, and operator labor (but not family labor) was that of 80 does with a production average of 2,400 lb/lactation/doe. These budgets were based on current prices received for dairy goat milk.

By comparing the breakeven costs of production with estimated net prices payable by processing plants, it is possible to determine the returns to the producer for all combinations of doe herd size, doe production level, market area, plant size, and product type. The combination of three herd sizes, three production levels, and 16 market area and plant sizes, resulted in 144 different scenarios to consider. Of these combinations, 36 yielded returns that exceeded total estimated production costs of goat milk; the remaining 108 combinations did not cover total costs.

9. Personnel Collaborating on Project Activities.

Dr. J. Martin Redfern, Professor of Agricultural Economics, University of Arkansas, Fayetteville.

Ms. Pamelo Jo Howard, former graduate student, Food and Resource Economics Department, University of Florida, Gainesville and current graduate student, Department of Animal Science Texas A&M MS degree at

Florida under Winrock support.

M. David Norman, former graduate student, Department of Agricultural Economics and Rural Sociology, University of Arkansas, Fayetteville. Partial Winrock support for MS thesis, 1982.

J. A. Yazman, Animal Scientist, Winrock International.

Wayne Hinerman, Computer Specialist, Winrock International.

Rick Bernsten, Agricultural Economist, Winrock International.

1. **Project Title:** An Investigation of Small Ruminant Health Problems.

2. **Institution:** Colorado State University

3. **Principal Investigator:** James C. DeMartini

4. **Funds Allocated From:**

   Grant No. AID/DSAN/XII-G-0049 from 1983-84 subgrant: $175,000
   Matching Contribution from 1983/84 subgrant: $58,275

5. **Brief Statement of Project Goals:**

The long range goal for the SR-CRSP Animal Health Project in Peru is to decrease disease-related losses of food and fiber produots of sheep, goats, and alpaca through the following objectives:

i. Determine the causes and prevalence of major infectious and non-infectious diseases in small holder production units as well as large cooperatives.

ii. Develop control or prevention strategies for chronic respiratory diseases of sheep based on increased knowledge of the cause, lesions, diagnosis, and transmission of the specific entities that comprise this complex.

iii. Develop control or prevention strategies for neonatal anteritis in alpaca based on increased knowledge of the cause, pathogenesis, diagnosis and transmission of microbial agents involved.

iv. Evaluate the role of infectious agents in losses due to infertility in sheep and develop control strategies for the responsible entities.

v. Provide advanced training for Veterinarians interested in disease investigation.

vi. Promote the exchange of ideas between US and Peruvian scientists.

vii. Enhance the dissemination of research findings to Peruvian officials and lay personnel concerned with disease control in small ruminants and camelids.

6. **Statement of Specific Objectives for 1983/84:**

i. Experimental transmission and role of retrovirus in sheep pulmonary adenomatosis.

ii. Development of a sheep, goat and alpaca serum collection in Peru for seroepidemiologic studies.

iii. Determination of epidemiologic, clinical, and pathologic features of jacapo (photosensitization) in sheep.

iv. Baseline study of lamb mortality and internal parasitism in community flocks.

v. Evaluation of the role of infectious agents in infertility in an experimental flock at SAIS Tupac Amaru.

vi. Determination of exposures and body burdens of several heavy metals in sheep located near a smelting operation in Peru.

vii. Determination of bacteriologic and toxin characteristics of S. coli and Cl. perfringens isolated from neonatal alpaca.

viii. Define the reservoir for Strep. zooepidemicus, the causative agent of alpaca fever.

ix. Compare the efficacy of ELISA and complement fixation tests in detection of rams with Brucella ovis infection.

x. Determine the kinetics and significance of colostral immunoglobulin transfer in alpaca.

7. Description of Work Undertaken and Technical Accomplishments - PERU:

In this section, research activities in Peru of the CSU animal health project will be described. For convenience, these will be divided into three spheres of activity, and the specific objectives of the project for 1983/84 will be related to these. The most significant research results are summarized in each section.

i. Chronic Respiratory Diseases of Sheep (Objectives 1 and 2):

We have previously established clinical and pathologic criteria for diagnosis of sheep pulmonary adenomatosis (SPA) and ovine progressive pneumonia (OPP), two causes of chronic respiratory disease in sheep in Peru. Further studies were undertaken to determine the frequency of occurrence of these disease in different geographic regions of Peru and to investigate the cause and mechanism of transmission of SPA.

Dr. Dennis Nelson worked at IVITA and San Marcos University in Peru from July, 1982 to July, 1983. He collected samples at necropsy from 5 suspected SPA cases for electro microscopy, tissue culture and transmission studies. In two experiments lung fluid or bone marrow from SPA and control sheep were inoculated into 16 neonatal lambs which were killed over a 7 month period. None of the lambs developed gross or histologic evidence of SPA, but ultrastructural studies of these animals are continuing. Cytopathic changes compatible with presence of a retrovirus were observed in bone marrow cell cultures from one SPA case. This correlates with previous ultrastructural evidence of such an agent in bone marrow samples of 12 SPA sheep and warrants further investigation.

Another approach to the identification of the SPA causative agent is to examine lung fluid or tumor tissue protein or DNA for evidence of cross reaction with products of known viral agents. Such analysis with samples collected by Dr. DeMartini at SAIS Tupc Amaru yielded cross reaction with antibody to another retrovirus, Mason Phizer

Monkey Virus, in an assay done at the Moredun Institute in Scotland. These studies will be continued when Dr. Michael Sharp of that institute arrives in Fort Collins for a one year sabbatical. DNA from SPA cases has also been collected for studies in collaboration with Dr. John Dahlberg of the National Cancer Institute to search for DNA sequences that hybridze with radiolabelled probes for known oncogenes and other retroviruses.

Epidemiologic investigations include a continuing serologio survey for ovine progressive pneumonia (OPP) in Peru, description of the geographical extent of SPA in the country, and a long term effort to develop an SPA-free breeding flock at SAIS Tupac Amaru. The most recent OPP survey indicated a prevalence of only about 1% reactors in 1098 SAIS sheep tested and no reactors in 199 criollo sheep. SPA, previously thought to be limited to the Central Sierra region of Peru, was found to occur extensively in the southern part of the country as 18 cases were found at SAIS Picotani near Juliaca. An attempt to develop an SPA-free flock at Tupac Amaru is well underway. Twenty-four hundred ewe lambs from primiparous ewes hava been selected, identified and isolated in 2 flocks at the Cochas unit. Succeeding generations from these and a control flock will be evaluated for development of SPA and positive animals will be removed from the principal flocks. Lamb survival, weaning weights and OPP seropositivity will be evaluated for all 3 flocks.

ii. Epidemiology of Sheep Diseases (Objectives 2-6):

Epidemiologic investigations of certain sheep disease problems have been directed by Dr. John Reif of CSU in collaboration with Dr. Ameghino. Dr. Reif travelled to Peru in June 1983 to maintain the continuity of this work.

Jacapo (photosensitization) has been repeatedly cited as a significant problem of sheep on range in the Central Sierra, particularly in the dry winter when grazing pressure is at its greatest. Data are currently being collected and analyzed for an epidemiologic study of this disease at SAIS Tupac Amaru 1971-1983. Specimens of the suspected causative plant, quillwort (Isoetes andicola), have been collected and identified and experimental evaluation of its toxicity is planned in the future.

There exists little information on parameters of health in smallholders (community) sheep flocks. In our initial studies we planned to study two important parameters, neonatal mortality and internal parasitism in three such flocks at Canchayllo community. Of 225 lambs born during the 9 month study period, the mortality rates for age groups 1-3 days, 4-30 days, and 30-180 days were 4.0%, 4.4% and 12.0%, respectively. The total of 20% is quite high compared to the 4.28 mortality rate at a nearby well-organized cooperative farm. Causes of death and internal parasitism were evaluated in the lambs. Infection rates with Ostertaga sp. were 80-90%, Trichostrongylus sp. 5-20% and Cooperia sp. were 5-15%. Parasite ova concentration was 150-400 eggs per gram of feces.

Perinatal death, stillbirth, abortion and infertility are major causes of economic loss in all sheep raising countries of the world. The causes for these losses are infectious, nutritional and environmental in nature. Our purpose in the present year was to determine to what extent these diseases contribute to reproductive wastage and neonatal death. The work was begun in 1983 with collection of sera from a flock of 3000 ewes held at the Consac Unit, SAIS Tupac Amaru by the Montana State University Breeding Project. The sheep were held at breeding and following parturition yielding 694 paired sera for comparison of titers of antibodies to 6 infectious agents known to be associated with infertility. Of these 694 ewes, 143 (20.6%) were infertile during the 1983 lambing season. An additional 35 (5%) had lambs which died during the perinatal period. approximately 2% of these ewes had a recognized abortion. It is likely that many of the infertile ewes had unrecognized early abortion or fetal death with resorption. Serologic titers will be correlated with reproductive outcome to determine the relationship between current and prior infection with each agent and varibles including live birth, abortion, perinatal death, infertility, birth weight, twinning and congenital anomalies. Complete ascertainment of reproductive health and outcome will be conducted on each ewe and her offspring. The data are to be stored on computer tape at La Molina University, thereby permitting easy access and statistioal analysis by correlation after entering the serologic results.

The objectives of the study on the effects of mining and smelting on the health of sheep are: 1) To conduct an epidemiologic survey of heavy metal accumulation in sheep living in proximity to a smelter in the Central Sierra of Peru in order to determine the distribution of these hazardous materials on the livers of Peruvian sheep; and (2) To determine whether chronic exposure to heavy metals as measured by liver content of arsenic, copper, lead, zinc, manganese and cadmium is associated with an increased frequency of certain diseases. Incidence of selected diseases in sheep living near the smelter with high liver levels of heavy metals will be compared with similarly sheep living at distances from the smelter where environmental contamination and body accumulations are lower.

During the preceding year, we collected and analyzed 52 liver samples, 14 hair and 14 serum samples for 5 heavy metals. Serum and hair were collected to determine whether hair can be used as a substitute for invasive procedures. In addition, soil samples were collected to determine whether the amounts of contaminant found in soil correlates with body burden of the same compound. The correlation between body burdens and disease rates should be completed in the 1984-1985 year.

iii. Bacterial Diseases of Alpaca and Sheep (Objectives 7-10):

Both E. coli and Cl. perfringens, type A have been shown to cause significant neonatal deaths in alpapa, which occur each year between January and March. Dr. Ellis travelled to Peru during January and February 1983 to coordinate research being conducted in Peru by Dr. Huaman and to collect samples. Approximately 100 E. coli isolates were obtained from diarrheic alpacas. Forty-five of these were

imported to CSU and further characterization included O:K:H serotyping, pilus typing, heat label enterotoxin (LT) production and heat stable enterotoxin (ST) production. A table listing the O:K:H serotyping results is attached. None of the isolates produoed either ST of LT, and none possessed pili types K88, K99, 987P or F41. Thus, although these isolates were from animals with diarrhea, and some of the isolates were positive in ligated alpaca intestine tests, the mechanism of a) attachment and colonization, and b) enterotoxin production are not defined.

Recent progress with Clostfidium perfringens Type A enterotoxin production and purification has been rapid. Standard strains have been obtained from researchers in the USA. These strains were used to assess media influence on enterotoxin production. Enterotoxin so produced was then subjected to purification. Purification was achieved which was nearly identical to that achieved by others. Thus, our in vitro methods of production and purification are working well. Several alpaca strains of C. perfringens type A were imported to the USA. These strains were compared biochemically with standard strains of C. perfringens Type A isolated from humans. There were a few small, probably insignificant differences between the alpaca and human strains.

The role of colostral transfer of immunoglobulins from dam to neonate in alpaca in prevention of neonatal infectious disease is unknown. This subject is being investigated by Dr. Antonio Garmendia, a PhD student at Washington State University. With financial and technical assistanoe from the CSU health project in Peru, Dr. Garmendia travelled to Peru between February and May 1984 to collect data for this research.

Extensive progress has been made in the development of an ELISA which can be used reliably to detect rams with Brucella ovis infections. This is the main cause or epididymitis in rams, both in the USA and Peru. Currently, it appears that a lipopolysacharide (LPS) antigen is the antigen or choice and will be the antigen which gives least false reactions but has a high degree or sensitivity for detection or reactor rams. Many other antigens were also tested, some very crude extract mixtures and others pure proteins. The LPS was the best in all assays whioh have been run to date.

8. Description of Work Undertaken and Technical Accomplishments - US:

The work undertaken at CSU for the Animal Health Project in Peru is classified as basic supporting research and training support for the project. The objectives are as listed in item 6 above and the research and training activities will be described in the same categories used in items 7 and 8.

i. Chronic Respiratory Diseases of Sheep:

Dr. John Ellis has completed his PhD research on the immunopathogenesis of ovine progressive pneumonia. This work explored the basis for the lymphoid proliferation that is characteristic of

this viral infection. In conduct of this research, our laboratory has gained extensive experience in propagation and titration of lentiviruses, assays for antibody to their antigens, and classification of pathologic features of diseases caused by these agents. Further studies are continuing on mechanisms of vertical transmission of the causative virus.

Research on SPA is also underway at CSU with the participation of a Peruvian PhD student, Dr. Raul Rosadio. Initial efforts underway involve development of an experimental model of transmission of the disease. Future efforts will be directed toward development of a specific serologic test for the disease.

ii. Epidemiology of Sheep Diseases:

In support of the work underway in Peru, laboratories at CSU perform heavy metal analyses and consultation is provided on questions of statistical analysis of data and other aspects of epidemiologic investigation.

iii. Bacterial Diseases of Alpaca and Sheep:

The laboratory of Dr. Robert Ellis at CSU provides basic support in the area of bacteriology for the work underway in Peru. Dr. Antonio Ramirez is currently a PhD student in that laboratory. Studies involving alpaca E. coli are currently directed toward defining the pilus antigen(s) which allow the E. coli to colonize the alpaca small intestine, and the enterotoxin(s) which cause hypersecretion and diarrhea. C. perfringens Type A future research involves 1) purification of enterotoxin from alpaca strins, 2) use of purified enterotoxin in biological assay systems (Vero cell culture assays and mouse lethality/neutralization assays), and 3) use of purified enterotoxin in ELISA.

During the past two years, Dr. Cleon Kimberling has conducted field investigations on parameters of ram maturation, diagnosis of ram epididymitis, and the effect of the latter disease on fertility of rams. The results of this work are of considerable importance in designing control programs for epididymitis in Peru.

9. Personnel Collaboration on Project Activities:

i. Project Personnel:

Investigators

CSU	IVITA
J.C. DeMartini	E. Caletti
R.P. Ellis	E. Ameghino
J.S. Reif	D. Barreto
C.V. Kimberling	J. Barsallo
D.T. Nelson	A. Chevera
J.A. Ellis	G. Guerrero
S.P. Snyder	D. Huaman

L. Inope
E. Lopez
C. Morales
H. Rivera
R. Sam
H. Samame
J. Sumar
A. Vargas

Trainees

Name	Location	Degree Objective	Expected Completion
J.A. Ellis	Colorado State University	PhD	Feb. 1984
A. Garmendia	Washington State University	PhD	1985
H. Rivera	South Dakota State University	None	1985
A. Ramirez	Colorado State University	PhD	1986
R. Rosadio	Colorado State University	PhD	1986

10. International Travel:

In addition to the SR-CRSP sponsored travel indicated above in Section 10b, the following trips were funded by the CSU Animal Health Project.

Name	Date	Destination	Purpose
E. Ameghino	Mar. 83	Calif, Wash, Colo (from Peru)	Short-term training, research coordination, attend meetings.
D. Nelson	Jul. 83	USA (from Peru)	Return from long-term assignment in Peru.
R. Rosadio	Aug. 84	Colorado (from Peru)	Start PhD program.
H. Rivera	Feb. 84	South Dakota (from Peru)	Start 1 year training in virology at SDSU.
A. Garmandia	Feb-May 84	Peru (from WSU)	Collection of thesis data.

1. Project Title: Dual-Purpose Goat Production Systems for Small-Holder Agriculturalists.

2. Institution: Winrock International, Morrilton, Arkansas

3. Principal Investigator: H. A. Fitzhugh

4. Funds Allocated From:

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant:	$263,300
Matching Contribution from 1983/84 Subgrant:	$104,494

5. Statement of Project Goals:

The goal of the dual-purpose goat production systems project, including the feed production component, is to improve the welfare of small-scale farm families in high potential tropical regions of developing countries. This goal will be attained by improving the nutritional status of family members and providing additional income from the sale of animal products.

An additional goal is to develop technical and scientific personnel interested and qualified in multidisciplinary research relevant to the needs of developing countries.

6. Project Objectives for Fifth Program Year (1983/84):

i. General Objectives:

a. Develop and adapt goat production Systems to the needs of smallholder agriculturalists in the humid/subhumid tropics, emphasizing dual-purpose utilization of goats for production of milk and meat.
b. Within this overall project objective, the general objective of the subproject, "Feed Production Systems" is to design and test feed production systems appropriate for dual-purpose goat production on small farms in the high potential tropics.

ii. Specific Objectives:

a. Nutrition-Management Strategies for Dual-Purpose Goats.

(1) Evaluate performance of dual-purpose goats on rations derived from low cost feed resources produced on small farms in western Kenya.
(2) Develop practical strategies for meeting year-round nutrient requirements of goats at different stages of maturity (kids, replacement females, mature females) and levels of production (growth, lactation).
(3) Compare feed requirements, preferences, and efficiency of goats and cattle for dual-purpose production.
(4) Evaluate simple, low cost practices for managing goats (control of goats and protection from climatic and disease stresses, predation and theft) and goat products (preserving food value,

hygienic practices).

b. Feed Resource Production and Preservation.

(1) Evaluate feed production from by-products and residues from food crops typical to small farms in western Kenya.
(2) Evaluate productivity of food and forage from multiple cropping systems involving mixture of food and forage crops over time (rotation) or space (intercropping).
(3) Screen forage crops which have shown potential in similar production environments in Kenya and other countries.
(4) Evalute means of preserving nutrient value of feed surplus available in rainy season for use in dry season when feed is in short supply.
(5) Evaluate fertilizer value of goat manure for food and feed crops.

c. Evaluation of Small Farms Systems (in collaboration with Health, Systems Analysis, Sociology, and Economics projects).

(1) Characterize small-scale farm systems in Kenya, including biological, economic, and human resources and constraints.
(2) Evaluate interaction between resources, i.e., complementation and (or) competition between livestock and cropping activities for land, labor, and capital resources.
(3) Identify priorities for research to develop interventions to small farm systems which will facilitate a viable dual-purpose goat component.
(4) Provide baseline data for assessment of biological, economic, and sociological interventions in small farm systems.

d. Training.

(1) Identify and support qualified candidates for graduate training in U.S. or other academic institutions.
(2) Provide training in planning, implementation, and analysis of crop and animal production research, including laboratory analyses.

7. Description of Work Undertaken:

Research activities are based at Maseno in western Kenya. Principal research is conducted by MALD and Winrock scientists on farms of cooperators in Western and Nyanza Provinces and on the MALD station at Maseno. Experiments supported by Winrock Production Systems project also involve active collaboration by scientists from other SR-CRSP projects in Kenya. Production Systems project has responsibility for coordinating integration of interdisciplinary SR-CRSP activities in Kenya.

In addition to research on nutrition and management of dual-purpose goats and on the production and preservation of feed resources, project scientists conducted other research. These activities included evaluation of acceptability of goat milk products by Kenyan consumers and continued collaborative research to characterize small

farm systems in western Kenya with respect to their potential for dual-purpose goat production.

Research activities in the U.S. were limited to data analysis and writing scientific reports.

a. Nutrition and Management of Dual-Purpose Goats.

(1) Ensiling versus drying to preserve nutritional value of five local feedstuffs in western Kenya.
(2) Yield and nutritional value of maize leaf strippings produced from short rains crop.
(3) Chemical composition and digestibility value for some important forages consumed by the dual-purpose goats.
(4) Performance of dual-purpose does and kids under different milking and nursing management systems.

b. Feed Resources for Dual-Purpose Goats.

(1) Effect of goat manure and compound fertilizer (NPK-20-20-0) on food and forage crop production.
(2) Potential for intercropping food and forage crops in different environments.
(3) Evaluation of potential interventions in the utilization of dual-purpose food and forage crops, such as maize, cassava, sweet potatoes, and pigeon pea.
(4) Effect time of planting, spacing and cutting frequency on productivity of pigeon pea, Sesbania, and Sudan grass.
(5) Introduction of germplasm and yield evaluation of fodder legumes, grasses, and potential fence-row cut-and-carry plants.
(6) Botanical composition and crude protein content of forages grazed and grazing behavior of goats at the Maseno Station and in the clusters.
(7) Studies on feed preservation, particularly silage and haymaking of the various feeds.
(8) Farmer acceptability of pigeon pea, Sudan grass, and Sesbania forage production alternatives.

8. Technical Accomplishments:

i. Evaluation of Local Feedstuffs for Dual-Purpose Goat Nutrition.

Two experiments were conducted. In the first, the quality of important forage resources in western Kenya were evaluated through laboratory techniques -- chemical analysis and in vitro digestion (IVADDM). These forage resources included:

Forage Crops
- Grasses
- Browse (trees, shrubs, and leguminous trees)

Dual-Purpose (Food/Forage) Crops (DPC)

All forage samples were collected in November 1983, that point during the short-rains season when most feed resources are generally at

nutritionally better phenological stages. The results are shown in Table 1. Feeds with digestible energy values (IVADDM) above 70% are adequate sources for lactating does. In each forage class some types had IVADDM above 70%, including Sesbania, Sudan grass, maize leaves, and bana grass.

In another experiment, yield and nutritional values of short rains maize strippings were evaluated. Two varieties (Kitale hybrid 512 and Katumani open-pollinated maize) were planted on Maseno station in October 1982. The five lowest leaves from plants in each of the 42 - 120 in rows of each variety were stripped between 45 and 90 days from planting. Effects of stripping on grain and leaf yield are shown in Figure 1. Additional data are given in Tables 2 and 3. Maize-leaf strippings as a sole diet were not sufficient to support lactation during late pregnancy. However, maize leaves represent a valuable feed resource that could adequately meet the needs of animals in less demanding physiological state.

ii. Feed Production.

a. Intercrops of grasses and legumes.

Given the increasing pressure on land in western Kenya, it is difficult to convince farmers to spare cropland for pastures. This study was therefore conducted to investigate potential of intercropping forages with the staple food crop in western Kenya, maize.

The first objective was to determine forage potential of two fodder legumes, Sesbania and pigeon pea, and Sudan grass when intercropped with maize, and any deleterious effects of these forages on maize grain yield. The second objective was to determine effect of fertilizer (NPK-20-20-0) on fodder and grain yields of forage and maize crops, respectively.

Variety H512 of maize was planted at the recommended density (90 x 30 cm) in October 1983 on farms in Kaimosi, Hamisi, Maseno, and Siaya. Forage crops were interplanted between the maize rows; the two legumes at a spacing of 90 x 30 cm while Sudan grass was drilled.

Maize grain and stover dry matter yields and forage dry yields of the other crops from three locations are presented in Figures 2 to 4. The data from Hamisi are not included because the experiment was extensively damaged by animals. In Siaya, maize grain yield was not realized because of general crop failure due to drought. There was a large response to compound fertilizer ranging between -12% in pigeon pea and +400% in mixed maize stover yields. Intercropping generally reduced yields. Yields presented in Figures 2, 3, and 4 show that there is potential for intercropping maize with various forage crops -- especially the two legumes. In Kaimosi (Figure 4) one season of data shows that maize grain yields generally improve under intercropping.

This experiment is being replicated in the current long rains season.

Conclusions: There is a potential for intercropping maize with Sesbania, pigeon pea, and, especially in Kaimosi, with Sudan grass. There is a large response to compound fertilizer (NPK-20-20-0), even in the recently cleared forest soils in Kaimosi. Apparently nutrient depleted soils are being cultivated so application of animal manure may be beneficial.

b. Fence row and pathway crops.

Pigeon pea. Forty lines of pigeon pea are being screened for forage qualities. Several lines in the screening nursery appear superior to the presently recommended cultivar, Kiboko. Plant characteristics such as protein content are being analyzed.

Sesbania. Another promising forage legume is Sesbania sesban var. nubian. This tree legume grows throughout Kenya, especially in western areas of the country. It has recently been introduced into Maseno Research Station. Growth rate of up to 2 m in 3 months have been recorded. Goats eat it readily. With a crude protein content of about 26% and no known negative factors discovered so far, it is a promising forage legume.

Gliricidia. Gliricidia sp. was recently introduced in Maseno from the ILCA Agronomy program in Ibadan, Nigeria. It is growing well but not as fast as Sesbania under the same conditions at Maseno. Its present height is about 0.5 m after a 4-month growing period. Although it has been reported to be a good tree fodder legume in Sri Lanka and the Caribbeans, its potential in western Kenya is still to be evaluated.

Leucaena. Leucaena does well as a fodder crop at altitudes below 1000 m, especially along the Kenya coast. Its performance at Maseno (1600 m) has been poor owing mainly to high altitude and high soil acidity. Application of goat manure at Maseno has improved growth rate. These observations suggest that different management techniques or cultivars may improve the performance of this fodder legume in western Kenya.

Pennisetum purpureum (Napier grass) and derivatives. These are often recommended to farmers for planting as fodder crops since they are both quite productive under low management and also drought hardy. However, many types are rather too coarse for effective utilization by goats, especially if not harvested at early stages of maturity (e.g., <6 weeks growth).

Conclusions: These fodder crops tend to be perennial and, therefore, serve as living feed banks on the farm during periods of feed shortage. Although this group of forages constitutes an important potential source of good quality feeds for goats, not enough data are presently available to accurately quantify their productivity. Research continues.

c. Dual-purpose food-feed crops.

These crops include sorghum, maize, sweet potato, cassava, and pigeon pea. All are both food and feed crops because they are usually planted as human food crops, but their foliage and young stems can either be used partially or wholly as animal feed. The question is the effect of forage harvest on yields of the food crop component. Several experiments have been conducted on leaf-stripping and cutting of vines to evaluate effects on food crop yields. About 25% yield reduction occurs in maize when leaves and tops are removed before grains are fully filled. Cassava and sweet potato show little reduction in tuber yields if about 35% of leaves and vines are cut and fed to livestock and there are indications that more than 35% of sweet potato vines can be harvested without affecting tuber yields. Pigeon pea readily ratoons. The forage crop could be ratooned and fed or the plant can develop grain then be ratooned for forage. Most of these alternatives provide between 1 and 5 tons/ha/yr of dry matter of feeds.

d. Food crop by-products.

These include stripped leaves, stover, vines, and industrial processing by-products (e.g., brewers wastes and molasses).

Brewers wastes are a readily available feed from the Kisumu beer-making plant at approximately US $3.00 per ton. Three tons of this feed were obtained during the February-March 1984 dry season. The goats on Maseno Station refused to eat it fresh. However, people claim that local goats eat brewers wastes when it is dry. The cows at Maseno Farm readily ate wastes in the wet form.

Molasses. Although the government restrictions on this feed resource are stringent because of its potential uses for illicit distillation, it is produced in large quantities by the sugar-making factories in western Kenya. A permit was obtained from the government to purchase 200 liters of molasses from Chemelil Sugar Factory at US $3.70/ton. The goats received it in water and also as a sweetener with their hay. They relished it. Further work with molasses as a cheap source of energy will also involve silage making.

iii. Feed Preservation.

Five local forage species (Zea mays, maize stover; Pennisetum purpureum, Pakistan Napier grass; Pennisetum sp., Bana grass; Impomea batata batata, sweet potato vines; Cajanus cajan, pigeon pea leaves) were preserved either as silage or as hay. The nutrient contents of substrate (fresh) hay and silage of the five forages are shown in Table 4. When the crude protein contents of the two forages with the highest acid detergent nitrogen (ADN) values (sweet potato vine and pigeon pea leaves) where corrected for ADN (Table 5), sweet potato vines protein was found to be more adversely

affected by ensiling than by drying. The apparent shift of nitrogen into the acid detergent residue of sweet potato vines upon ensiling represented a loss of 37 g protein per kilogram of silage dry matter. Only 15 g/kg was lost upon drying. In this study. the hypothesis (drying preserves more of each nutrient -- except water from each forage than ensiling) was rejected with regards to all nutrients except sweet potato vines protein.

iv. Milking and Nursing Management Systems.

The first phase of this study used goats which kidded in October 1983. All kids were solely fed milk until weaning weight (10 kg) was reached. Three milking and nursing management systems were compared.

a. Hand milking once per day (morning and evening). All kids bottle fed to satisfaction.
b. Hand milking once per day (morning). Kids bottle fed the exact amount produced by the mother in the morning and suckled the evening meals.
c. Hand milking one-half (udder) and letting kid nurse the other half in the morning. Reverse teats in the evening.

All animals were assigned to the treatments five days after parturition. All does were cut-and-carry fed available local feedstuffs. During the period of acute feed shortage (January 1984), all does were allowed to graze (Table 6).

Kids in treatment 1 grew faster and reached weaning weight in 52 days (Figure 5). It took kids in treatment two more than four months to reach the 10 kg weaning weight. However, their milk consumption during that period was more than milk consumed by kids in treatment 1 (81 kg/kid compared to 77 kg/kid) as shown in Table 7.

This experiment will provide information to develop a milking and nursing system where both farm family members and dual purpose kids get adequate supply of milk.

v. Consumer Acceptance of Goat Milk.

Field trials in Siaya and Kakamega districts were conducted to evaluate consumer acceptance of goat versus cow milk (sour, fresh). Table 8 summarizes the result of the study in which 286 subjects ranging in age from 1 to 80 years were requested to participate. Most people readily accepted goat milk, whether served fresh, sour, in tea, or cooked with other foods. Some people preferred goat milk to cow milk. It was concluded that consumer acceptance of goat milk products will not be a constraint to the acceptance of dual-purpose goats in western Kenya.

9. Collaborating Personnel.

i. Personnel Based in Kenya.

a. Collaborators from Ministry of Agriculture and Livestock Development.

Agronomy	- Moses Mathuva, M.Sc. Kenneth Otieno, B.Sc.
Animal Science	- Mohamed Salim Khainga, B.Sc. L. Musalia, DVM
Maseno Farm Manager	- W. Ochieng
Laboratory Analysis	- E. Chavulimu

b. Winrock International.

Agronomy	- Sandra Russo, Ph.D. (1981-83) J. F. Moses Onim, Ph.D. (1983-)
Animal Science	- Kathy J. Boor, M.S. (1982-83) Dan L. Brown, Ph.D. (1981-83) Ahmed E. Sidahmed, Ph.D. (1983-)

Dr. Sidahmed serves as Research Coordinator for SR-CRSP in Kenya.

c. Field enumerators - A. Amuhinda, H. Kiguhi, E. Ochieng, E. Otieno

ii. Winrock Personnel Based in U.S.

Principal Investigator	- H. A. Fitzhugh, PhD
Co-Investigator	- R. D. Hart, PhD
Research Assistant	- E. A. Henderson, BA
Computing Specialists	- W. Hinerman, BS J. A. Peden, BS

iii. Training.

a. Moses Mathuva. This Ministry of Agriculture and Livestock Development Officer successfully completed an MSc. course at University of Reading in Grassland Science and returned to Kenya in January 1984. He returned to Maseno Research Station and resumed his duties in Feed Resources Research.

b. Ephraim Mukisira. In M.Sc. program at Louisiana State University in Animal Production investigating forage utilization by sheep. He is expected to complete his studies by August 1984.

c. Kenneth Otieno. Applied to Reading University for an MSc course in Grassland Science to begin August 1984. Attended CIMMYT sponsored training program in Farming Systems Research during February-March 1984, Harare, Zimbabwe.

d. Moses Salim Khainga. Accepted by Texas Tech University to begin MS program in range nutrition beginning August 5, 1984.

e. Action Aid conducted a 2-week training course in Maseno Farmers' Training Center in April 1984 for their extension staff in Kakamega District. Kenneth Otieno and Mohamed Salim delivered Agronomy and Goat Management lectures and conducted practicals for the participants.

TABLE 1. DIGESTIBILITY AND CHEMICAL COMPOSITION OF VARIOUS LOCAL FORAGE RESOURCES IN WESTERN KENYA (% OF DRY MATTER)

	IVADDM	CP	ADN, % of DM	ADN, % of TN	NDR	ADR	Sulphuric lignin	Silica
FORAGE CROPS								
Grasses								
Bana grass	76.2	15.5	1.02	41	56.0	33.1	3.1	2.8
Couch grass	63.0	8.8	1.18	84	64.2	41.1	6.6	2.5
Napier grass	76.1	11.0	1.1	63	63.1	37.4	3.7	1.6
Sudan grass	72.0	13.3	1.1	50	58.9	34.6	3.9	3.1
Star grass	61.3	10.5	1.1	64	67.9	36.2	6.5	2.9
Napier-clone 13	69.9	14.4	1.05	46	50.4	34.4	3.4	5.8
Giant pannicum	57.5	4.3	1.2	71	68.9	44.1	5.2	3.9
Browse (trees, shrubs & leguminous trees)								
Lantana camara	62.6	19.8	1.3	40	45.7	44.2	24.4	1.3
Bwar	53.9	17.3	1.3	46	46.2	45.5	23.5	0.3
Hydrocotyle	68.8	11.9	0.9	49	34.00	28.6	6.6	1.5
Sesbania	74.3	22.1	0.8	23	31.3	22.4	5.7	0.4
Leucaena	57.7	21.3	1.0	29	42.6	30.4	14.6	0.3
Mango leaves	46.5	6.6	1.2	>100	39.3	38.9	12.2	5.6
Olando leaves	74.9	18.1	0.8	28	32.1	21.5	7.5	0.6
Grewia tricocardia	49.1	12.4	1.1	54	50.6	35.2	13.3	0.5
DUAL-PURPOSE CROPS								
Sweet potato vines	65.3	9.8	1.4	73	39.3	39.2	14.6	1.1
Cassava leaves	66.1	24.8	.89	22	39.6	25.9	8.9	0.5
Pigeon pea	62.1	23.0	1.04	29	45.6	33.7	11.9	1.04
Maize leaves	76.6	20.1	.87	27	47.7	24.5	2.6	2.6

TABLE 2. CHEMICAL COMPOSITION OF FEEDS, REFUSALS, FECES, AND APPARENT DIGESTIBILITIES OF FRACTIONS[a] [b]

Nutrient	Feed	Refusals[c]	Feces[c]	Apparent digestibility[c]
Cell walls	62.42	63.47-64.14	59.40-60.67	0.63-0.58
Acid detergent residue	34.46	40.19-39.29	47.79-45.68	0.75-0.39
Ash	15.28	20.25-20.91	29.38-27.53	0.01-0.02
Crude protein	12.90	10.09-11.75	10.78-10.59	0.69-0.61
Acid detergent nitrogen	0.19	0.18- 0.17	0.29- 0.26	0.37-0.02
Calcium	0.64	0.75- 0.79	1.00- 1.10*	0.32-0.53*
Phosphorus	0.44	0.46- 0.55	0.71- 0.83*	0.33-0.18*
Organic matter	84.72	79.75-79.09	70.62-72.47*	0.68-0.65
Dry matter	19.89	21.53-24.22	37.25-37.15*	0.61-0.62*

[a] All values are % of dry matter, except dry matter itself which is expressed as % of fresh material.
[b] Averages of 30 days sampling (days 56-85 after planting).
[c] Values from goat 17 on left, goat 23 on right.

TABLE 3. WEIGHT GAIN AND MILK YIELD FOR DOES FED MAIZE LEAVES

Animal	Initial wt	Final wt	Weight	Average milk yield/day[a]
Doe 17	32.0	33.0	+1.0	543 (1000-0)
Doe 23	35.0	35.5	+0.5	732 (975-0)

[a] Values between parenthesis show highest and lowest daily milk yield during 38-day trial period.

TABLE 4. NUTRIENT CONTENTS OF SUBSTRATE (FRESH), HAY AND SILAGE OF FIVE FORAGE SOURCES

Nutrient	Maize stover			Pakistan grass			Bana grass		
	Substrate	Hay	Silage	Substrate	Hay	Silage	Substrate	Hay	Silage
Moisture, %	77.60	8.25	77.60	80.93	7.03	81.08	86.18	7.10	85.37
Dry matter, %	22.40	91.75	22.40	19.17	92.97	18.92	13.84	92.90	15.63
Crude protein, %[a]	7.06	9.21	8.95	11.51	11.14	11.42	9.90	10.79	11.23
Cell wall, %[a]	63.43	72.02	64.57	63.50	76.41	65.87	74.97	72.83	65.94
ADR, %[a]	36.25	40.30	36.25	50.09	43.33	45.42	49.65	48.41	46.22
ADN, %[a]	.06	.17	.14	.14	.19	.21	.19	.29	.29
Ash, %[a]	6.70	9.03	8.75	12.59	12.56	14.76	15.74	16.39	17.27
Ca, %[a]	.18	.73	.71	.31	.58	.75	.52	.61	.69
P, %[a]	.52	.21	.22	.52	.21	.22	.42	.17	.22

Nutrient	Sweet potato vine			Pigeon pea leaves		
	Substrate	Hay	Silage	Substrate	Hay	Silage
Moisture, %	81.88	13.95	83.00	59.78	6.97	47.56
Dry matter, %	18.12	86.05	16.69	40.22	93.07	52.64
Crude protein, %[a]	17.17	17.04	17.04	31.63	29.39	30.88
Cell wall, %[a]	52.98	38.11	50.49	59.17	50.99	54.82
ADR, %[a]	40.51	32.49	40.68	27.20	34.69	34.31
ADN, %[a]	.25	.48	.85	.43	.60	.57
Ash, %[a]	8.37	10.53	9.44	5.17	6.77	5.00
Ca, %[a]	.46	.90	.78	.87	.78	.85
P, %[a]	.70	.24	.22	.82	.30	.30

[a] % of dry matter.

TABLE 5. CRUDE PROTEIN CONTENTS (CORRECTED AND UNCORRECTED FOR ADN), %

Forage species		Fresh	Hay	Silage
Sweet potato vines	uncorrected	17.2	17.0	17.0
	corrected	15.4	14.2	11.7
Pigeon pea leaves	uncorrected	31.6	29.4	30.9
	corrected	27.3	25.5	27.1

TABLE 6. FEED MENU FOR DOES ON MILKING-NURSING EXPERIMENT

Week of lactation	Grazing	Sudan grass	Couch grass	Napier grass	Pigeon pea	Sweet potato vines	Sorghum stover	Dairy meal
Nov. 4								
5	x		x		x			
6	x	x				x	x	
7			x	x	x			x
Dec. 8		x		x		x		
9				x		x		
10		x		x		x		
11		x		x		x		
Jan. 12		x		x	x	x	x	
13		x		x	x	x		
14		x			x	x		
15	x	x				x		
16	x	x				x	x	

TABLE 7. MILK CONSUMED BY KIDS ON MILKING-NURSING EXPERIMENT

Treatment	Daily (g/kid) Mean	Daily (g/kid) Range	Total consumed (kg/kid)	Age at 10 kg weaning wt.
1. Bottle fed ad lib	1488	900-2300	77	52 days
2. Bottle fed and suckled	682	500- 800	81	>4 months
3. Suckle half udder	461	400- 700	55	>4 months

TABLE 8. RESULTS FROM CONSUMER COMPARISONS OF FRESH GOAT AND COW MILK TASTE

Location	No. of people present	No. of refusals	Mean scores[a] Cow milk	Mean scores[a] Goat milk
Kakamega:				
Site I	68	5	1.95	1.90
Site II	88	8	1.34	1.46
Siaya:				
Site I	64	3	1.23	1.55
Site II	66	4	1.23	1.61

[a] Scores: 1 - like very much; 2 - like; 3 - neither like nor dislike; 4 - dislike; 5 dislike very much.

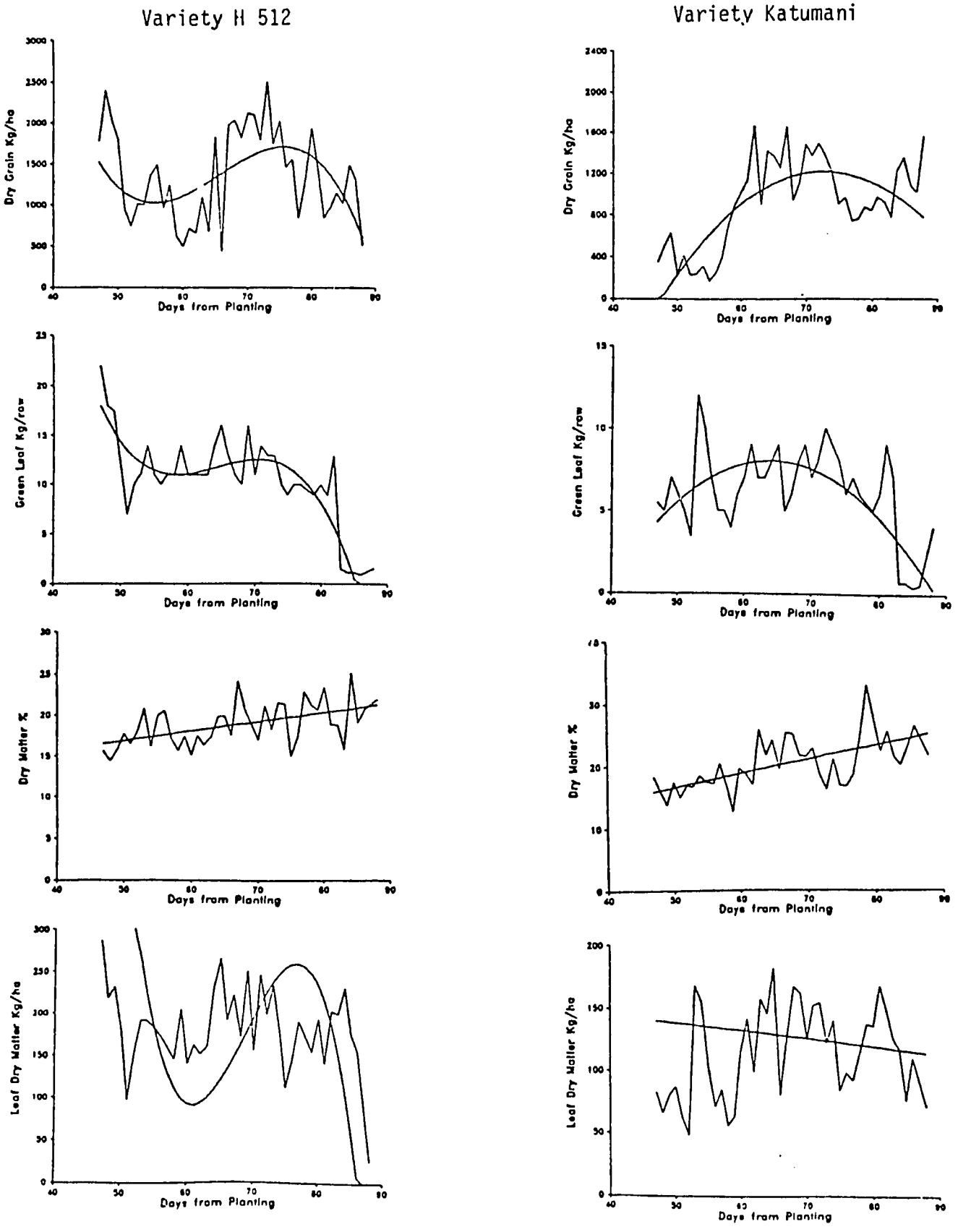

Figure 1. Grain and forage yield from maize leaf stripping experiment.

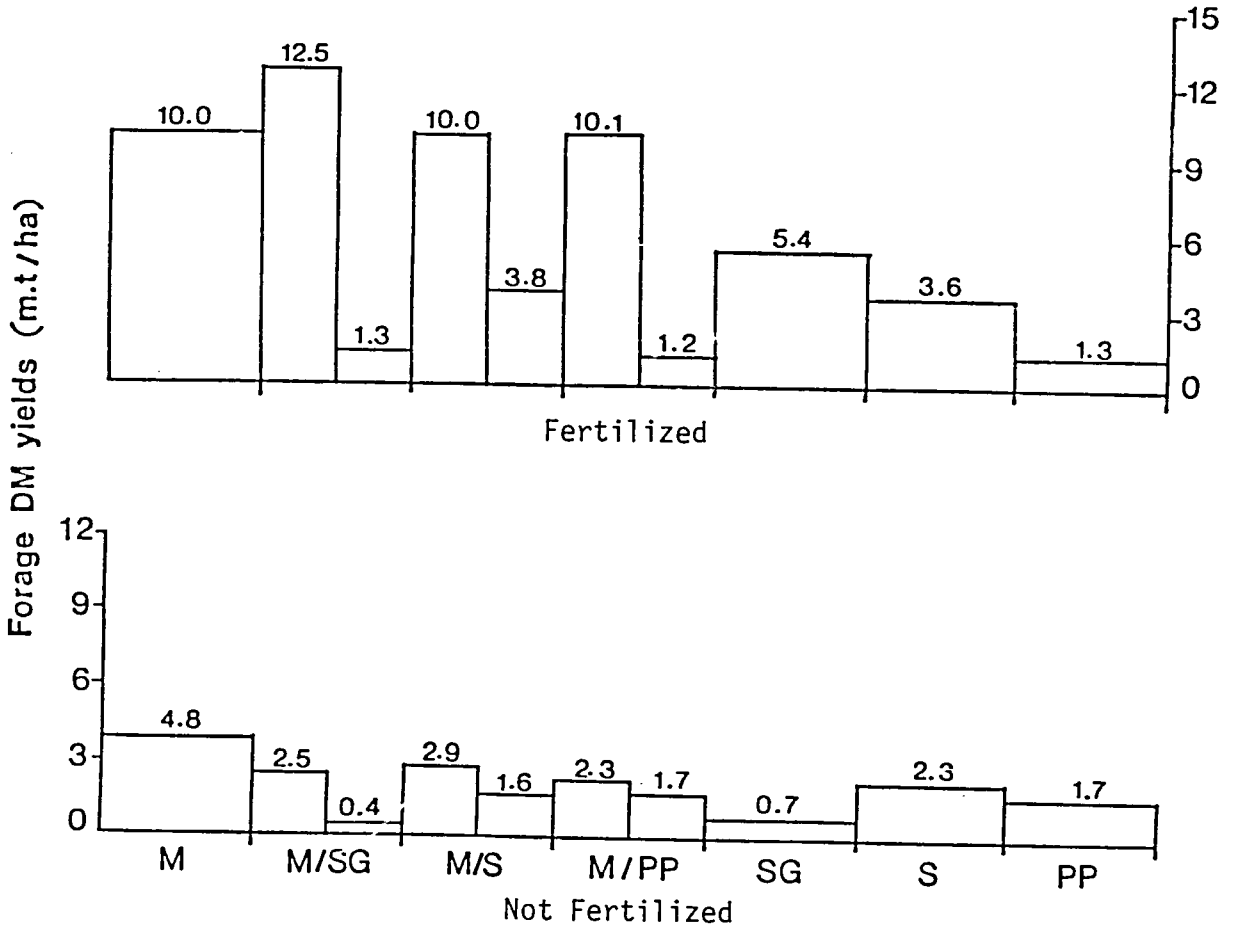

Figure 2. Forage yields from crops and intercrops grown on plots in fields of cooperating farmer in Masumbi, Siaya District (M-maize, SG-sudan grass, PP-pigeon pea, S-Sesbania).

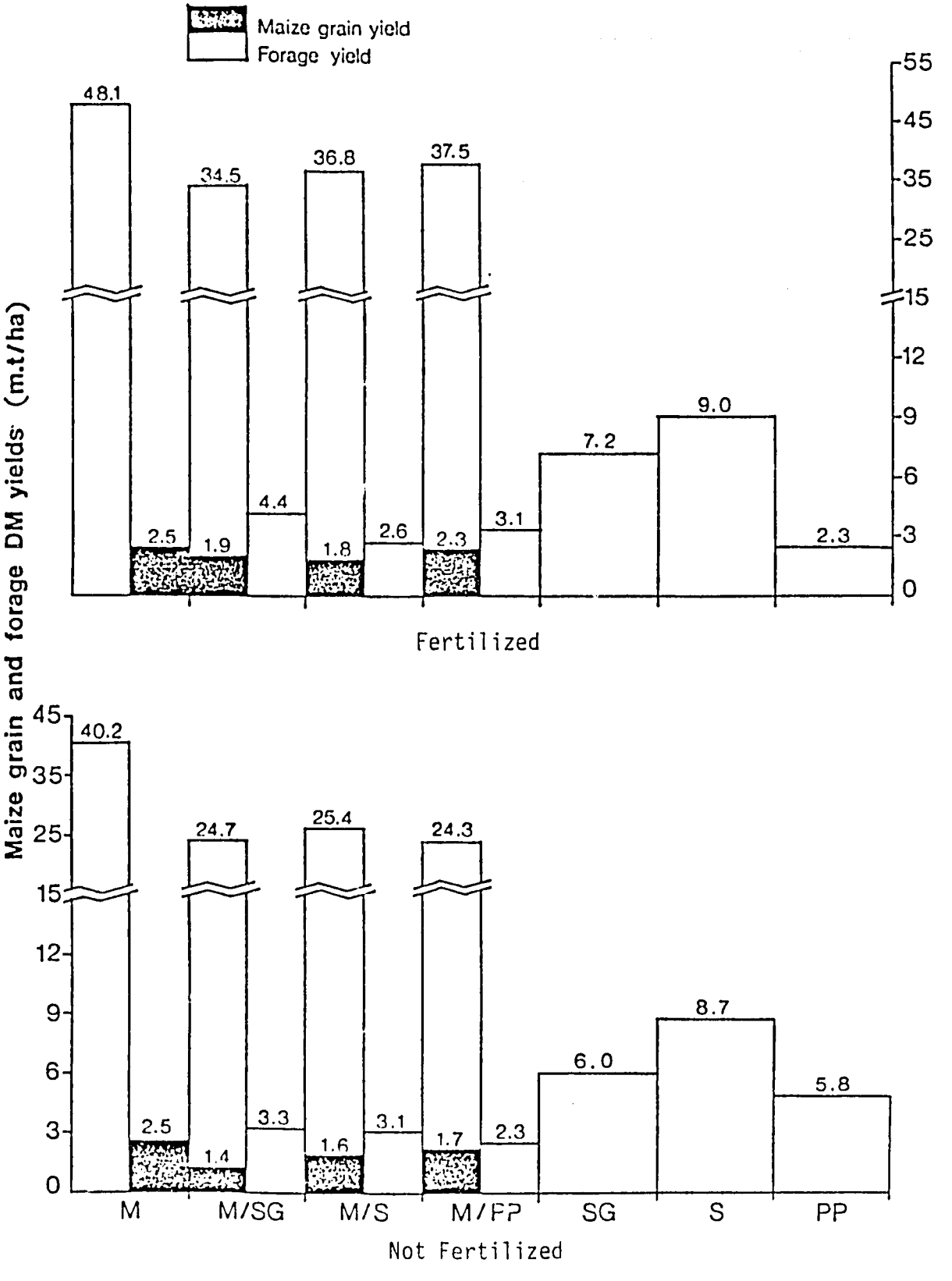

Figure 3. Forage and grain yields from crops and intercrops grown on plots at Maseno Station.

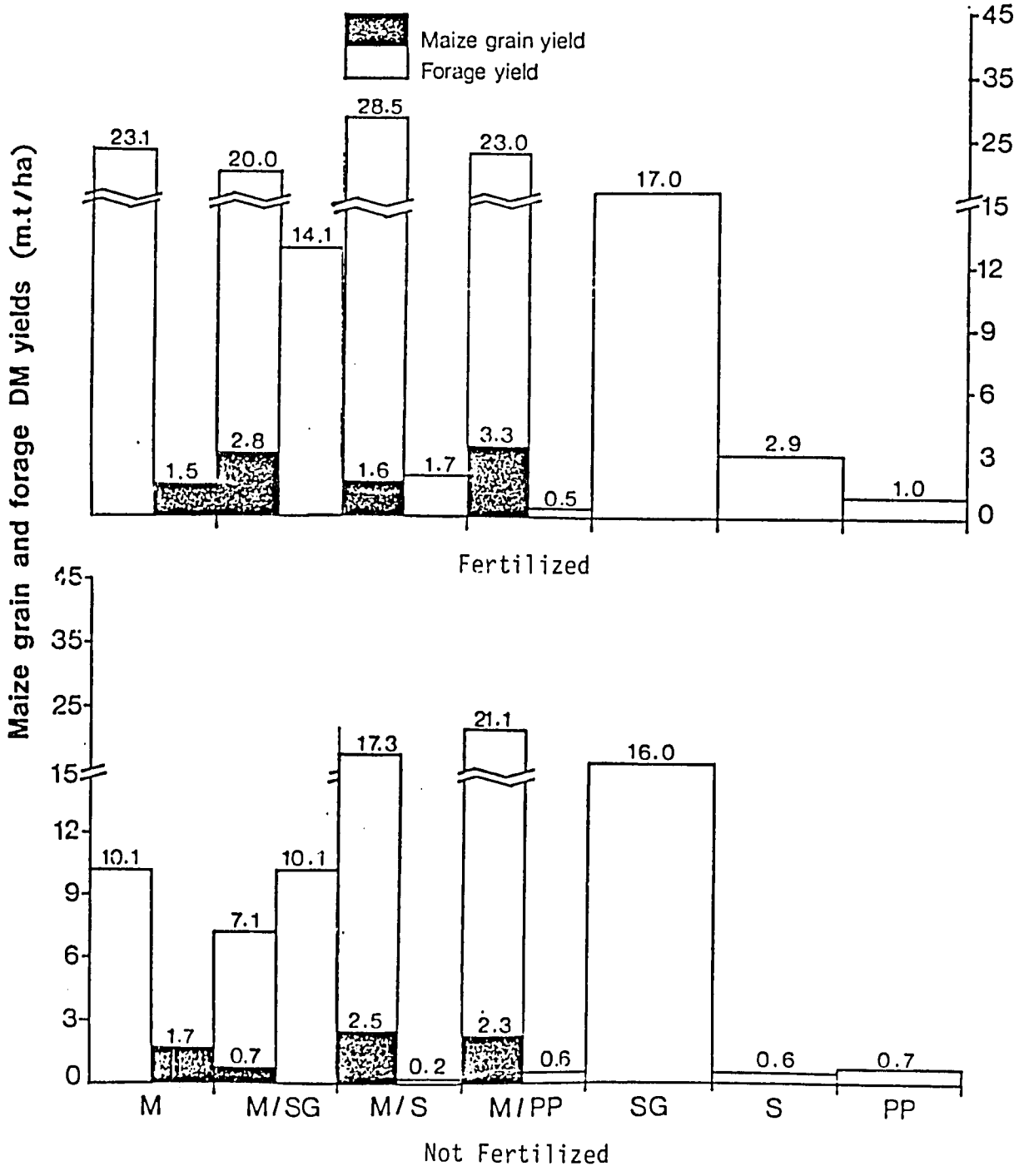

Figure 4. Forage and grain yields from crops and intercrops grown on plots in fields of cooperating farmer in Kaimosi, Kakamega District.

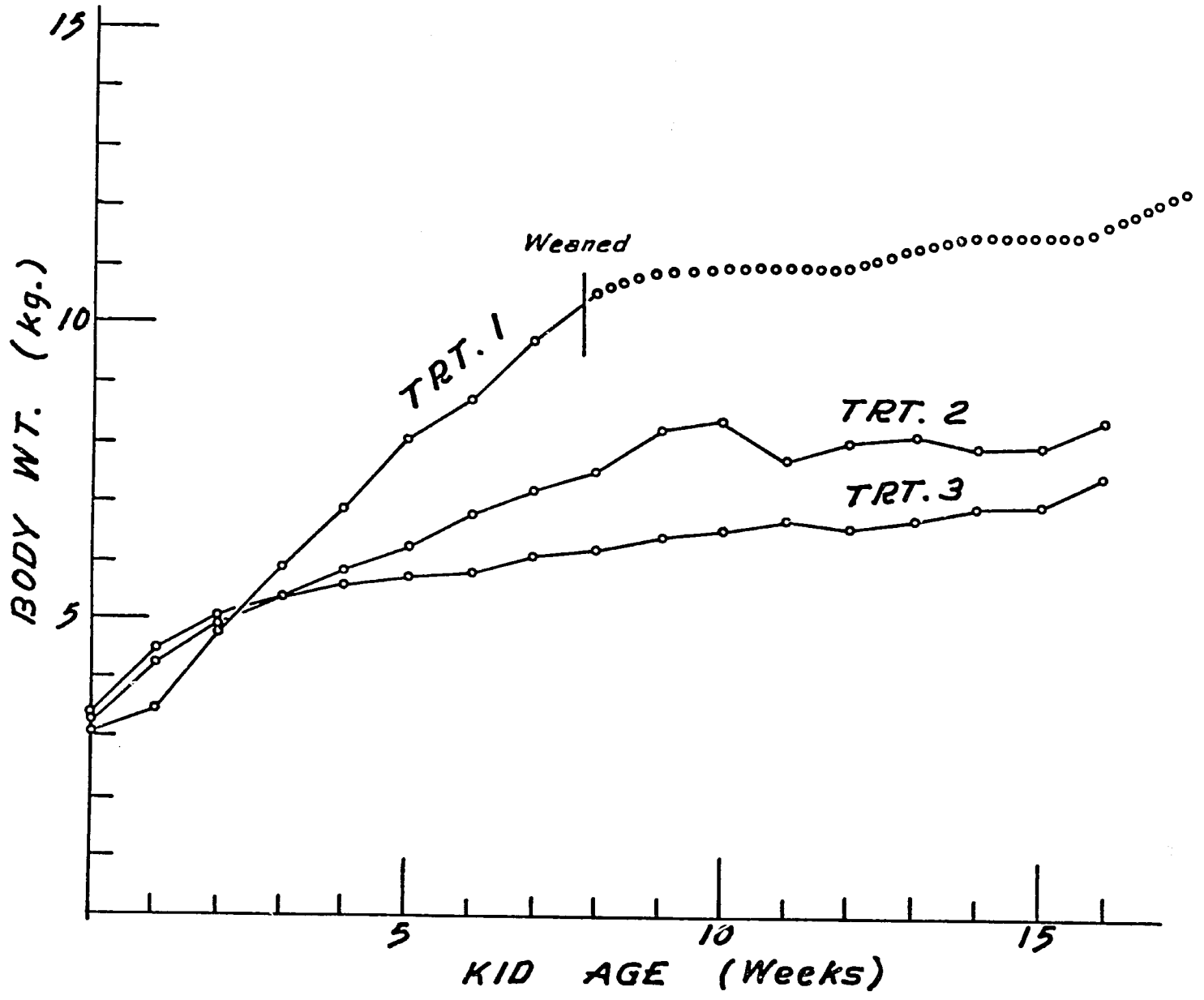

Figure 5. Growth curves for goat kids on different preweaning treatments (1-ad lib bottle fed, 2-limited bottle fed and suckled, 3-suckled half udder).

1. **Project Title:** Improving Reproductive Performance of Small Ruminants.

2. **Institution:** Utah State University

3. **Principal Investigator:** Warren C. Foote

4. **Funds Allocated From:**

Grant No. AID/DSAN/XII-6-0049 from 1983/84 subgrant:	$ 200,000
Matching contribution from 1983/84 subgrant:	$ 268,748

5. **Statement of Project Goals:**

The SR-CRSP, Utah reproduction project is executing a strong based, basic and applied reproduction and related management research program. The research program in collaboration with EMBRAPA/CNPC, Sobral, Brazil, is directed to determine the reproduction and production potentials of small ruminants commensurate with the specific needs and resource limitations of the local conditions. The final goal following the stated philosophy, is to optimize the small ruminant productivity and enhance the socio-economical level of the rural population dedicated to small ruminant production.

6. **Statement of Specific Objectives for 1983/84:**

i. To measure and evaluate the reproductive capability of genotypes of small ruminants in relation to their environment.

ii. To determine levels of reproduction of small ruminants owned or controlled by the smallholder-producer and the traditional management systems involved in production and to develop alternative management practices to increase reproductive performance.

iii. To provide graduate and non-degree training programs, such as short courses, in host countries and the United States to extend and upgrade expertise of cooperating personnel.

iv. To cooperate with other Small Ruminant-CRSP projects and programs with the purpose of improving small ruminant production particularly by the smallholder.

7. **Description of Work Undertaken:**

Based on the work carried out in collaboration with national personnel, various research proposals were presented and approved by EMBRAPA/CNPC. Several projects have been completed and some are still underway. Data on age and weight at puberty under range nutrition in both sexes of goats and in female sheep has been established. The semen characteristics in relation to the existing climate condition throughout the year and by season is now established. The estrous cycles pattern and the accuracy of pregnancy diagnosis using ultrasound in both goat and sheep is documented. The first post partum estrous interval in sheep and the influence of nutrition during late pregnancy and early lactation in goats were studied and the results are

available for use by producers. A study at the producer level is underway with goats. In this study, estimation of reproduction and production performance is being obtained. Information has been obtained on flock composition, congenital defects, frequency of colors, kidding and mortality rates throughout the year, and the influence of improved selected management practices.

8. Research Accomplishments:

During the period of this report two new research project proposals for goats were presented to and approved by the EMBRAPA/CNPA to be carried out at the center. One research project was completed in its execution and the data will be analized and used as material for a PhD dissertation by Aurino A. Simplicio. Some other research projects are in progress.

Data gathered from the projects were organized, analyzed and interpreted and they are as follows.

i. Goats:

Puberty Study in Goats.

The puberty study in Moxoto kid bucks was first initiated and it is already reported. To continue the puberty study, Nubian, Marota, Bhuj and SRD type of kid bucks were used. The results show that the age (4 months) at penis separation from the prepuce coincides with the first ejaculate with the presence of sperm cells. This information indicates that the spermatogenesis begins some time before or at the time of penis separation, showing the fertilizing ability. These results have a practical value in goat management in terms of castration or sex separation to avoid undesirable matings.

Fertility Study of Moxoto Adult Bucks.

A two year study is being conducted to determine the semen characteristics throughout the year. This study will be terminated in July 1984, and the data will then be analyzed and reported. Preliminary results indicate that based on semen production, the bucks are fertile throughout the year. However, during the dry season, the ejacuiated volume and libido are reduced and the thermo-stress test shows that during the wet season the individual sperm motility lasts longer compared with the motility of semen obtained during the dry season.

Influence of the Scrotal Morphology on Semen Characteristics and Fertility of SRD Goats.

It has been shown that 20-25 percent of the goats in northeast Brazil and in other tropical areas have divided scrotum. The producers appear to prefer to use bucks with this characteristic. From our research in Brazil we have reported that the proportion of abnormal (pathological) sperm cells was greater in semen from animals with non-divided scrotum. During the present year and following the same research project procedures used during August to October 1983, it has been found that the testicle temperature (intrascrotum) in animals with and without divided scrotum is the same. But, the temperature varies from the spermatic cord (36.74°C) to the tail (cauda) of the epididymus

(33.15°C) in an average of 3.59°C, confirming previous findings reported world-wide (Table 1). It seems that the scrotum morphology has no influence in reducing the temperature of the testes. Further study is being undertaken in this matter and its relationship to semen quality in various seasons of the year.

Reproduction Capabilities of Selected Genotypes of Goats in Northeast Brazil.

In this study, 108 non-pregnant adult does of SRD, Marota and Moxoto genotypes were alloted to nutrition-management treatments of natural pasture or confined (chopped elephant grass plus concentrate). Monthly body weights, incidence of ovulation and estrus and the ovulation rate were recorded. The incidence of estrus was measured using teaser bucks and laparotomies to observe the ovarian activity in terms of incidence of ovulation and ovulation rate. A full analysis of all data will be reported after the dissertation of Aurino A. Simplicio is completed using these experimental data. However, preliminary data analysis shows that the rates of ovulation were higher in goats under native range nutrition (1.62) compared with confined goats (1.46), but the incidence of ovulation of goats was the same (73%) under both nutrition-management groups. The incidence and rate of ovulation (combined for both nutrition-management treatments), were higher in SRD goats (80.9%, 1.68), followed by Marota (75.00%, 1.44) and Moxoto (62.15%, 1.40) breeds (Table 2).

During much of the first year, does in confinement had a minimized forage consumption due to slow adaptation to the confinement. This may be the reason why does under this nutrition management performed at an unexpectedly lower magnitude compared with does grazed on native pasture. However, from the reproduction performance in terms of ovarian activity obtained, goats in northeast Brazil are continuous breeders. To obtain increased fertility in goats, nutrition management may be the important variable that the producers should take into account.

Influence of the First Suckling on Survivability of Newborn Kids.

To establish the influence of the birth weight, sex and type of birth on the time from parturition to the first suckling and the survivability of the kids, data was obtained during two kidding seasons. The results show no statistical difference among breed types and birth weight at the time of first suckling and survivability. It was expected that kids with heavier birth weights should spend a shorter time from birth to their first suckling to guarantee survivability. Further study also needs to define this aspect which relates with kid management to improve reproductive efficiency.

Reproduction and Production Performance of Goats Subjected to Selected Management Practices at the Producer Level in Northeast Brazil.

A study is in progress to establish the constraints of goat reproduction and production at the community level. Several data related to reproduction and production are being taken. In October 1984, a three year study will be completed. The data will then be analyzed and finally reported. The information taken at the initiation of the project is already reported. Additional information is showing that some management practices are improving

reproductive and productive efficiency such as the imposition of a restricted breeding season, navel disinfection in newborn kids, directed culling and sire exchange. Weaning practice is one which shows difficulties in adoption by the producer because of its limitations. Depending on the degree of cross breeding with improved dairy goats, the weaning practice induces mastitis, especially during the rainy season, when more forage is available and the milk production is the highest. Some producers do milk the goat, some do not. When weaning a practice was applied to those goats who were not milked, mastitis became a problem. The reverse is observed during the dry season. So, the weaning practice is accepted. Finally, it can be stated that not all the technology recommended by the research is appropriate and accepted by the producer. The navel disinfection practice was completely adopted because only this practice helps to save the kids, reducing the mortality, especially during the first 30 days of life. More detailed information will be given after the completion of the project and the data is analyzed.

ii. Sheep:

An experiment under two nutrition-management treatments (fed in confinement and grazed in native pasture) and three hair sheep breeds was undertaken with 72 weaned ewe lambs beginning July 1982. In confinement the ewe lambs receive chopped elephant grass at libitum plus one percent of their body weight in concentrate mixture (cottonseed meal and corn)/day containing 16 percent crude protein and 75 percent TDN. The feed intake is measured or estimated in both treatment groups. Consumption by grazing on native pasture is estimated in cooperation with a range scientist at the Center.

The overall mean age and weight at puberty, regardless of breed and nutrition management was 303.5 days and 25.2 kg, respectively. A significant effect of nutrition-management on puberty was found. For the three breeds combined, the lambs in confinement reached puberty at 250.2 days of age and 28.2 kg body weight compared to 356.8 days of age and 22.2 kg body weight for ewes on native pasture ($P < 0.01$). The Brazilian Somali and Morada Nova sheep showed lighter weight than the Santa Ines. The Brazilian Somali attained puberty at an older age than both Morada Nova and Santa Ines. The rate of ovulation was higher in ewes fed in native range (1.17) compared to confinement (1.09). The Morada Nova breed showed a higher ovulation rate (1.23) than B. Somali and Santa Ines (1.14 and 1.04, Table 3). No statistical differences ($P < 0.05$) were found in the age at the first permanent teeth eruption due to breed or the nutrition management. But, differences at ($P < 0.01$), were found between breeds and nutrition management for live body weight at first permanent teeth eruption. This experiment will continue for 30 more months to find the frequency of estrus and ovulation, ovulation rate and estrous cycle length throughout the year. Data from June to November 1983 are shown in Table 4. Preliminary information shows that the Morada Nova sheep have a higher ovulation rate (1.75) compared to Santa Ines (1.50) and B. Somali (1.33). Ewes fed in native range showed increased incidence of ovulation (77.8%) compared to those in confinement (75.0%).

Influence of the First Suckling on Survivability of Newborn Lambs.

To establish the influence of birth weight, sex and type of birth on the time from parturition to the first suckling and survivability of lambs, data was obtained during two lambing seasons. The analysis of data shows that

there is a statistical difference among breeds. The mean time elapsed from parturition to first suckling was significantly ($P < 0.05$) shorter in Morada Nova compared to Santa Ines and Brazilian Somali breeds. Because of the high proportion of twinning in the Morada Nova breed, the lamb losses were higher compared to the other two breeds. Within breeds, lamb losses were observed in a higher proportion at a younger age when the first suckling was delayed, compared to those lambs suckled shortly after birth. This information will have practical application in terms of lamb management to save lambs and to increase lamb production per ewe lambing.

Radioimmunoassay Laboratory (RIA).

The Utah reproduction project worked with the EMBRAPA/CNPC administrators, the SR-CRSP management entity, and the International Atomic Energy Agency to develop and establish the RIA laboratory. The CNPC made a good effort to find financial support to build the physical facilities, which are now completed. The list of equipment to implement this laboratory was developed collaboratively among the Utah reproduction project, ME and the IICA-OAS consultant in reproduction. At the present time, the RIA project is in the process of purchasing the equipment and supplies required to begin hormone analyses. The Utah reproduction project has also been involved to obtain support from the International Atomic Energy Agency primarily for training and for additional equipment and supplies. It is expected that hormone analysis will begin during the summer, 1984. The reproduction personnel at the CNPC are developing antibodies for LH and progesterone analysis with supplies provided by the Utah reproduction project.

9. Personnel Collaborating on Project Activities:

i. Personnel:

Antonio Emidio F.D. Silva, EMBRAPA/CNPC Co-Principal Investigator.

Jose F. Nunes, EMBRAPA/CNPC Scientist in reproduction.

Aurino A. Simplicio, EMBRAPA/CNPC Co-Principal Investigator (at USU in a PhD program).

Jose U. Alves, EMBRAPA/CNPC Scientist in Animal Production and Technology Transference (at Santa Maria University, Rio Grande do sul, Brazil, in a MS program).

Miriam Paiva Montenegro, SR-CRSP-EMBRAPA/CNPC trainee in reproduction.

Luiz H.R. Leitao, EMBRAPA/CNPC, Research Assistant.

Luiz Aurelio A. Leite, EMBRAPA/CNPC, Research Assistant.

Jose Nobrega Medeiros, EMBRAPA/CNPC, Research Assistant.

Honorio E. Beserra, EMBRAPA/CNPC, Research Assistant.

Evaristo F. Cirilo, EMBRAPA/CNPC, Research Assistant.

Fatima Lima, EMBRAPA/CNPC, Reproduction Laboratory Technician.

ii. Training:

Aurino A. Simplicio, Scientist at EMBRAPA/CNPC, receiving from August 1982, his PhD training at USU. It is expected that he will complete his work by June 1985.

Jose U. Alves, Scientist of EMBRAPA/CNPC, receiving from February 1984, his MS training at Santa Maria University of Rio Grande do Sul. He will probably use data obtained in goat reproduction and production at the communities.

Miriam Paiva Montenegro, Trainee for one year in reproduction. Her salaries were paid with SR-CRSP-Reproduction project funds.

Table 1. Rectum and testicle temperature in native goats with divided (DS) and non-divided scrotum (NDS). Brazil[1]

	August		September		October	
	NDS	DS	NDS	DS	NDS	DS
7:30 AM[2]						
Rectum	38.38 ± 0.58	38.45 ± 0.43	38.65 ± 0.46	38.49 ± 0.58	38.10 ± 0.34	37.90 ± 0.38
Spermatic cord	36.41 ± 0.62	36.73 ± 0.49	36.77 ± 0.55	36.02 ± 1.48	36.11 ± 0.59	36.21 ± 0.55
Head of epididymis	34.82 ± 0.54	35.42 ± 1.34	34.59 ± 0.38	34.55 ± 0.40	34.37 ± 0.33	34.55 ± 0.45
Septum Scroti	34.65 ± 0.27	34.60 ± 0.46	34.37 ± 0.29	34.41 ± 0.50	34.24 ± 0.32	34.29 ± 0.48
Tail of epididymis	33.16 ± 0.57	33.15 ± 0.65	32.91 ± 0.58	32.86 ± 0.75	32.55 ± 0.66	32.62 ± 0.76
4:30 PM						
Rectum	39.60 ± 0.45	39.63 ± 0.32	39.57 ± 0.27	39.66 ± 0.30	39.47 ± 0.28	39.58 ± 0.28
Spermatic cord	37.40 ± 0.31	37.29 ± 0.69	37.43 ± 0.50	37.21 ± 0.92	36.45 ± 0.71	36.79 ± 1.16
Head of epididymis	35.40 ± 0.50	35.28 ± 0.67	34.85 ± 0.53	34.80 ± 0.58	35.06 ± 0.66	35.11 ± 0.74
Septum Scroti	34.99 ± 0.64	34.88 ± 0.54	34.64 ± 0.39	34.75 ± 0.61	34.66 ± 0.66	35.02 ± 0.75
Tail of epididymis	33.74 ± 0.42	33.66 ± 1.02	33.00 ± 1.07	33.48 ± 0.79	33.50 ± 0.91	33.19 ± 0.64

[1]Temperature taken with Omega Thermocouple Thermometer 450 AET, Type E, twice a week in three goats for each type of scrotum

[2]7:30 AM the coolest temperature of working hours and 4:30 the hotest

Table 2. Incidence and rate of ovulation in three genotypes of goats in northeast Brazil.

Nutrition-Management/Breed	Incidence %	Ovulation Rate
N. Pasture		
Marota	76.04	1.50
Moxoto	61.46	1.54
SRD	80.21	1.79
Combined	72.57	1.62
Confinement		
Marota	73.96	1.40
Moxoto	62.50	1.33
SRD	81.25	1.62
Combined	72.57	1.46
Combined Overall	72.57	1.52

Table 3. Means (± S.E.)[1] ovulation rate, weight (kg) and age (days) at puberty of three herds of hair sheep under two nutrition management systems (Northeast Brazil, 1982 - 1983).

	Ovulation rate	Weight	Age
Overall Mean	1.13	25.17 ± 5.78	303.50 ± 68.23
Breed			
Somali	1.14	21.88 ± 0.62[a]	335.40 ± 12.82[a]
Santa Ines	1.04	29.75 ± 0.61[b]	282.97 ± 14.84[b]
Morada Nova	1.23	23.88 ± 0.64[a]	292.13 ± 11.77[b]
Nutrition Management System			
Confinement	1.09	28.16 ± 0.53[a]	250.20 ± 9.56[a]
N. Pasture	1.17	22.18 ± 0.53[b]	356.81 ± 9.56[b]
Breed X Nutrition			
Somali X Confinement	1.20	24.94 ± 0.88[b]	281.49 ± 15.64[a]
Somali X N. Pasture	1.08	18.82 ± 0.88[a]	389.31 ± 18.53[c]
S. Ines X Confinement	1.08	34.53 ± 0.84[c]	209.31 ± 23.27[a]
S. Ines X N. Pasture	1.00	24.96 ± 0.93[b]	356.64 ± 15.35[bc]
M. Nova X Confinement	1.00	25.03 ± 0.92[b]	259.79 ± 15.55[a]
M. Nova X N. Pasture	1.42	22.74 ± 0.85[b]	324.47 ± 16.03[b]

[1] $P < 0.01$ for means within column subsets not bearing the same superscript letter

Table 4. Percent ewes ovulating and ovulation rate in three breeds of hair sheep by month and nutrition management system (Northeast Brazil, June - November 1983).

	Morada Nova		Santa Ines		Somalis		Combined		
	Confin	N. Past	Confin	N. Past	Confin	N. Past	Confin	N. Past	Overall
				Incidence of Ovulation					
June	100.00	66.67	66.67	50.00	66.67	83.33	77.78	66.67	72.22
July	66.67	83.33	50.00	83.33	33.33	100.00	50.00	88.89	69.44
August	66.67	100.00	66.67	50.00	83.33	100.00	72.22	83.33	77.78
September	83.33	100.00	100.00	66.67	83.33	66.67	88.89	77.78	83.33
October	33.33	66.67	100.00	66.67	100.00	66.67	77.78	66.67	72.22
November	100.00	100.00	50.00	50.00	100.00	100.00	83.33	83.33	83.33
Combined	75.00	86.11	72.72	61.11	77.78	86.11	75.00	77.78	76.39
				Ovulation Rate					
June	1.17	1.50	1.25	1.33	1.50	1.40	1.29	1.42	1.35
July	1.25	1.40	1.67	1.20	1.00	1.50	1.33	1.38	1.36
August	1.25	1.67	1.00	1.00	1.20	1.33	1.15	1.40	1.29
September	1.00	1.67	1.50	1.00	1.60	2.00	1.38	1.57	1.47
October	1.00	1.50	1.50	1.00	1.00	1.50	1.21	1.33	1.27
November	1.33	2.17	1.00	1.00	1.33	1.33	1.27	1.60	1.43
Combined	1.19	1.68	1.35	1.10	1.29	1.48	1.27	1.45	-

[1]Observations on six ewes per subgroup per month

1. **Project Title:** Improving Reproductive Performance of Small Ruminants.

2. **Institution:** Utah State University

3. **Principal Investigator:** Warren C. Foote

4. **Funds Allocated From:**

Grant No. AID/DSAN/XII-G-0049 from 1983/84 subgrant:	$ 200,000
Matching Contribution from 1983/84 subgrant:	$ 268,748

5. **Statement of Project Goals:**

The research conducted in Peru deals with sheep, goats and alpaca. The SR-CRSP Utah reproduction project has collaborated with host country institutions such as INIPA, UNA, UNMSM, SAIS's, with small holders of sheep and goats, and with other SR-CRSP projects. In terms of geographical area, the project covers high Central Sierra, southern Sierra and the northwestern arid coast of Peru.

The research projects are designed to measure and evaluate the reproductive capabilities of existing small ruminant genotypes in relation to the environment. The levels of reproduction and production of sheep owned by small holders and the influence of selected management practices are also being gathered. The results obtained will furnish means to develop alternative management practices to increase reproductive performance and consequently the productive efficiency.

6. **Statement of Specific Objectives for 1983/84:**

i. To measure and evaluate the reproductive capabilities of genotypes of small ruminants (sheep, goats, alpacas) in relation to their environment.

ii. To develop alternative management practices to increase reproductive performance.

iii. To determine levels of production and management systems of small holder producers and measure the influence of selected management practices in their systems.

iv. To provide graduate and non-degree training programs such as short courses in Peru and the United States to extend and upgrade scientists expertise.

v. To cooperate with other Small Ruminant-CRSP projects and programs in Peru directed at improving Small Ruminant Production particularly by the small holder.

7. Description of Work Undertaken:

Research procedures in the southern and central altiplano were standardized to measure reproductive capabilities of Corriedale, Junin and Criollo sheep. Preliminary results obtained on fertility, ovulation rate and incidence were found to be low for sheep regardless of breed. Arrangements were made to characterize levels of reproduction and production under the traditional system of small sheep operations at the producer farm. Selected management practices were imposed to obtain the impact in terms of productivity and to see how the private producers could cooperate to undertake research. Laboratory facilities were developed at Central Sierra for research in both male and female sheep reproduction.

In alpaca, low fertility rates and high embryo/fetal losses were reported. These problems could be due to hormone and nutritional imbalances. To overcome these problems, experiments were designed and established to study hormone levels in different phases of the reproductive cycle of alpacas. The percent ovulating by 30 hours or less postmating, 36-60 hours postmating or that failed to ovulate postmating were 42, 23 and 35 percent for one-year-old females and 49, 29 and 23 percent for adults.

In goats, reproduction and production performance data were obtained at the producer level. Arrangements were made to begin a basic and well controlled experiment to define the reproductive performance throughout the year and by season.

8. Technical Accomplishments:

i. Sheep in Central Sierra, Peru:

Puberty Study in Sheep.

Results of a two-year puberty study carried out at Central Sierra with three breeds of rams (Criollo, Corriedale and Junin) show that the age at penis separation from the prepuce did not differ between Criollo (6.37 mo) and Corriedale (6.62 mo). These two breeds differ ($P < 0.05$) from Junin (7.85 mo). The age of lambs at first ejaculation with sperm cells was not statistically significant among breeds ($P > 0.05$). The live body weight at penis separation and at the first ejaculation containing sperm cells, was statistically different ($P < 0.05$) among the Criollo compared with Corriedale and Junin breeds (Table 1). Statistical differences ($P < 0.05$) among breeds were found for ejaculated volume and motility. But no difference ($P > 0.05$) was observed for sperm concentration (Table 2). In summary, puberty in ram lambs occurs at 7-9 months of age. This information has a practical value in sheep management in terms of castration or sex separation to avoid undesirable matings.

Fertility Study of Three Genotypes of Rams.

In adult rams grazed on Central Sierra native range, data on live body weight, scrotal girth, ejaculated volume, sperm concentration and

motility was obtained monthly. The data were classified by breed, age, seasons of the year and dry and wet periods, as they are shown in Table 3. The Criollo rams showed better ($P < 0.05$) sperm concentration (1.85×10^9/ml) and motility (56.1%) compared with Junin (1.58×10^9/ml and 48.3%, respectively) except for ejaculated volume (1.03 vs 1.14 ml for Criollo and Junin, respectively). The Corriedale breed was intermediate to the Criollo and Junin. No statistical difference was found for any of the semen characteristics, affected by age of the rams ($P > 0.05$). The ejaculated volume and sperm concentration were affected by wet and dry period of the year, being higher during wet period for ejaculated volume (0.97 vs 1.18 ml) and the reverse for concentration (1.82 vs 1.62×10^9/ml). No difference ($P > 0.05$) was observed for sperm motility (50.3 vs 53.3% for dry and wet period, respectively). The monthly information on semen quality indicates that there are some seasonal variations. However, the magnitude was not enough to indicate that the rams should not be used for breeding throughout the year.

Fertility Study of Two Genotypes of Ewes.

A two-year study to establish the fertility levels of Criollo and Junin sheep, using 1.5, 2.5, 3.5, and 4.5 year age groups was completed. This project will be completed in one more year. Preliminary results (Table 4) indicate that Junin breed (86.1%) showed higher fertility rate than Criollo (62.1%) at $P < 0.01$. The level of fertility was affected by age of the ewe ($P < 0.01$). Ewes at 3.5 and 4.5 years of age are statistically different (78.3 and 91.7%). They differ ($P < 0.01$) from ewes of 1.5 and 2.5 years old (61.3 and 67.5%). The overall mean for prolificacy was 1.01. However, in Table 4, it can be seen that the fertility rate and prolificacy tend to increase as the age of ewes increases. The birth weight of lambs and the weight at parturition of Criollo ewes were less (3.02 and 26.4 kg) compared to Junin breed (3.67 and 41.3 kg, respectively) at $P < 0.01$. The potential of ewes to show good fertility seems to exist, which could be increased in the flock of small producers, improving the reproductive related management.

Estrus and Ovulation in Three Genotypes of Ewes.

The incidence of ovulation and estrus and the ovulation rate in Junin, Corriedale and Criollo sheep of 1.5 to 3.5 years of age at high Central Sierra of Peru, are being observed throughout the year. The incidence and rate of ovulation are established through laparoscopy and the incidence of estrus using painted vasectomized teaser rams. A two-year study has been completed and one additional year will be required to complete the research project. Analysis of data obtained during the two years shows that the Junin sheep had lower monthly mean incidence of ovulation (32%) compared with Corriedale (40%) and Criollo (44%, Table 5). Ewes of 1.5 years of age showed significantly ($P < 0.05$) lower monthly mean incidence of ovulation compared to older ages. Significant differences did not occur ($P > 0.05$) among older ages: 2.5 (44%) and 3.5 year-old ewes (38%). The overall monthly mean ovulation rate of sheep in Central Sierra of Peru is 1.10 (Table 6). The Criollo breed was a lower ovulation rate

(1.07) followed by Junin (1.09) and Corriedale (1.12). This reproductive trait in terms of age, was 1.08, 1.11 and 1.10 for 1.5, 2.5 and 3.5 year old ewes, respectively. The monthly mean incidence of estrus by breed was 37.8, 38,9 and 18.9 percent for Junin, Corriedale and Crioilo, respectively. The incidence of estrus due to age was not different, being 32.6, 33.0, and 30.0 for 1.5, 2.5, and 3.5 years of age, respectively (Table 7). In summary, this information indicates that the sheep in the Central Sierra have low ovulation rates and low monthly incidences of ovulation and estrus. The higher proportion of ewes ovulating and showing estrus occurs from February to August (7 months) indicating that the sheep in Central Sierra are extended seasonal breeders. However, comparing the monthly proportion of ewes ovulating and showing estrus, it was established that 16.9 percent of ewes are ovulating without accompanying estrus. This reproductive performance added to low ovulation rate may be influencing the low fertility rate at lambing.

Reproduction and Production Performance of Sheep Subjected to Traditional and Selected Management Practices at the Producer Level.

Since April 1982, three privately owned flocks with a total of 290 sheep have been used in collaboration with small producers to study reproduction and production performance.

In this study, the overall mean fertility rate was 77.2 percent (Table 8). The variation between flocks was from 48.4 to 83.5 percent, indicating that variation exists in management practices among producers. The prolificacy rate of ewes in all forms was low (1.0). The birth weight of lambs varied from 2.0 to 3.5 kg with an overall mean of 3.2 kg and the live body weight of ewes at parturition varied from 26.6 to 35.4 kg with an overall mean of 31.2 kg. The peaks of lambings and mortality (lambs and adults) observed were from May to September (87.2%) and May to October (83.3%), respectively. This trend indicates that the matings in 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 a shortage of available forage. This depresses the body condition of the ewes, thus lowering lactation and enhancing the lamb losses. The overall mortality rate for both lambs and adults was 11.6 percent (59/509). The mortality rate for lambs was only 26.9 percent (59/219). Arrangements were made at the owner's request to introduce selected management practices in two out of three flocks, to measure their impact on the existing production system and on levels of production. The practices introduced are parasite control and a limited breeding season. Also in these two flocks, data are being obtained where animals are assigned to two categories according to those that should be culled and those that should be kept for breeding (all animals remain in the flocks). The responses to these imposed management practices will be measured during the coming year.

Ovulation and Lambing Rates in Exotic and Native Crossbred Ewes.

It has been reported that the ovulation rate is low in native sheep in Central Sierra. The SR-CRSP Montana breeding and Utah reproduction

projects collaboratively are measuring the potential benefit of crossbreeding exotic, more prolific Targhee and Finn-Targhee rams with Junin ewes. A one-year study showed an ovulation rate of 1.3 for crosses Finn-Targhee x Junin, 1.06 for Junin x Junin and 1.00 Targhee x Junin. The incidence of ovulation for the same crosses was 83.3, 59.3, and 45.8 percent respectively. These results show that potential reproductive performance can be improved by introducing prolific genotypes. However, better nutrition management should be exercised to take advantage of the crosses. Additional data are required.

ii. Sheep in Southern Altiplano (La Raya):

Estrus and Ovulation in Two Genotypes of Ewes.

The monthly ovarian activity was observed throughout two years in Corriedale and Criollo sheep of 1, 2 and 3 years of age (2, 4 and 6 pair of permanent teeth, respectively). The overall monthly mean incidence of ewes ovulating and showing estrus was 49.7 and 57.8 percent. The results also show that the incidence of ovulation was observed year-round, varying from 18.6 to 71.11 percent. The higher proportion of ewes ovulationg was observed from February to August (51.7 to 71.1%). The incidence of estrus had the same trend, but the higher proportion of ewes showing estrus was from March to August (89.3 to 58.3%). In total, 5.9 percent more ewes are showing estrus compared to ewes ovulating. This may indicate that there is a proportion of ewes showing estrus not ovulating or that estrus was not properly checked.

Fertility of Rams.

In male sheep, a two-year semen study is underway at the La Raya Experiment Station for Criollo and Corriedale breeds with 2, 4 and 6 pair of permanent incisor teeth as an indication of 1, 2 and 3 years of age. Results of 21 months of research indicate that the body weight of Corriedale rams is heavier compared to Criollo. In both breeds, the heaviest weight was recorded during February to July and the lightest weight in December. The monthly mean of semen ejaculated volume varied from 0.66 to 1.10 ml for Corriedale breed and from 0.65 to 0.89 for Criollo. The monthly mean sperm concentration varied from 1.59 to 3.54 in the Corriedale and in Criollo breeds from 1.60 to 2.72 x 10^9 sperm cells/ml of ejaculate. The mean sperm motility in Corriedale varied from 32.7 to 65.6 percent and in Criollo from 43.3 to 57.1 percent. In both semen characteristics, the Corriedale breed seems to have larger means especially for semen volume and sperm concentration. The motility was probably reduced as a result of the adverse conditions under which the study was conducted.

iii. Alpaca and Llama in Southern Altiplano (La Raya).

Physiology and Endocrinology in Alpaca and Llama.

Research is underway at the IVITA-UNMSM La Raya Experiment Station in alpaca and llamas on physiology and endocrinology of reproduction

relating to sexual receptivity and related ovulation in, 1) non-pregnant, non-lactating females, 2) pregnant females, and 3) non-pregnant, lactating females. Data for sexual receptivity in both lactating and non-lactating females were collected to determine the incidence of estrus and the progesterone levels in the circulating peripheral blood serum. Estrous periods were checked using vasectomized males. Blood samples were drawn prior to and after matings. The incidence of ovulations and CL regression were also obtained by means of laparoscopies taken immediately after, 72 hours after, and 18 days after mating. In lactating females, progesterone will also be determined in the milk. The experiment will be terminated as soon as the progesterone levels in the blood samples and milk are obtained. Then, the final report will be prepared. In pregnant alpacas from breeding to parturation, weekly blood samples were obtained to determine progesterone levels of pregnancy in alpaca. The results of this study will also be reported at the completion of the RIA. The RIA's are being conducted at UNA.

The same studies are being undertaken in llamas.

Frequency of Abnormal Testis in Alpacas.

In male alpaca, efforts are being made to obtain the best method of semen collection and evaluation. No successful results have yet been obtained, and the project is continuing. However, observing 1414 Huacaya type and 106 Suri type alpacas of 1.0, 1.5, 2.0 and 3.0 years of age, 11.2 and 14.2 percent of abnormal testicles were found for the two types, respectively. The higher proportion of abnormal testicles were observed in animals of 1.5 years of age. From the total of both types of animals with abnormal testicles, 67.2 percent of the males belong to the 1.5 year-old age group.

iv. Goats of the Northwestern Coast.

A general proposal for research in male and female goats on the northwestern coast of Peru was submitted to Peruvian counterparts. A detailed research project in female reproduction was also prepared to be carried out in cooperation with CIPA II-INPA-UNA, SR-CCSP-Utah Reproduction and CIID-Canada at Chiclayo INIPA Center. Arrangements are being made to furnish equipment and supplies to begin the project this summer. Further results will be reported next year.

9. Personnel Collaborating on Project Activities and Training:

i. Personnel:

H. William Vivanco, UNA-La Molina, Co-Principal Investigator.

Julio Sumar, IVITA-UNMSM, La Raya Experiment Station, Co-Principal Investigator.

Walter Bravo, IVITA-UNMSM, La Raya Experiment Station (at USU in a MS Program).

Maximo Gamarra, SAIS Tupac Amaru Consac and UNMSM, Research Associate.

Jose Camacho, IVITA-UNMSM, Research Associate.

ii. Training:

H. William Vivanco, Professor of UNA, La Molina, during August-September 1983, has completed his MS degree at California State Polytechnic University, Pomona.

Cesar Novoa, IVITA-UNMSM, Co-Principal Investigator (at USU in a PhD Program).

Walter Bravo, IVITA-UNMSM, has begun his MS training at USU in spring quarter of 1984.

Victor Alarcon, UNA-La Molina, Research Assistant and Trainee.

Victor Llacssa, SR-CRSP, SAIS Tupac Amaru, Research Assistant and Trainee.

Cesar Pinares, SR-CRSP, SAIS Pachacutec, Research Assistant and Trainee.

Horacio Cardenas, UNA, Research Assistant and Trainee.

Virgilis Alarcon, SR-CRSP/IVITA La Raya, Research Assistant and Trainee.

Table 1. Mean body weights, age and scrotal circumference in ram lambs in puberty study (Central Sierra - Peru).

Variables	Breed[1]		
	Criollo	Corriedale	Junin
Age (Months)			
At penis separation	6.37[b]	6.62[b]	7.85[a]
At 1st ejaculation	7.00[a]	7.25[a]	8.80[a]
Weight (kg)			
At penis separation	29.11[b]	30.50[a]	28.00[a]
At 1st ejaculation	22.65[b]	31.66[a]	35.33[a]
Scrotal Circumference (cm)			
At penis separation	25.75[a]	24.75[a]	17.33[b]
At 1st ejaculation	25.26[a]	24.50[a]	21.00[a]

[1] $P < 0.05$ for means between columns not bearing the same superscript letter.

Table 2. Semen characteristics of ram lambs at puberty by year and breed (April 1980 - March 1982, Peru).

Main Effects	Ejac. Volume ml	Motility %	Concentration n x 106/ml
Year			
1980-1981	0.82[a]	40.61[a]	1.09[a]
1981-1982	0.67[b]	42.03[b]	1.09[a]
Breed			
Criollo	0.87[c]	50.90[c]	1.10[a]
Corriedale	0.76[b]	41.90[b]	1.10[a]
Junin	0.62[a]	29.90[a]	1.10[a]

$P < 0.05$ for means within column subsets not bearing the same superscript letter.

Table 3. Body weight, scrotal circumference, semen characteristics by breed of ram and period of year at SAIS TUPAC AMARU (CONSAC) Central Sierra, Peru (1980 - 1982).

Main Effects[2]	VARIABLES Body Weight (kg)	Scrotal Circumf. (cm)	Ejaculate Volume (ml)	Concentration (n X 10^9/ml)	Motility (%)
Overall Mean	48.33 ± 0.81	29.80 ± 0.20	1.07 ± 0.02	1.71 ± 0.04	51.72 ± 0.86
Breed					
Criollo	38.15 ± 0.79[a]	28.35 ± 0.28[a]	1.03 ± 0.04[a]	1.85 ± 0.08[b]	56.07 ± 1.27[b]
Corriedale	45.61 ± 1.05[b]	29.52 ± 0.31[b]	1.04 ± 0.05[ab]	1.76 ± 0.10[ab]	50.83 ± 1.60[a]
Junin	60.17 ± 1.38[c]	31.45 ± 0.39[c]	1.14 ± 0.04[b]	1.58 ± 0.08[a]	48.31 ± 1.58[a]
Age (years)					
1.5	50.55 ± 1.07[a]	31.39 ± 0.22[a]	1.23 ± 0.05[a]	1.93 ± 0.09[a]	55.42 ± 1.59[a]
2.5	54.33 ± 1.46[b]	31.14 ± 0.29[a]	1.21 ± 0.05[a]	2.02 ± 0.11[a]	56.87 ± 1.55[a]
3.5	56.90 ± 1.56[c]	32.16 ± 0.30[b]	1.12 ± 0.05[a]	1.90 ± 0.11[a]	54.23 ± 1.67[a]
Seasons					
Summer	42.12 ± 4.04[a]	31.10 ± 0.34[c]	1.37 ± 0.06[b]	1.31 ± 0.09[a]	54.94 ± 1.83[a]
Fall	46.52 ± 1.45[a]	30.36 ± 0.43[b]	1.01 ± 0.05[a]	1.61 ± 0.10[b]	50.09 ± 2.03[a]
Winter	48.99 ± 1.23[b]	28.28 ± 0.38[a]	0.94 ± 0.04[a]	1.98 ± 0.10[c]	50.31 ± 1.58[a]
Spring	50.60 ± 1.62	29.78 ± 0.35[b]	1.05 ± 0.04[a]	1.83 ± 0.09[bc]	52.28 ± 1.55[a]
Periods					
Dry	47.75 ± 0.94[a]	29.38 ± 0.30[a]	0.97 ± 0.03[a]	1.82 ± 0.07[b]	50.28 ± 12.6[a]
Wet	50.43 ± 1.56[b]	30.31 ± 0.25[b]	1.18 ± 0.04[b]	1.62 ± 0.07[a]	53.28 ± 1.18[a]

[1] $P < .05$ for means within column subsets not bearing the same superscript letter

[2] Differences between years were non-significant ($P > .05$) and the years were pooled

Table 4. Mean reproductive traits of ewes in Central Sierra, Peru (April 1981 March 1983).

Main effects	Fertility at parturition %	Prolificacy n	Lamb birth weight (kg) $\bar{x} \pm$ S.E.	Ewe weight at parturition (kg) $\bar{x} \pm$ S.E.
Overall Mean	73.60	1.01	3.52 ± 0.05	36.89 ± 0.55
Breed (x^2)	27.88**			
Criollo	62.05	1.01	3.02 ± 0.12^a	26.42 ± 0.46^a
Junin	86.11	1.01	3.67 ± 0.07^b	41.33 ± 0.33^b
Age (x^2)	19.56**			
1.5 years	61.33^a	1.00	3.12 ± 0.11^a	32.36 ± 0.70^a
2.5 years	67.50^a	1.01	3.48 ± 0.08^{bc}	34.76 ± 0.53^{bc}
3.5 years	78.33^b	1.01	3.55 ± 0.07^c	35.36 ± 0.48^c
4.5 years	91.67^c	1.02	3.23 ± 0.09^{ab}	33.00 ± 0.54^{ab}
Breed X Age (x^2)	7.27 N.S.			
Criollo X 1.5	48.89	1.00	2.80 ± 0.21^a	24.14 ± 1.16^a
Junin X 1.5	80.00	1.00	3.45 ± 0.12^a	40.58 ± 0.79^c
Criollo X 2.5	50.00	1.03	3.12 ± 0.17^a	26.06 ± 0.91^{ab}
Junin X 2.5	85.00	1.01	3.84 ± 0.10^b	43.46 ± 0.55^d
Criollo X 3.5	68.33	1.00	3.08 ± 0.15^a	27.35 ± 0.80^{ab}
Junin X 3.5	88.33	1.02	4.02 ± 0.10^b	43.38 ± 0.53^d
Criollo X 4.5	93.33	1.04	3.08 ± 0.14^a	28.12 ± 0.77^b
Junin X 4.5	90.00	1.00	3.38 ± 0.11^a	37.89 ± 0.75^c

Table 5. Proportion of ewes ovulating per ewes observed by breed and age (April 1981 - March 1983). Central Sierra - Peru.

Breed	AGE (years) 1.5	2.5	3.5	Total
Junin	.28(110)[1]	.34(90)	.34(95)	.32(295)[a]
Corriedale	.33(109)	.43(114)	.43(103)	.40(326)[b]
Criollo	.39(91)	.56(72)	.39(65)	.44(228)[b]
Total	.33(310)[a]	.44(276)[b]	.38(263)[b]	.38(849)**

[1]Number of ewes observed.

Table 6. Ovulation rate per ewe ovulating by breed and age (April 1981 - March 1983). Central Sierra - Peru.

Breed	AGE (years) 1.5	2.5	3.5	Total
Junin	1.13(31)[1]	1.13(30)	1.00(32)	1.09(93)
Corriedale	1.00(37)	1.16(49)	1.18(44)	1.12(130)
Criollo	1.11(35)	1.03(40)	1.08(25)	1.07(100)
Total	1.08(103)	1.11(119)	1.10(101)	1.10(323)

[1]Number of ewes ovulating.

Table 7. Incidence (%) of ewes in estrus by breed and age (April 1981 - September 1983). Central Sierra - Peru.

Breed	AGE (years) 1.5	2.5	3.5	Total
Junin	38.15(270)[1]	38.52(270)	36.67(270)	37.78(810)
Corriedale	37.41(270)	40.00(270)	39.26(270)	38.89(810)
Criollo	22.22(270)	20.37(270)	14.07(270)	18.88(810)
Total	32.59(810)	32.96(810)	30.00(810)	31.65(2430)

[1]Number of observations.

1. **Project Title:** Improving Reproductive Performance of Small Ruminants.

2. **Institution:** Utah State University

3. **Principal Investigator:** Warren C. Foote

4. **Funds Allocated From:**

Grant No. AID/DSAN/XII-6-0049 from:	
1983/84 Subgrant	$200,000
Matching contribution from	
1983/84 Subgrant	$268,748

5. **Statement of Project Goals:**

Utah State University (USU), with the cooperation of California State Polytecnic University, Pomona (CSPU), has placed a major emphasis on endocrine and physiological mechanisms regulating reproduction, environmental, and other limiting factors and reproduction and production capabilities of indigenous genotypes under existing conditions. This has included endocrinology and physiology of the estrous cycle, pregnancy and post-partum, seasonal anestrous and prebuberal anestrus in females, and the fertility of the males from prepuberal age to adulthood. Research programs conducted in the US will answer relevant questions concerning the reproductive performance of small ruminants in host countries, other SR-CRSP project, and finally, worldwide.

The training of host country personnel and graduate US students was one of the primary goals. Both formal and informal training has been used. For host country personnel, research projects were outlined and implemented in both sites and in the US to provide for host training and to fulfill the requirements of the graduate degrees sought.

Several techniques and procedures used in the US have been integrated into the host country programs to improve expertise and the level and precision of research through standardized methodologies for research data collection, analysis and reporting.

6. **Statement of Specific Objectives for 1983/84:**

i. To provide training and demonstration programs for SR-CRSP and other international students and scientists.

ii. To provide resources for research of host country and US graduate students that are compatible with programs undertaken in the countries.

iii. To conduct research that contributes to basic and applied knowledge of small ruminant reproduction in the US, host countries and other resources.

iv. To strengthen programs in SR-CRSP host countries and other countries.

7. Description of Work Undertaken:

Several reproductive traits have been compared between Rambouillet and St. Croix sheep. The St. Croix sheep showed higher reproductive capabilities compared with the Rambouillet in terms of precocity, prolificacy, extended breeding season and short postpartum interval.

In Spanish-type or Brush goats, progesterone and LH profiles were established for comparable periods of time during postpartum, breeding and anestrous seasons.

Embryo transfer techniques are being used as an important tool to study the time and route of vertical transmission of scrapie. If the technique is successful, it would provide means for international exchange of disease-free germ plasm.

In male reproduction, semen production and quality of various genotypes at different times of the year has been established. Information on semen collection, freezing and artificial insemination in both sheep and goats has been generated and evaluated. Manuscripts on these topics will be available in the near future.

As much as possible, efforts have been made to standardize RIA methods at USU and CSPU countries and equipment and materials have been and are being supplied as needed and as resources have been available.

Successful training programs for host country personnel have been established at USU and CSPU. One participant is back in his home country, and at present, three are in the process of completing their training for advanced degrees.

Research techniques such as endoscopies, laparotomies, embryo culture and transfer, pregnancy diagnosis and semen processing are familiar in both host countries as a result of efforts of the SR-CRSP reproduction project.

8. Technical Accomplishments:

The USU and CSPU research results which are most directly related to the SR-CRSP during the past year are as follows.

i. The influence of sexual season, seasonal anestrus and exogenous gonadotropins on hormone receptor sites of the reproduction axis.

Ewes from the estrous and anestrous phase were checked for standing heat using painted vasectomized rams. Ewes having been marked at least twice within the time allowed for passage of two estrous cycles were considered to be in the breeding phase, and ewes not marked in that same period of time were considered to be in anestrus.

Ovaries were removed from cycling ewes at day 14 of the estrous cycle as determined from the last standing heat. Ovaries from anestrous ewes were removed during what was believed to be in deep anestrous without regard to date of last cycle. The ovaries were frozen in

liquid nitrogen and prepared for labeled hormone incubation as frozen sections. 1251-FSH was applied to the tissue sections, excess washed off, and slides were dipped in autoradiography emulsion. They were developed after 7-10 day exposure at -20°C, and stained with a routine H & E staining procedure. A reflecting light, microscopic spectrophotometric system was used to quantify the silver grains on each section. The presence of these silver grains was indicative of labeled LH bound to cellular binding sites in the tissue. Thus, the more silver grains on an area, the more hormone bound to the tissue, showing up as higher reflectance picked up by the photomultiplier tube and the higher the reading from the indicator.

Several steps were taken to standardize readings taken from tissue sections at different times to determine the amount and location of LH binding in the sheep ovarian compartments during estrous and anestrous seasons. The methodology used enables comparisons with other studies conducted on the same topic.

The ovary was divided into five reading sites according to anatomical function: the antrum, the granulosa, theca interna and externa of the follicle, and the stroma. Different size categories were considered for follicles such as small (< 4mm), medium (4-8mm) and large (7-8mm).

It was found that there was a significant difference ($P < 0.05$) in binding in the theca interna due to follicle size, interaction between the reproductive phase and hormone treatment and hormone treatment interaction with follicle size. The theca externa readings show significant difference ($P < 0.05$) due to reproductive phase and hormone interaction as well. The greatest binding was seen in the theca interna treated with 1251-hCG rather than LH ($P < 0.01$). Human chorionic gonadotrophin was found to bind to all cell compartments more than LH ($P < 0.01$). See Tables 1-2.

Binding by theca interna in small follicles from ewes in the breeding season showed a bimodal distribution i.e. very little binding or high levels of binding. Small follicles from anestrous ewes had theca interna binding values which were uniformly very low. Medium and large follicles from breeding season ovaries showed a continued distribution of binding values, and those from the anestrous ovaries clustered in the area of low binding.

There was more LH/hCG binding present in follicles (theca interna) during the breeding season than the anestrous season, and within the breeding season the larger the follicle became, the more binding was seen. The theca interna was the only one showing a significant change in binding due to season, hormone treatment (LH vs hCG) or size of follicle. A method was revised by which readings from different sections and different experiments could be compared using transformations on readings based on a standard curve obtained from emulsion dilution slide readings. This method will be used in future autoradiography studies on binding sites.

ii. The occurrence of estrus and ovulation and ovulation rate throughout

the year in Rambouillet and St. Croix sheep:

Ten mature Rambouillet and 10 mature St. Croix ewes have been observed during the past two years (1982-84) for estrus and ovulation. The incidence of estrus was observed daily using painted vasectomized rams and the occurrence and rate of ovulation through laparoscopy. The results indicate that there is a close relationship among the incidence of estrus and ovulation. However, it was observed that ovulation without estrus has occurred during the transition of anestrous to breeding season or vice versa. The St. Croix sheep seem to show a longer breeding season (August to May vs. August to April) and a consistently higher ovulation rate compared to the Rambouillet sheep. Differences were observed within breeds, but no significant differences were observed among breeds (Table 3).

iii. Interrelationship between source and level of progesterone and number of fetuses at different states of pregnancy (Cesar Novoa, Peru, Dissertation data):

Approximately 128 mature ewes of three genotypes (Finnsheep x Targhee, Rambouillet and St. Croix) were used in this research. All ewes were kept in confinement and received alfalfa or alfalfa and barley pellets at levels which met the NRC recommended nutrient requirements throughout the experimental period. One exception to this was the Finnsheep x Targhee group used in Objective 1 where one-half of the ewes received 115% and one-half received 60% of NRC recommendations for energy during the last 9-10 weeks of pregnancy. These levels are part of the experimental design for another study which was being conducted concurrently on these animals, but also provided preliminary information on the influence of level of feed on progesterone level in this study. All peripheral blood was collected via the jugular vein, the serum removed and prepared and analyzed for progesterone by RIA.

Approximately 36 Finnsheep x Targhee, 20 Rambouillet and 20 St. Croix ewes were bred during their established breeding periods of late summer and fall. Dates of breeding were confirmed by use of painted sterilized teaser rams. The ovulation and fetus rate were estimated by laparotomy and uterine palpation on days 28-35 post breeding. The number, sex and weight of lambs were determined at parturition. Beginning on the day of breeding, blood samples were drawn at weekly intervals throughout pregnancy, on the day of parturition, and during the first and second week postpartum. The blood serum was analyzed for progesterone. The interrelationships between levels of progesterone, the number of fetuses present at 28-35 days and lambs born and the ova/embryo/fetal loss was also determined.

Approximately 22 Rambouillet and 30 Targhee-type ewes were bred following progesterone treatment (40 mg FGA in intravaginal sponges) and 400 and 800 i.u. PMSG treatment to induce a slight increase in ovulation rate for the purpose of increasing the proportion of multiple fetuses. Rates of breeding were confirmed by use of painted sterilized teaser rams. The following information was obtained at different periods of pregnancy as follows: day 28-35, ovulation rate

and number of fetuses: day 05-112 (ewes were ovariectomized, hysterectomized or sham operated as indicated in Table 4), number and weight of CL, placentae and fetuses removed and the progesterone content of the CL and placentae determined. Blood was drawn at weekly intervals from day 35 of pregnancy throughout the remainder of pregnancy, on the day of parturition and for two weeks postpartum. Three samples of blood were drawn during a period of 1-1.5 hours at each weekly interval and pooled to minimize the within animal variation. Blood was also taken at two hour intervals from six hours pre-surgery on day 105-112 to 12 hours post-surgery to determine more specific changes in levels following surgical reproductive organ modification. These procedures were used to provide for partitioning of the CL and placentae as sources of progesterone and their relationship to embryo/fetal survival.

Preliminary results indicate that from the beginning of gestation to 8-9 weeks of pregnancy the jugular blood progesterone level resembles the luteal phase level (3.6 - 6.08 ng/ml). From this state to the parturition the progesterone level seems to increase linearly (6.89 - 16.19 ng/ml). Differences were found in the progesterone levels due to breed, being higher in St. Croix sheep compared to Rambouillet at the same stage of pregnancy. Another result is that blood of twin bearing pregnant St. Croix sheep contains a higher (almost twice) progesterone concentration than single pregnancies. This tendency is also shown by Rambouillet sheep. But the difference in progesterone concentration due to genotype is clearer, being higher in St. Croix sheep.

iv. Endocrinology of postpartum sheep:

In a pilot study, the influence of estradiol on tonic LH release was measured. In non-postpartum ewes estradiol has been shown to have a positive effect on tonic LH release during the sexual season and a negative effect during seasonal anestrus and puberty. In this pilot study, estradiol (administered exogenously in ovariectomized ewes or occurring naturally in ovary intact ewes) inhibited tonic LH levels during the regular sexual season (Fall) in postpartum but not in non-postpartum ewes indicating that this hormone may be involved in the occurrence of postpartum as well as seasonal anestrus. This is of special significance because seasonal anestrus is related to seasonal photoperiodicity where postpartum anestrus is apparently independent of photoperiodicity.

v. Pulsatile release of tonic LH in goats during the sexual and anestrous season (research of A.A. Simplicio, Brazil, for Dissertation):

During the anestrous season (May-July, 1983) six adult female Spanish-type goats were placed with a teaser buck for at least 24 days to confirm that they were in anestrous. Blood samples were collected to determine profiles for progesterone, estrogen and LH. The bleeding schedule was as follows: each doe was bled (5 ml via jugular puncture) between 7:00 a.m. and 5:00 p.m. every 15 minutes for 10 hours on day 0, 7, 14, and 21 of the experimental period. Following a resting period of 21 days, two of the six does were bled at five

minute intervals for a three hour period from 1:00 a.m. to 4:00 p.m.

During September 1983, the does were again placed with the bucks to find out if the breeding season has been established. At this time (mid-October) the estrous cycle was synchronized in eight does by use of progestogen containing pessaries placed in the vagina for 21 days. Subsequent estrus was observed using teaser bucks. Blood samples were obtained beginning on day three following the second most synchronization estrus. Samples were obtained at 15 minute intervals for six hours daily from day 17 to day 3 of the next estrous cycle. Also, blood was taken from two additional does at five minute intervals for three hours on days 3, 9, and 15 and daily from day 17 to day 3 of the next estrous cycle.

All blood samples were immediately placed on ice until the clot was formed. The blood serum was then removed by centrifugation and stored at -20°C. Progesterone, LH and estrogen are being determined using RIA in 1058 serum samples obtained during the anestrous season and 2898 samples obtained during the estrous season.

The purpose of the blood collection schedules in this experiment is to determine the episodic patterns of LH release in terms of frequency, duration and interval and also to establish levels of progesterone and estradiol during these same time periods.

vi. Research undertaken at CSPU:

a. Effect of season and age on semen characteristics.

A three year study dealing with the effect of season of year and age on semen characteristics of sheep and goats has recently been terminated. Five breeds of sheep (Rambouillet, Suffolk, Hampshire, Finn and St. Croix) and goats (Saanen, Alpine, LaMancha, Nubian and Toggenburg) from five different age categories (less than 1 year, 1 to 2 years, 2 to 3 years, 3 to 4 years and older than 4) were utilized in this study. Semen from these animals was collected and processed at weekly intervals and evaluated for: volume, concentration, initial motility, prefreeze motility, post-thaw motility, reaction to stress, as well as spermatozoa morphology and acrosomal condition. At present, data from 1,776 ejaculates collected in this study are being analyzed.

b. Frozen semen processing techniques.

Since post-thaw motility rates are generally lower than prefreezing motility rates, researchers are constantly looking for a better buffer system to increase the quality of frozen semen.

The purpose of this experiment was to investigate the efficacy of various zwitter-ion buffers titrated with $Mg(OH)_2$ instead of NaOH or KOH as used by Graham, to improve the quality of frozen goat semen. Recent research has indicated that Na^+ and K^+ ions significantly decrease spermatozoa motility and increase released Glutamic-Oxalacetic Transaminase (GOT) concentrations. In addition, this

experiment examined the effects of tonicity and glycerol dilution rate on processed semen quality. The effects of glycerol dilution rates (one-step vs two-step), in three different buffers (Tris, Hepes and MOPS) at three different osmotic pressures (285, 325 and 360 mOsm/kg) on prefreeze, post-thaw and stress motility and released GOT concentrations were examined.

This experiment is not totally completed nor has the collected data been statistically analyzed. However, a cursory analysis of initial post-thaw motility data would suggest that the MOPS zwitter-ion buffer, titrated with $Mg(OH)_2$ to a pH of 7.2, is a better buffering system than either Tris or Hepes. A buffer solution osmolarity of 360 mOsm and a one-step glycerol dilution method, yield superior post-thaw motility rates. The GOT raw data has not been computed to meaningful IU standard values, but spectrophotomic results suggest that a Hepes buffer results in the least amount of acrosomal damage during semen processing. It would appear that the use of a MOPS buffer, titrated with $Mg(OH)_2$ at an osmotic pressure of 360 mOsm utilized in a one-step glycerol dilution method yields superior post-thaw semen quality in comparison to the accepted standard Tris-Citrate (325 mOsm) two-step dilution technique previously developed in our lab.

c. Properties of egg yolk diluents.

One of the early breakthroughs in semen preservation was the selection of a suitable semen processing diluent to increase the viability of spermatozoa stored at less than body temperatures.

In the process of experimenting with different semen diluents, a tremendous variability in the efficacy of egg-yolk to dissolve in various diluents and create a homogenous solution has been observed. Often the particulate matter in the egg-yolk seemed to provide the nucleus for the appearance of small "clumps" in our standard semen diluents. The inability to totally homogenize egg-yolk with various diluents may in part explain the variation in the cryoprotectiveness of these solutions. Hence an experiment was designed to remove the particulate substances from fresh egg-yolk and observe the effects of this "treated" egg-yolk on the release of GOT from the spermatozoa. In this experiment, five semen samples from eight ejaculates were processed for freezing with either centrifuged (31,000xG) or non-centrifuged fresh egg-yolk. The difference in released GOT concentrations were determined following thawing of processed frozen spermatozoa.

At present time, not all of the data from this experiment has been collected and thoroughly analyzed. The preliminary results indicate that the use of centrifuged fresh egg-yolk decreases ($P < .06$) releasable GOT concentrations by 19.2% vis-a-vis non-centrifuged egg yolk.

d. Effects of freezing rate, glycerol and equilibration time.

Tw experiments were recently completed to evaluate the effects of th.ee glycerol levels (2, 4 and 6 percent) in the diluent, three

equilibration times (0, 1 and 2 hours) and three semen freezing rates (slow, intermediate and fast) on motility and the release of GOT from ram semen.

In Experiment 1, pooled semen was collected from mature rams and evaluated for concentration and motility. The semen was then diluted to 400 million spermatozoa per milliliter with TEST diluent and transferred to a coldroom to cool to 5°C within 60 minutes. Then an equal volume of the same diluent containing glycerol was added in three aliquotes at 10 minute intervals to reach a final concentration of four percent. The semen was then allowed to equilibrate either zero, one or two hours following glycerolization before being frozen to -80°C. The freezing rates (i.e. time from 5°C to -80°C) used in this experiment were either slow (30 minutes), intermediate (10 minutes) or fast (7 minutes). After reaching an internal temperature of -80°C, the semen straws were then transferred to liquid nitrogen (-196°C) for final storage. Progressive motility and extracellular GOT concentrations were estimated at prefreeze, post-thaw (75°C for 5 seconds) and post-stress (1 hour at 37°C).

From the analysis of these data it can be concluded that there were no significant differences between the three freezing rates for percent motility nor GOT release. There was a decrease ($P < .01$) in motility following equilibration for one and two hours vis-a-vis immediate freezing. However, following thawing, the above differences were negated and a lower ($P < .01$) motility rate was associated with an absence of equilibration time. Also an increase ($P < .01$) in GOT release was also associated with the non-equilibration treatment.

Experiment 11 was similar to Experiment 1 except that the three final glycerol levels (2, 4 and 6 percent) were evaluated, instead of the three freezing rates, as well as the equilibration rates. It was observed that semen frozen immediately after glycerolization had the lowest ($P < .05$) motility and the highest ($P < .01$) GOT release concentrations. In addition, the decrease in motility, but not GOT release, was lower ($P < .05$) for two hours compared to one hour equilibration time. Similarily, the post-thaw and post-stress motility rates were the lowest ($P < .05$) and the GOT release the highest ($P < .01$) for two percent glycerol solution. This would suggest that a two percent final concentration of glycerol in diluted semen was not as efficacious in protecting the spermatozoa from freezing damage as was either a four or six percent solution.

e. Photoperiod effects on male reproduction.

Recently a study to examine the response of the buck's hypothalamic-hypophyseal-testicular axis to photoperiod modulation was initiated. Twelve mature bucks will be exposed to either an 8 or 16 hour photoperiod (200 lux) for a period of 90 days. Sequential blood samples at 15 minute intervals will be collected from all bucks for a period of six hours following each of two GnRh challenge at days 0, 45 and 90 of this study. All blood samples will be analyzed for blood serum LH and testosterone hormone concentrations. Throughout the duration of their photoperiod treatment, ejaculates will be collected

from all bucks and analyzed for sperm volume, concentration and motility. At the conclusion of the study, three bucks in each photoperiod treatment will be castrated and leydig cell LH receptor concentrations will be quantified.

f. Estrous synchronization in the doe.

The purpose of this study was to compare the effectiveness of $PGF_2\alpha$, cloprostenol and intravaginal sponges to synchronize the estrous cycles of five different breeds (Toggenburg, Saanen, French Alpine, LaMancha and Nubian) of dairy goats.

Forty does displaying at least two previous estrous periods were equally and randomly assigned to one of four treatment groups by age, weight and breed. The four treatment groups consisted of: 1) progestagen-impregnated intravaginal sponges (60 mg Repromap, UpJohn) left in place for 17 days: 2) IM injections of cloprostenol (50 ug Haverlochart) given in a split dose at eleven day intervals; 3) IM injections of $PGF_2\alpha$ (2.5 mg, UpJohn) given in a split dose at eleven day intervals, 4) saline-impregnated intravaginal sponges left in place for 17 days.

Even though the respective treatments were administered and blood sampling was initiated, this experiment had to be cancelled because of the development of a generalized outbreak of uterine pyometria in the breeding herd. This experiment will be repeated during the next breeding season.

g. Effect of $PGF_2\alpha$ on libido and semen characteristics.

The purpose of this experiment was to evaluate the effect of various levels of $PGF_2\alpha$ (10, 20 and 30 mg) on libido, sperm concentration and percent prefreeze, post-thaw and stress motility rates in the buck. At present, this experiment is still in progress and only preliminary results are available. A cursory analysis of these data would suggest that $PFG_2\alpha$ injections will increase the ejaculated volume and concentration but have no effect on either percent progressive motility or libido.

9. Personnel Collaborating on Project Activities and Training:

i. Personnel:

Warren C. Foote, SR-CRSP Utah Reproduction, Principal Investigator, USU.
Gerardo S. Riera, Co-Investigator, USU.
Edward A. Nelson, Co-Investigator, CSPU.
Edward S. Fonda, Co-Investigator, CSPU.
Carl Hausler, USU, Investigator, sabbatical leave from Southern Illinois University, Carbundale.
Michael Huie, Laboratory Technician.
Alma Maciulis, Laboratory Technician.
Cole Evans, Animal Technician.

ii. Training:

William Vivanco, Professor at Agrarian National University of La Molina, Co-Principal Investigator in Peru, came back in August-September 1983 to CSPU, Pomona, California to successfully complete his MS thesis and final examination.

Charles F. Ferris, US student, has already completed his PhD training.

Cesar Novoa, Professor at San Marcos University, Peru, has approved in USU his five comprehensive examinations for his PhD degree. It is expected that by June 1984, he will complete his dissertation and final doctorate exam.

Jane Mole, US student, will complete her PhD program in summer 1984.

Aurino A. Simplicio, scientist at EMBRAPA/CNPC, is receiving training in a PhD program at USU. He will be completing his work by summer of 1985.

Walter Bravo, scientist at IVITA-UNMSM, Peru, began in spring quarter, 1984, his MS training program.

Adewald Adegoke, student from Nigeria, receiving MS training in male reproduction at CSPU.

David Kooyman, US student, receiving MS training in male reproduction at CSPU.

Kevin Krown, US student, receiving MS training in male reproduction at CSPU.

Table 1. Overall means of the binding values by ovarian compartment for all hormone treatment groups.

Hormone Treatment Group	Ovarian Compartment									
	Antrum		Granulosa		Theca Interna		Theca Externa		Stroma	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
[^{125}I]-labeled hCG	2.4	0.5	1.9	0.5	13.0	0.9	3.0	0.8	1.1	0.6
Excess cold FSH + [^{125}I]-labeled hCG	0.2	0.6	-1.0[a]	0.6	3.5	1.1	-0.5	0.8	-1.8	0.7
Excess cold LH + [^{125}I]-labeled hCG	1.3	0.6	-0.7	0.6	-0.9	1.1	0.2	0.9	-1.1	0.7
Excess cold hCG + [^{125}I]-labeled hCG	1.8	0.6	1.1	0.5	3.5	1.1	1.7	0.8	0.6	0.7
[^{125}I]-labeled FSH	0.9	0.6	1.9	0.6	0.4	1.1	1.4	0.9	-0.2	0.7
Excess cold FSH + [^{125}I]-labeled FSH	1.1	0.6	1.5	0.6	1.7	1.1	2.6	0.9	2.1	0.7
Excess cold LH + [^{125}I]-labeled FSH	0.3	0.6	0.1	0.6	-1.0	1.2	1.8	0.9	-1.4	0.7
Excess cold hCG + [^{125}I]-labeled FSH	0.8	0.6	0.8	0.6	0.3	1.1	0.1	0.9	-1.1	0.7
[^{125}I]-labeled LH	3.0	0.6	2.8	0.6	6.5	1.1	4.1	0.9	3.1	0.7
Excess cold FSH + [^{125}I]-labeled LH	1.4	0.6	1.1	0.6	1.3	1.2	0.8	0.9	1.0	0.7
Excess cold LH + [^{125}I]-labeled LH	1.9	0.6	0.8	0.6	1.0	1.0	1.5	0.8	2.4	0.7
Excess cold hCG + [^{125}I]-labeled LH	2.3	0.6	1.4	0.6	1.6	1.2	2.0	1.0	1.9	0.8
Total	1.4	0.2	1.0	0.2	2.6	0.3	1.5	0.3	0.5	0.2

[a]Negative means are a result of subtracting a buffer observation which had a larger reflectance value than that of the treated observation.

Table 2. Binding values of the [^{125}I]-labeled treatment group.

Compartment Follicle Size	Reproductive Phase: Day 14 of estrous cycle Mean	SE	Deep anestrus Mean	SE	Combined Total Mean	SE
Antrum						
Small (<4 mm)	3.2	0.8	3.4	1.0	3.3	0.6
Medium (4-10 mm)	3.4	1.2	2.8	1.1	3.1	0.8
Large (>10 mm)	2.5	1.3	1.2	1.1	1.8	0.9
Total	3.0	1.0	2.5	1.0	2.7	0.4
Granulosa						
Small (<4 mm)	2.6	0.6	3.6	0.7	3.1	0.4
Medium (4-10 mm)	-0.1[a]	0.9	1.9	0.9	0.9	0.6
Large (>10 mm)	4.1	0.9	-0.5	0.8	1.8	0.6
Total	2.2	1.0	1.7	1.1	1.9	0.3
Theca Interna						
Small (<4 mm)	16.4	2.9	9.2	3.3	12.8	2.2
Medium (4-10 mm)	17.6	4.0	2.5	3.8	10.0	2.8
Large (>10 mm)	26.0	4.3	12.1	3.9	19.0	2.9
Total	20.0	3.7	7.9	3.7	14.0	1.3
Theca Externa						
Small (<4 mm)	2.2	1.1	3.7	1.3	3.0	0.9
Medium (4-10 mm)	1.3	1.6	2.8	1.5	2.1	1.1
Large (>10 mm)	5.0	1.8	3.0	1.7	4.0	1.2
Total	2.8	1.3	3.2	1.3	3.0	0.5
Stroma						
Small (<4 mm)	0.6	1.0	2.8	1.2	1.7	0.8
Medium (4-10 mm)	2.0	1.6	1.1	1.4	1.6	1.1
Large (>10 mm)	1.5	1.6	0.5	1.4	1.0	1.1
Total	1.4	1.2	1.5	1.4	1.4	0.5

[a] Negative means are a result of subtracting a buffer observation which had a larger reflectance value than that of the treated observation.

Table 3. The occurrence of estrus and ovulation and ovulation rate in Rambouillet and St. Croix ewes (1982-83).

Month	ESTRUS (%)		OVULATION (%)		OVULATION RATE	
	Ramb.	St. Croix	Ramb.	St. Croix	Ramb.	St. Croix
January	100	100	95	100	1.68	1.74
February	75	95	100	100	1.40	1.84
March	80	90	90	95	1.44	1.53
April	55	74	55	74	1.29	1.57
May	0	5	0	5	0	1.00
June	0	0	0	0	0	0
July	0	0	0	0	0	0
August	35	45	70	70	1.47	1.57
September	95	100	95	100	1.96	1.60
October	95	95	100	100	1.67	1.93
November	100	100	100	100	1.83	2.09
December	100	100	100	100	1.72	2.09

Table 4. Experimental design to study the partition source of progesterone during the last two-thirds of pregnancy.

Surgical Modification[1]	Genotype						Total		
	Rambouillet			Targhee-type					
	No. fetuses[2]			No. fetuses[2]			No. fetuses[2]		
	1	2	1+2	1	2	1+2	1	2	1+2
Intact	3[3]	3	6	3	3	6	6	6	12
Hysterectomy	3	3	6	3	3	6	6	6	12
Ovariectomy	3	3	6	3	3	6	6	6	12
Total	9	9	18	9	9	18	18	18	36

[1] Hysterectomies and ovariectomies were performed at 105-112 days of pregnancy. Intact ewes underwent sham surgery (laparotomy).

[2] The number of CL and fetuses were estimated by laparotomy and uterine palpation on day 28-35 of pregnancy. They were reconfirmed again at surgery on day 10,-112.

[3] Indicates the number of animals used.

1. **Project Title:** Nutrition and Supplemental Feeding For Small Ruminants in Northeast Brazil.

2. **Institutions:**

National Goat Research Center (EMBRAPA), Sobral
Paraiba State Agricultural Research Agency (EMEPA)
North Carolina State University

3. **Principal Investigator:** William Johnson

4. **Funding, 1983-84:**

$48,369 allocated from AID/DSAN/XII-G-0049 subgrant.

5. **Project Goals:**

The major long-term objectives of North Carolina State University's collaborative nutrition projects with EMBRAPA and EMEPA are:

i. To determine the nutritive value of local feedstuffs which could be used for dry season supplementation of goats and sheep.

ii. To develop practical guidelines for dry season supplementation.

6. **Specific Objectives for 1983-84:**

Much of the effort of this project since 1980 has been devoted to work with growing kids and lambs in confinement or semi-confinement during the dry season, using mixed rations based on corn crop residues. The emphasis this year has shifted to the adult doe, raised either to produce kids for slaughter or as a dairy animal.

The economic environment of Northeast Brazil dictates that a major part of the nutrition of small ruminants should come from grazing in the caatinga brushland at any time of year, and that pen-feeding should be seen as a strategy to help animals get through the critical periods of their production cycle--especially when the latter coincide with the periods of nutrient deficiency from the herbage on offer in the caatinga. Supplemental minerals, energy, or protein may be needed, especially during the latter part of the dry season. The projects currently underway with mature breeding does are designed to test their response to supplemental minerals, and to learn exactly what levels of intake are being achieved by mature does when they graze the caatinga at different times of the year and in different stages of gestation or lactation.

7. **Work Undertaken and Technical Accomplishments, 1983-84:**

i. Corn plant residues and molasses in dry season post-weaning diets for confined and semi-confined SRD kids. (T. W. Robb, N. N. Barros, E. R. de Oliveira, W. L. Johnson.)

This project has been completed and articles have been submitted

Table 1. Corn residue diets for confined or semi-confined weanling SRD goats in Northeast Brazil.

Item	Treatment No. 1	2	3	4	5
Treatment Descriptions					
Dietary Corn Stover (%)	50	40	30	30	30
Dietary Molasses (%)	5	5	5	0	5
Confinement	yes	yes	yes	yes	no
Results					
Average Daily Gain (g)	37	49	62	30	73
Average Daily Feed Consumption (g)	781	736	662	574	720
Carcass Yield (%)	42	41	42	43	54
Digestibility (%):					
Dry Matter	53	58	70	66	77
Neutral Detergent Fiber	40	37	41	28	56
Crude Protein	53	61	68	69	76

for publication. Treatment descriptions and a summary of results are shown in Table 1.

Comparing diets 1, 2 and 3, one can see that weight gains were improved by decreasing the level of corn stover and increasing the level of ground corn grain and cottonseed cake (which comprised the balance of all rations). However, even with treatment 3 (30% corn stover, 5% molasses, 65% corn/cottonseed meal) the rate of gain was only half that achieved in previous trials with native Santa Ines and Morada Nova sheep. The results with sheep, it should be noted, were obtained with a diet resembling that of treatment 1 in the present trial with goats. Apparently, there are inherent differences between the two species (as represented by Brazilian tropical breeds) in their ability to utilize a medium-fiber diet for rapid weight gains.

This trial also demonstrates that when diets for growing kids are based on corn stover residues, inclusion of molasses seems to be beneficial for feed consumption, weight gain, and diet utilization (treatments 3 vs. 4). Also, semi-confinement (i.e. 12 hours of grazing in the caatinga and 12 hours access to a complete ration) promoted better animal performance and diet utilization than did total confinement (treatments 3 vs. 5).

ii. Evaluation of copper and zinc supplementation for SRD goats. (N. Barros, J. W. Spears, W. L. Johnson. T. W. Robb.)

This project is being conducted on two private farms, one near Sobral and the other near the Ceara-Piaui state line. Treatments are:

Control (no mineral supplementation).
Copper supplementation.
Zinc supplementation.
Copper and zinc supplementation.

Eighty-five mature female animals on one farm and more than 100 on the other have been divided into four uniform groups, to receive the four treatments. Copper is being administered as injectable copper sulphate and zinc in the form of ruminally placed zinc impregnated iron oxide pellets. An additional 10 animals at the CNPC station are being used to determine the longevity of the zinc pellets in the rumen.

Data have not yet been sufficiently analyzed to allow reporting of results.

iii. Chromic oxide prediction of fecal output of grazing goats. (Helaine Burstein, Expedito Lopes, T. W. Robb, W. L. Johnson.)

This project was conducted during the period of June - August 1983. Comparisons were made of fecal output estimations of goats using a total fecal collection method or using chromic oxide as an indirect marker. The correlation coefficient of predicted fecal output and actually measured fecal output was .73 with a standard error of .21. It is felt that this correlation is sufficiently high to warrant the use of chromic oxide in the prediction of fecal output, which will simplify the process of collecting data related to animals grazing in the caatinga.

iv. Effect of breeding season of native goats on milk production and kid growth. (Helaine Burstein, Luiz C. Freire, Expedito Lopes, W. L. Johnson, T. W. Robb.)

In this project, native goats are being bred to kid either at the start of the rainy season or toward the end of the rainy season. The hypothesis is that judicious supplemental feeding to promote estrual activity prior to breeding in the dry season, with the goal of having kidding occur coincident with the start of the rains, will result in higher levels of milk production, better kid growth, and improved economic returns, when compared to the normal pattern of allowing does to be bred at the start of the rains and thus kidding when optimal feed availability is already past.

Observations in this experiment include feed intake of animals while grazing in the caatinga; in vitro digestibility and chemical composition of the grazed caatinga herbage; reproductive performance; and milk yield and persistency of lactation in the post-partum female.

This project was initiated in October, 1983. No data have yet been summarized and therefore results cannot be presented.

v. Buffel grass and sorghum hays, with or without energy

supplementation, for lactating goats. (T. W. Robb, W. H. Sousa, C. A. Zometa, W. L. Johnson.)

This project, which has been completed and submitted for publication, was carried out at EMEPA's Pendencia station in Paraiba. German Alpine and Anglo-Nubian goats were used to evaluate milk production when fed either buffel grass hay or sorghum hay ad libitum, with or without energy supplementation. Treatment descriptions and a summary of results are presented in Table 2.

Table 2. Two hays with or without supplemental energy for lactating goats in Paraiba.

Item	Treatment No. 1	2	3	4
Treatment Descriptions				
Hay Source	Buffel Grass		Sorghum	
Supplemental Corn, g/day	0	400	0	400
Results				
Milk Yields, g/day	856	1,044	1,000	1,367
Fat Yields, g/day	30	38	40	50
Digestibility (%):				
Dry Matter	66	76	67	68
Crude Protein	68	75	71	68
Neutral Detergent Fiber	63	67	65	61

The milk and milk fat yields in Table 2 are for the first 90 days of the lactation period. Under these conditions, sorghum hay proved to be superior to buffel grass hay. Also, energy supplementation of both hays proved advantageous in terms of milk and milk fat yields.

vi. Supplemental diets with cottonseed cake or Canavalia ensiformis for lactating goats. (T. W. Robb, C. A. Zometa, W. H. Sousa, W. L. Johnson.)

Since protein is the most expensive component of purchased supplements, this project was designed to evaluate the substitution of cottonseed cake by Canavalia ensiformis ("Feijao de Porco," or jack bean) as a protein supplement for lactating dairy goats receiving sorghum green chop ad libitum and 400 g per day of ground corn. This project has been terminated and submitted for publication. Treatment descriptions and a summary of results are shown in Table 3.

Table 3. Protein sources for lactating goats in Paraiba.

Item	Treatment No. 1	2	3	4
Treatment Descriptions				
Supplemental Protein (%) from:				
Cottonseed Cake	100	67	30	0
Canavalia Ensiformis	0	33	67	100
Results				
Milk Yield (g/day)	1,028	871	789	763
Milk Fat Yield (g/day)	22	19	19	20
Dry Matter Intake (g/day)	1,688	1,724	1,821	1,866
Digestibility (%):				
Dry Matter	70	66	63	61
Crude Protein	77	66	64	64
Neutral Detergent Fiber	80	71	63	59

Although milk and milk fat yields decreased with increasing levels of Canavalia ensiformis, it is felt that this is a result of the increasing dietary roughage levels and subsequent decreasing DE intakes. Canavalia ensiformis at judicious levels and in proper combination with other dietary ingredients could be an economical source of protein for dairy goats in Northeast Brazil.

vii. Evaluation of the leguminous forages Canavalia ensiformis, Macroptilium penduncularis , Clitoria ternatea and Macroptilium atropurpureum. (T. W. Robb, J. J. Viana, W. L. Johnson.)

This project was designed to evaluate the four leguminous forages listed in the title as to their potential for producing high quality hay that could be used for supplementing animals during the dry season in Northeast Brazil. Forages were harvested at five different maturity stages: immature, pre-bloom, mid-bloom, full-bloom and mature - on June 15, June 30, July 15, July 30 and August 15, respectively. This project has been completed and a manuscript is in review. Table 4 lists some of the production and quality parameters measured in this trial.

It would appear that the forage Canavalia ensiformis is the superior forage to the other three tested, both on the basis of quality and productivity.

Table 4. Productivity and nutritive value of four forage legumes in Paraiba.

Forage[a]	Harvest Date				
	6-16	6-30	7-15	7-30	8-15
Dry matter yield, kg/ha					
CE	2,048	2,744	3,310	3,498	4,478
MP	1,124	2,628	2,702	3,470	2,006
CT	382	778	1,090	1,068	1,338
MA	318	874	912	1,318	818
Nitrogen yield, kg/ha					
CE	84	117	149	156	219
MP	44	98	101	99	67
CT	20	45	59	49	64
MA	15	39	39	47	32
In vitro dry matter digestibility, %					
CE	76	81	78	83	75
MP	79	76	73	73	67
CT	73	76	74	76	69
MA	65	65	68	68	63

[a]CE = Canavalia ensiformis, MP = Macroptilium peduncularis, CT = Clitoria ternatea and MA = Macroptilium atropurpureum.

8. Collaborating Personnel:

Senior Investigators: Nelson N. Barros, CNPC[1]
Ederlon R. de Oliveira- CNPC[2]
T. W. Robb, NCSU
W. L. Johnson, NCSU (Principal Investigator)

Research Associate: Helaine J. Burstein, NCSU[3]

Collaborators: Wandrick Hauss de Sousa, EMEPA[4]
Joao Janes Viana, EMEPA
Luiz Carlos Lopes Freire, CNPC
Expedito A. Lopes, CNPC
Carlos A. Zometa, Texas A&M University
Jerry W. Spears, NCSU
Maria Auxiliadora Vasconcelos, CNPC[5]
H. R. Gaskins, NCSU[6]

[1]Centro Nacional de Pesquisa em Caprinos (National Goat Research Center)
[2]On leave for PhD. study at Utah State University
[3]PhD candidate
[4]Paraiba State Agricultural Research Agency
[5]Post-baccalaureate intern

1. Project Title: Nutrition and Feeding Systems for Small Ruminants in Indonesian Villages.

2. Institutions:

Animal Husbandry Research Institute, Bogor
North Carolina State University

3. Principal Investigator: William Johnson

4. Funding, 1983-84:

$85,733 allocated from AID/DSAN/XII-G-0049 subgrant.

5. Project Goals:

i. Study existing village feeding systems for small ruminants, including a survey of feeds utilized and their nutritive value, and estimates of daily intake and animal productivity.

ii. Determine animal response to improved diets of known composition which incorporate feed ingredients actually or potentially available in the villages.

The specific objectives for 1983-84 are implicit in the 26 project titles in the sections that follow, including 13 that were completed during this period and 13 that are still in progress.

6. Projects Completed and Technical Accomplishments, 1983-84:

i. Monitoring of small ruminant production in West Javanese villages. (I. W. Mathius, J. E. van Eys, H. Pulungan, M. Rangkuti, A. Prabowo, W. L. Johnson)

Analysis of the first year's monitoring data has been completed. The majority of the results have been summarized and published as SR-CRSP working papers or presented at national and international meetings. Part of the results, particularly the data on chemical composition of sheep and goat diets, have been analyzed but not yet been prepared for publication.

In February 1983, the second year of monitoring sheep and goat production under village conditions was started. Questionnaires and sampling techniques were reviewed and changed according to experience from the first year. One more village was added to the monitoring program, giving a total of four villages. As in the first year, monitoring was carried out as a multi-disciplinary activity involving all SR-CRSP disciplines. The nutrition observations were made on two consecutive days on each farm (30/village) in order to determine feed source, amount of feed collected, amount of feed offered, and refusals. Attention was paid to the feeding of individual animals and to amounts and frequency of supplementation. Feeds and refusals were sampled for botanical and chemical composition.

Results of the first year show important differences in small ruminant production systems between the three villages studied. Since the villages were selected as representatives for three different environmental and socio-economic strata in West Java, the results may be taken as representative for each strata.

Table 1 shows the average size and structure of sheep and goat flocks in three West Javanese villages. Flock size was relatively larger in Ciburuy and similar in Garut and Cirebon. The larger flock size in Ciburuy is likely to be associated with higher feed availability. Relationships between flock size and a number of management characteristics of the small ruminant production system indicated that labor requirements for feed provision and consequently feed availability was a major determinant of flock size. Other, as yet unidentified, factors must also be influencing flock size as flock sizes did not respond to seasonal changes in feed availability.

Size of the sheep and goat flocks within villages did not differ significantly. In many aspects, farmers within each village seem not to make distinctions between sheep and goats. However, in terms of feeding, goats are exclusively fed cut forage or harvested by-products in confinement while sheep are frequently allowed to graze.

Flock structure differed greatly between villages. The proportion of mature males to females was high in Ciburuy but low in Garut and Cirebon. This is expected to be the major reason for higher numbers of pre- and post-weaned animals in Ciburuy vs. Garut. The lower number of young sheep in Cirebon cannot be attributed solely to the low male:female ratio. Lamb mortality has been identified as an additional major factor.

The poorer management conditions for sheep in Cirebon are also reflected in lower live weights. In particular, ewe weights in Cirebon were lower than in Garut and Ciburuy. The lower average weights of pre-weaning young is likely to be associated with the lower ewe weight. These differences could not be observed in goats.

Data on litter size and young weaned per available mature female (Table 2) underline the conclusion drawn from the differences in male:female ratios, as well as the importance of feed availability. Where feed is not a limiting factor, such as in Ciburuy, and farmers do not object to keeping an additional (male) animal, the number of dry and unproductive ewes or does is drastically decreased. Increased forage production through the introduction of improved grass and legume species may alleviate this problem. Field trials on the introduction of these species on marginal lands are planned for 1984-85.

Litter size in Garut was significantly larger than in Ciburuy or Cirebon, with no substantial differences between Ciburuy and Cirebon in sheep or goat litter sizes. Despite the higher litter size, pre-weaning gain of lambs was higher ($P<.05$) in Garut with no differences between Ciburuy and Cirebon. Post-weaning gain was smiliar for male and female lambs and goats except for ram lambs in Garut where daily

Table 1. Average size and composition of sheep and goat flocks in West Javanese villages ($\bar{X}$±SEM)[1].

Location	n	Flock size	Mature		Post-weaning		Pre-weaning[2]
			Male	Female	Male	Female	
Sheep							
Garut	30	5.5± .3	.25±.08	3.54±.16	.35±.06	.42±.07	.97±.10
Ciburuy	22	8.3± .6	.87±.07	3.31±.38	1.02±.21	1.57±.22	1.27±.23
Cirebon	17	5.2±1.5	.36±.09	3.07±.27	.40±.11	.80±.14	.68±.11
Goats							
Ciburuy	6	7.3±1.0	.86±.20	2.57±.39	.97±.34	1.46±.45	1.10±.35
Cirebon	13	4.7± .4	.31±.11	2.52±.27	.39±.13	.64±.19	.53±.16

[1]Each value is the average monthly count for all farms (n) per location over a one-year period. Flock structure is therefore based on animal-months per farm.

[2]"Mature" = older than one year; "post-weaning" = 4-12 months old; "pre-weaning" = 0-4 months old.

gain was almost twice as high as for females. In addition to being more agressive feeders, ram lambs in Garut are provided with a qualitatively better diet than other animals in the flock. This is likely related to their superior economic and recreational value. It indicates, nowever, that farmers are familiar with the principle of strategic feeding and are able to select qualitatively superior portions in their cut-and-carry forages. Future field trials should capitalize on these facts, especially in light of the fact that live weight gains of pre- and post-weaning lambs and kids are far below the estimated potential of approximately 150 and 75 g/head/day for local sheep and goats, respectively.

The amount of feed provided can generally be considered to be adequate. However, the large variability among farms indicates that on a small number of farms in each village the amount of feed is insufficient for meeting maintenance requirements. In a larger group of farms the quality of feed provided may appear to be adequate but

Table 2. Litter size, animals weaned per available mature female, pre-weaning and post-weaning daily gain of small ruminants in three West Javanese villages.[1]

	Litter Size[2]	Animals Weaned per Available Mature Female[2,3]	Average Daily Gain		
			Pre-Weaning[4]	Post-Weaning[5] Males	Post-Weaning[5] Female
Sheep					
Garut	1.9±.2	.66±.08	74.4^{Aa}	53.9^{Ba}	28.5^{C}
Ciburuy	1.3±.1	1.17±.23	53.8^{Ab}	37.7^{Bab}	31.6^{B}
Cirebon	1.2±.1	.57±.11	62.5^{Ab}	22.5^{Bb}	20.5^{B}
Goats					
Ciburuy	1.1±.1	.93±.27	40.9	26.9	23.2
Cirebon	1.2±.1	.59±.18	63.8^{A}	32.9^{B}	35.3^{B}

[1]Based upon averages per farm; gains are expressed in g/head/day.

[2]X±SEM.

[3]Total number of lambs/kids weaned per farm over one year divided by the average number of mature females present.

[4]Zero to 4 months of age.

[5]Between 4 and 12 months of age.

A,B,C, Means of A.D.G. in the same row with different superscripts are significantly ($P<.05$) different.

a,b,c, Means of ADG in the same column, within each animal species, are significantly ($P>.05$) different.

does not allow for maximum selectivity, thus effectively reducing intake. Consequently, on a significant number of farms feed quantity may be a serious constraint to animal productivity. Furthermore, it seems unnatural that sheep are often allowed to graze while goats, with probable superior ability to select a more nutritious diet from poor forages, are kept exclusively under a cut-and-carry system. It is recognized that management, in particular herding, of the young goats constitutes a problem for farmers. Development of workable systems which solve this problem should be considered.

From a nutritional point of view the major constraint to small ruminant production under village conditions is the quality of the diet offered. The botanical composition of the cut-and-carry forage was analyzed (Table 3) for 1981-82.

Table 3. Proportions of feed ingredients of hand-fed small ruminant diets, and frequency of ingredient usage.[2]

		Garut		Ciburuy		Cirebon	
Feed Type	Season	%[1]	F[2]	%	F	%	F
Grasses[3]	Wet	65.2	95.2	91.4	100.0	61.8	72.4
	Dry	74.3	96.1	94.1	100.0	80.0	76.7
Herbs	Wet	3.1	12.0	3.7	18.2	11.3	11.2
	Dry	2.7	11.0	2.9	19.4	1.9	2.4
Crop By-Products	Wet	20.8	66.8	2.7	21.1	12.8	10.5
	Dry	10.6	39.4	1.9	14.5	2.8	15.2
Shrub and Tree Leaves	Wet	9.8	35.1	.6	4.5	12.2	21.3
	Dry	11.5	38.7	1.8	4.2	15.0	18.2

[1]Proportion expressed as a percentage of the total feed offered (as-fed basis).

[2]Frequency of ingredient usage (F) = percent of monitored flocks receiving each feed category.

[3]Including sedges.

Results indicate that a majority of the diet consisted of low quality grasses. Unpublished results of the chemical composition of these grasses showed average total cell-wall fiber (NDF) values of 63.6±2.0% and 63.7±1.7% for the wet and dry seasons, respectively. Corresponding values for lignocellulose (ADF) were 37.3±1.3% and 38.9±1.4%, respectively. Such high concentrations of cell-wall constitutents cannot be compensated for by other components of the diet as even shrub and tree leaves which had the lowest level of NDF

and ADF average 49.7±3.9% for NDF and 38.7±3.6% for ADF. In addition to the high NDF concentration, in vitro digestibility of the cell wall fraction of native grasses is low: 50.3±2.8%. In vitro cell-wall digestibility for other components of the diet were even lower: 35.2±2.2% for herbs, 27.5±9.2% for shrub and tree leaves, and 40.0±15.0% for crop byproducts. This is clear evidence that digestible energy intake constitutes the major limiting nutritional factor to increased animal productivity. Shifting the composition of small ruminant diets to include higher levels of shrub or tree leaves will not necessarily improve nutritional status in terms of digestible energy. Introduction of more nutritive forage species could be considered but changes in harvest methods (in particular cutting time or maturity) and diet composition (inclusion of new and different forage sources to optimize utilization of the low quality components) may be more efficient and may lead to more immediate results.

Higher quality tree legumes and crop by-products such as cassava leaves appeared only in very low proportions in the diet. Where the frequency of feeding of such forages was high, as in Garut, animal performance was also high. It seems unlikely that the positive effect of such ingredients is solely due to their higher level of crude protein. The overall range in crude protein for village feedstuffs was 7.1 to 30.3% with average values for the various forage classes considerably in excess of NRC requirements for all classes of sheep and goats. The quality of this protein is not known and may be limiting, given the high levels of cell wall constituents and often high solubility.

This needs to be investigated.To determine which management factor had a decisive effect on small ruminant productivity under the existing system of production, feeding and management characteristics were analyzed and related to daily gain. In general, the relation for each individual factor was poor, as might be expected given the complexity of the farming systems and the extreme variability among and within farms.

Significant positive relationships were observed between daily gains for most animal classes (based on age) and the amount of feed provided (total or per kg of body weight). Forage quality in terms of maturity and condition was also related to animal performance. Weight gains decreased with advancing forage maturity and poor condition (drying and soiling). Such relationships indicate that under the current production systems, improvements are possible by increasing the amount of feed offered (equivalent to improving the opportunity for selection) and emphasizing the need to provide fresh, clean forage in the vegetative stage of maturity. Exceptions should be made for those crop by-products and tree leaves which require wilting before feeding.

No consistent relationships could be detected between average daily gain and salt or concentrate provision (largely not practiced), watering, grazing time or frequency of feeding. Also, within each village, flock size and flock weight were not related to daily gain per farm or animal, suggesting that improvements in feeding and management are likely to be an equally effective way to increase small

ruminant productivity on farms with small or large flocks.

A large number of feeding, management and associated factors were studied. Most striking, however, was the relationship between non-live-stock related activities and animal productivity. These differed among villages. In Garut and Cirebon, farmers whose main occupation was agricultural-oriented ranked among those with the highest productivity in terms of average daily gain (ADG) of their animals. In these villages the lowest ADG's were observed for small ruminant holders which had non-agriculture-oriented occupations (hired labor in town, fishing, home industries). In Cirebon, on the otherhand, maximum ADG's were observed for small ruminant holders who had non-agricultural occupations (hired labor on rubber estate or in nearby town) and persons who had only an agriculture-related occupation realized the lowest levels of daily gain in their small ruminants. These factors, which largely reflect a farmer's economic necessities or his cultural and sociological motives must be taken into consideration when attempts are made to improve animal productivity at the village level. Farmers' meetings, as they are currently conducted, should focus on these important distinctions among small ruminant producers.

ii. Utilization of Gliricidia maculata as a supplement for growing sheep and goats fed chopped napier grass. (M. Rangkuti, I. W. Mathius, J. E. van Eys)

Sixteen local sheep and goats were randomly allocated to four diets. All animals were fed chopped napier grass ad libitum. Sheep received 0, 500, 1000 or 1500 g/day of withered gliricidia leaves; goats received 0, 300, 600 or 900 g/day. Napier grass and gliricidia were fed separately. Changes in intake and body weight were recorded over a 12-week period followed by a seven-day digestibility tria].

Intake of all nutrients, expressed as g/head/day or g/kg of body weight$^{.75}$, were higher ($P<.05$) for sheep than for goats. Intakes of dry matter (DM), crude protein (CP), gross energy, calcium and phosphorus were constant across diets for both sheep and goats. Across those diets which included the legume, sheep utilized gliricidia for 80% as a substitute and 20% as a supplement to napier grass. The goats substituted only 45% of napier grass for gliricidia. The sheep and goats digested DM and CP similarly. However, digestibilities of total cell-wall fiber (NDF) and energy were higher ($P<.05$) for goats, reflecting their ability to select a more nutritious diet. Increased levels of gliricidia intake did not affect digestibility of DM or CP in either species but increased ($P<.05$) digestion of NDF and energy in goats. There were large differences in growth rate between sheep and goats. Average daily gains (ADG) increased with level of gliricidia feeding. For sheep mean ADG was 35, 41, 56 and 63 g/head/day and for goats 7, 18, 25 and 28 g/head/day on the four levels of gliricidia feeding, respectively.

iii. Intermittant feeding of Gliricidia maculata as a supplement to napier grass for local goats: intake, digestibility and weight gains. (M. Rangkuti, H. Pulungan, J. E. van Eys)

Sixteen growing male goats of 10 to 15 kg body weight were stratified on the basis of their body weight and subsequently assigned to four treatment groups which received gliricidia leaves in the following amounts and intervals, as a supplement to chopped napier grass fed ad lib:

a. No supplement (control)
b. 300 g gliricidia per day
c. 450 g gliricidia on two consecutive days followed by one day without gliricidia
d. 900 g gliricidia on the first day followed by two days without gliricidia.

Animals were kept in individual pens with dual-compartment feed bunks such that refusals of napier grass and gliricidia could be measured separately. A 12-week feeding trial was followed by a 2-week digestibility trial.

Feeding equal amounts of wilted gliricidia either daily (b) or intermittantly (c or d) did not change utilization of the basal diet (napier grass) or of the gliricidia. Goats that received gliricidia every day gained 54 g/head/day, whereas average daily gains for all three treatments with gliricidia were 24 g/head/day.

iv. Leucaena leucocephala supplementation of napier grass diets for growing sheep. (Armiadi Semali, I. W. Mathius)

The experiment was carried out in randomized complete block design with four growing ram lambs per treatment and four levels of supplementation. The levels of fresh leucaena supplementation were 0, 500, 1000 and 2000 g/head/day. Napier grass and leucaena were fed separately and animals were penned individually. A 10-week feeding trial was followed by a 2-week digestibility trial.

Supplementation with leucaena increased the DM and CP intake ($P<.001$) but digestibility of DM and CP was maximized at supplementation with 500 g fresh leucaena. Although leucaena increased ($P<.05$) ADG at all levels of supplementation, ADG's of sheep were highest at the 1000 g level (46 g/head/day).

v. Utilization of napier grass with and without Sesbania grandiflora by growing sheep. (I. W. Mathius, J. E. van Eys)

Sixteen Javanese thin-tail sheep, 12 to 14 months old and averaging 14.3 kg, were stratified on the basis of body weight and randomly assigned to four treatment groups. Each sheep was placed in an individual pen and fed a basic diet of chopped napier grass, ad lib. Sesbania and napier grass were fed separately and sheep had free access to water and iodized salt. The following treatments were used:

a. No supplement (control)
b. 500 g fresh leaves of Sesbania grandiflora per day
c. 1000 g fresh leaves of Sesbania grandiflora per day
d. 2000 g fresh leaves of Sesbania grandiflora per day

The feeding trial lasted 6 weeks and was followed by a 2-week digestibility trial.

Supplementation increased intake of total dry matter (P>.05), but dry matter intake of napier grass was significantly (P<.05) decreased at the higher levels of sesbania supplementation. Apparent digestibility coefficients of dry matter, organic matter, crude protein and neutral detergent fiber (NDF) also increased (P<.05). Maximum average daily gains were achieved at the highest level of supplementation (2000 g). Efficiency of feed conversion increased sharply due to supplementation, but there were no differences among the three levels of supplementation. Maximum utilization of napier grass was achieved at a supplementation level of 500 g.

vi. Mineral supplementation of sheep fed native grass diets. (A. Prabowo, J. E. van Eys, W. L. Johnson, H. Pulungan)

Twenty Javenese thin-tail lambs (average weight 15 to 20 kg) were maintained in individual stalls and fed a mixture of native grasses. The grass mixture was similar to grasses fed under village conditions where they represent the major fraction of the total diet. Lambs were divided into four groups receiving no mineral supplement, salt, salt + $CaPO_4$ or a complete mineral mix. Dry matter intake and changes in live weight were recorded during a 3-month period. At the beginning of the trial and at 4-week intervals blood samples were taken from the jugular vein for serum mineral analysis and other characteristics. At the end of three months, balance trials were carried out (7-day preliminary period, 7-day collection period) to determine digestibility and mineral retention. Also, three animals were slaughtered at the beginning of the trial and all remaining animals were slaughtered at the end of the trial. Samples from liver, kidney, spleen and bone (rib) were analyzed for mineral composition.

Supplementation of native grass diets with salt, $CaPO_4$ or a complete mineral mix increased (P<.05) DM intake and ADG. DM intake as well as weight gains were highest for sheep receiving a salt plus calcium phosphate mixture. Additional provision of microminerals did not increase animal performance.

vii. Chopped cassava root as an energy supplement for growing lambs fed napier grass. (H. Pulungan, I. W. Mathius, A. Prabowo)

Cassava root, chopped and soaked in water for 24 hours, was fed to growing Javanese thin-tail lambs with live weights of 13.7±1.6 kg. Fifteen lambs were divided into three groups receiving 0, .5 or 1.0 kg chopped cassava root and having free access to chopped napier grass. Animals were fed individually. Intakes are recorded daily and changes in live weight weekly. A digestibility trial was carried out at the end of the 3-month feeding trial.

Feeding of chopped and water soaked fresh cassava root did not change DM intake but decreased crude protein and NDF intake (P<.01) due to the decrease in napier grass intake. DM digestibility also was not affected by supplementation, but at the 1000 g level of cassava root

feeding both CP and NDF digestibilities were significantly (P<.01) decreased. Digestibilities of CP and gross energy were highest when 500 g cassava roots were included in the diet; ADG's of lambs were also maximized at this level.

viii. Cassava leaf meal as a supplement for growing sheep fed chopped napier grass. (B. Sudaryanto B., I. W. Mathius, M. Rangkuti)

The experiment was carried out over a 10-week period (9-week feeding trial, 1-week digestibility trial) to evaluate the utilization of cassava leaf meal as a supplement for sheep fed chopped napier grass. A completely randomized design was used.

Twenty growing male lambs with initial body weights of 13±1.8 kg were used in this trial. All animals were fed napier grass ad lib. plus cassava leaf meal supplement at four levels:

a. No supplement (control)
b. 50 g/day cassava leaf meal
c. 100 g/day cassava leaf meal
d. Cassava leaf meal ad lib.

Sheep were penned individually and the two feeds were offered separately.

Increased levels of cassava leaf meal increased (P<.01) intakes of DM, CP and NDF, while digestibilities of DM and NDF were not different among treatments. Digestibility of CP increased linearly with level of supplementation. ADG of lambs increased with higher levels of cassava leaf meal but this was only significant (P<.01) for lambs receiving the supplement ad lib. These results are in agreement with previous experiments using wilted cassava leaves.

ix. Utilization of napier grass-cassava leaf mixtures supplemented with corn meal or rice bran by growing sheep and goats. (I. W. Mathius, J. E. van Eys, M. Rangkuti)

Individually-penned growing intact male sheep (average body weight 11.5 kg) were offered dried cassava leaves and fresh chopped napier grass ad lib. in separate feed bunks. The napier grass-cassava leaf diet was fed alone or supplemented with 100 g of corn meal or rice bran. A 20-week feeding trial was followed by a two-week (one-week preliminary) digestibility trial.

Intakes of DM and CP increased (P<.05) for sheep and goats when fed cassava leaves and corn meal or rice bran, but differences between the two supplements were small. Nutrient intake was lower (P<.05) for the goats compared to the sheep. Apparent digestibility of DM and CP did not differ between the two animal species. Supplementation with cassava leaves decreased (P<.05) digestibility of organic matter (OM) but addition of corn meal or rice bran resulted in OM digestibilities equal to that of napier grass. Apparent digestibility of CP was higher (P<.05) on napier grass diets. Type of supplementation had no effect on apparent digestibility of CP. Digestibility of NDF was not

affected by supplementation and was similar for sheep and goats. Average daily gains differed (P<.05) between the animal species and were highest on the rice bran diets.

x. Feeding value of fresh and ensiled tropical grasses for growing sheep. (J. E. van Eys, I. W. Mathius, H. Pulungan, W. L. Johnson)

Nine stack silages (1000 kg each) were prepared from three tropical grasses, cut at the anthensis-flowering stage of maturity. The grasses were napier grass (Pennisetum purpureum, guinea grass (Panicum maximum) and signal grass (Brachiaria brizantha). Three silages were prepared from each grass. Leaves and stems of napier grass and guinea grass were chopped by hand at 5 to 10 cm length. To all silages 15 kg of molasses were added. Silages were opened after two months. Each silage was fed to five lambs and at the same time five lambs were fed each grass as green material. Fresh grasses were of comparable maturity and quality as those used to make silages. The sheep were intact males of 8 to 12 months, with an initial mean live weight of 14.8 kg. Lambs were randomly assigned to treatment groups, kept in group pens and had free access to water and a complete mineral mixture. Fresh herbages and silage were fed ad lib.; total feed offered was 40% in excess of daily intake. Following an adaptation period and a one-week preliminary period, a 10-week feeding trial was carried out. At the end of the feeding trial an eight-day digestibility trial was conducted with four sheep per treatment.

Silages had higher levels of NDF, ADF and lignin and lower concentrations of crude protein than the fresh material. Intakes (g/kg BW) of ensiled and fresh grasses were not significantly different (P<.05) but differed among grass species. Intakes were highest on guinea grass and lowest on napier grass. Sheep fed fresh material had higher (P<.05) daily gains than those fed ensiled grasses. On napier and guinea grass silages, the sheep were able to maintain weight, but the sheep on signal grass lost weight.

Weight loss on ensiled signal grass was higher than on the fresh grass (43 vs. 14 g/head/day). Feeding of signal grass silage was discontinued after six weeks due to poor condition and death of some sheep. Digestibilities of dry matter, CP and ADF, were lower (P<.05) for silage of napier grass compared to green napier grass. Apparent digestibility of CP was also lower (P<.05) in guinea grass silage but NDF digestibility was similar to the green material.

xi. Observations on Brachiaria toxicity in sheep. (Tri Budi Murdiati, Paderi Zahari, D. H. Stoltz, J. E. van Eys, A. J. Wilson)

This was a cooperative project between the Research Institutes for Animal Diseases and Animal Production in Bogor.

In the course of nutrition experiments at BPT Bogor a syndrome resembling facial eczema was observed in sheep fed Brachiaria grasses. Post-mortum observations were carried out on affected sheep. Fresh and ensiled Brachiaria used in the feeding experiment were examined to identify the fungus Pithomyces chartarum. Fungal

material from a reference of P. charterum was fed to guinea pigs in order to study the toxic syndrome.

Sheep fed Brachiaria grass, green or ensiled, and which died, exhibited symptoms resembling facial eczema. Post-mortum observations indicated that the main organ affected was the liver where severe lesions were observed, associated with the portal system. Major changes were bile duct hyperplasia, necrotising cholangitis, perioportal fibrosis and lymphocyte infiltration, leakage of bile through the liver and local degenerative changes in hepatocytes. Change in other organs included nephrosis of the kidney tubules and haemosiderin deposition in the spleen. The observation of pathology characteristic for facial eczema, and its association with Brachiaria, a common substrate for Pithomyces chartarum, strongly suggest that the toxic syndrome observed is indeed facial eczem.

Attempts to culture the fungus from dead grass and from the air surrounding a plot of Brachiaria onto Sabouraud's agar have not yet yielded cultures identifiable as Pithomyces. Fungal spores washed from Brachiaria have been compared to those produced from a reference culture and found to be morphologically similar. Fungal material from a reference of P. chartarum was fed to guinea pigs. Lesions similar to those seen in sheep showing Brachiaria toxicity were induced, suggesting that the reference strain is toxigenic.

xii. Carcass characteristics and adipose tissue distribution in Indonesian and crossbred male sheep. (Henniawati, P. Sitepu, J. E. van Eys, D. A. Little)

This was a cooperative project between the Ciawi and Bogor nutrition groups of BPT. Three groups of rams were slaughtered and dissected: (1) Twenty young Javanese Thin-tailed (JTT), mean LW 14.7 kg; (2) Five mature JTT, mean LW 49.3 kg; (3) Eight mature JTT X British crossbred, mean LW 56.7 kg. Observations were made on dressing percentage, proportions of lean and bone, and fat disposition.

The dressing percentage of young JTT, mature JTT and mature JTT X British crossbred rams were respectively 39.6, 49.3 and 49.8%; there were no significant differences between the groups of mature rams due to cross-breeding. The carcasses of the mature JTT's and crossbreds contained the same proportion of lean and bone (approximately 51% and 18%, respectively). In this respect they were similar to African tropical sheep, but differed appreciably from temperate breeds recorded in the literature, which yield more lean and less bone. The bodies of the mature JTT and crossbred rams contained similar quantities of adipose tissue, but the JTT's had a significantly greater kidney fat depot and lesser carcass fat deposition than did the crossbred.

xiii. Utilization of soybean curd sludge as a supplement for confined sheep fed low quality grass mixtures. (H. Pulungan, J. E. van Eys)

Sixteen growing rams of 12.5±1.8 kg were divided into four treatment groups and fed a mixture of native grasses. Soybean curd sludge was

supplemented separately at 0, 1.25, and 2.5% of body weight and ad lib. A 12-week feeding trial was followed by a 2-week digestibility trial (1-week preliminary period).

Supplementation with soybean curd sludge increased (P<.05) intake and digestibility of DM, CP and NDF. Digestibility coefficients were similar at the high levels of soybean curd sludge feeding. Average daily gain increased linearly with level of supplementation to a maximum of 133 g/head/day. At ad lib. feeding of soyhean curd sludge voluntary intake of native grasses constituted 25.6% of the total DM intake. Efficiency of DM utilization was maximized at the highest level of supplementation.

7. Conclusions from Projects Completed.

Several conclusions can be drawn from the above results.

i. Performance of sheep and goats under similar nutritional regimes differ considerably. The exact nature of the differences between these two small ruminant species needs to be defined, for feed types as well as for individual feedstuffs.

In comparative studies, the growth potential of the two species must be considered. In order to evaluate feedstuffs for feeding sheep and goats in existing farming systems, more attention should be paid to the respective efficiencies of utilization of the two animal species.

ii. Feeding of protein supplements at levels above 10 to 15% of DM intake results in substitution and decreased utilization of the basal diet. The inclusion of alternative low-cost, high-energy feedstuffs in mixed diets of grasses and protein supplements should be studied. Indigestible cell-wall constituents still appear to be the most important limitation to increased intake of digestible energy. Composition and digestibility of NDF varies greatly among feedstuffs (especially supplements) and more detailed analyses of the NDF fraction (including its indigestibility) seem necessary.

iii. Intermittent (one time per three days) feeding of low levels of tree legumes appears to be as effective as daily feeding.

iv. Native grass diets require mineral supplements in addition to salt; phosphorus, particularly, is indicated.

v. Preservation of grasses in small conventional-type silos does not seem to be a practical alternative to drying and storage of crop by-products or grasses.

vi. At this moment Brachiaria species are not recommended as a major introduced grass for feeding small ruminants.

vii. By-products of the food industry such as soybean curd sludge are valuable feeds for high-producing animals. Further studies on their inclusion in mixed low quality diets are needed.

8. Work in Progress, April 1984:

i. Monitoring of small ruminant production in West Javanese villages. (I. W. Mathius)

Data analysis of the first-year monitoring activities has been completed. Organization of second-year monitoring results has been initiated. Questionnaire responses and measurements on flock composition, body weights of sheep and goats and characteristics of the feeding system are being prepared for computer analysis. Feedstuffs continue to be analyzed for fiber, protein, mineral composition and in vitro digestibility. Data from these analyses will be made available to INDOFIC (Indonesian feed composition data bank).

ii. Survey on small ruminant production in Sumatra. (H. Pulungan)

Results from surveys which were carried out in North and West Sumatra during the latter part of 1983 are being analyzed and prepared for summarization. These surveys will be used as orientation for future research to be conducted at the BPT research station in North Sumatra.

iii. Intermittent feeding of Gliricidia maculata as a supplement for sheep. (M. Rangkuti)

This trial was conducted according to the protocol described above for goats. Feeding and digestibility trials have been completed. Samples await laboratory analysis.

iv. Low level legume supplementation for goats fed chopped napier grass. (J. E. van Eys)

Sixteen male, intact goats are receiving gliricidia, sesbania and leucaena at 15% of their DM intake. A feeding (12 weeks) and digestibility (2 weeks) trial will be carried out.

v. Supplementation of cassava leaf-napier grass diets with concentrates of different protein quality. (I. W. Mathius)

This experiment is a follow-up of two previous experiments. Sixteen local sheep and goats, allocated to 4 treatments, are fed napier grass (ad lib.) supplemented with 1.5 kg wilted cassava leaves. The four treatments consist of (1) no concentrate supplement, (2) corn meal, (3) corn meal plus urea, (4) fish meal. A 12-week feeding trial followed by a 2-week digestibility trial will be conducted.

vi. Evaluation of cassava meal as an energy supplement for sheep and goats fed low quality grasses. (J. E. van Eys)

Feeding and digestibility trials and carcass analysis of sheep have been completed. Identical trials for goats are in progress. Five levels of cassava meal are being fed to 20 goats. The diets are isonitrogenous and the levels of cassava meal are 0, .45, .9, 1.35 and 1.8% of the body weight. The feeding trial will last for 3 months, followed by a 10-day digestibility trial. All goats will then be

slaughtered. Studies on mineral balance and retention are included in the project protocol.

vii. Utilization of soybean curd sludge as a supplement for confined goats fed low quality grass mixtures. (H. Pulungan)

The feeding and digestibility trials for goats, which followed identical procedures to the trials for sheep described above, have been completed. Samples are currently being analyzed in the laboratory.

viii. Preservation of soybean curd sludge and effects on protein quality. (H. Pulungan)

Formaldelyde-treated soybean curd sludge is being compared over time with untreated soybean curd sludge and soybean meal in terms of preservation characteristics and rumen solubility of protein.

ix. Protein quality in small ruminant diets. (P. Pongsapan)

A series of agricultural crop by-products, grasses (native and improved) and legumes are being analyzed for protein solubility in the rumen (in situ) and subsequent solubility in acid pepsin solution.

x. Effect of level of feeding on reproductive performance of Javanese sheep. (B. Tiesnamurti, I. Inounu)

One hundred and fifty ewes at the Cicadas experiment station were allocated to two nutritional regimes approximating 90 and 125% of NRC requirements. Data are being collected on ewe weights, litter size, birth weight of lambs, weaning weights, ovulation rates and embryonic mortality.

xi. Effects of level of feeding and litter size on milk production in Javanese ewes. (Sorta Silitonga)

Twenty-four ewes with single (12) or twin (12) lambs, were assigned to two levels of feeding (90 and 125% of NRC requirements). Milk production and composition was measured every two weeks by separating lambs and ewes for 12 hours and handmilking of ewes following oxytocin injections. Weights of lambs and ewes were recorded. Samples are being analyzed and data compiled.

xii. Production and composition of improved forages as affected by level of sulfur fertilizer. (J. E. van Eys)

Data have been collected over a one-year period on the production of Pennisetum purpureum, Panicum maximum, Brachiaria bryzantha, Setaria sphacelata and Centrocema pubescens. Total dry matter production and proportion of stems and leaves was evaluated in each of seven cuttings. Analyses of these data are in progress. Kinetics of cell wall digestion are being studied in vitro on stems and leaves of six and nine weeks regrowth.

xiii. Village on-farm trials. (Nutrition program staff)

Following termination of the monitoring activities in the four villages, field trials are being set up with a selected group of farmers on the basis of their cooperation during the monitoring program. For constant supervision and day-to-day care of the trials the monitoring staff is being employed and given special training. The trials will be based on information from the monitoring program and results of experiment station research. The following trials are planned:

a. Mineral supplementation. It is felt that these trials should receive first priority as they seem to be the most useful and are likely to produce the best results relative to the input required. Daily supplements in mixtures with rice bran or in mineral-molasses blocks with or without urea will be used. Suitable mineral-molasses blocks are currently being developed by Ms. S. Silitonga.

b. Supplementation with soybean curd sludge. These trials will be limited to locations where soybean curd sludge is available on a daily basis.

c. Creep feeding of lambs and kids using locally available feed-stuffs of good quality.

d. The nutrition group will participate in the introduction and evaluation of improved grass-legume mixtures or pure legume stands on small farms. This work will be carried out in cooperation with USAID-funded projects in the Citanduy watershed area and eventually in Provincial Development Program areas. In cooperation with staff from the Animal Health Research Institute, studies will continue on Brachiaria toxicity in areas where this grass has already been introduced.

The field trials will be carried out in conjunction with farmers' meetings. These meetings will be held monthly in rotation with the breeding, economics and sociology sub-programs. They will be used to provide farmers with background information, progress reports and final results. Planning and preparation of the field trials will involve consultation with other disciplines of the small ruminant research program.

9. Training Activities.

Several junior scientists are being supported for thesis research at North Carolina State University (see list below). Also, the Principal Investigator is serving on the committee of advisors for a BPT staff member (M. Sitorus) who is enrolled at the Bogor Agricultural Institute.

A major training contribution is the in-service advise and support to junior staff members on a daily basis, as they work together with Dr.

van Eys. This type of training also extends to the staff village workers and the laboratory support personnel.

The nutrition project has joined other SR-CRSP projects in Bogor in the support of a micro-computer consultant, Ms. Nancy van Eys. She has been very successful over the past year in training Indonesian junior scientists and support personnel in the programming and use of Apple and IBM microcomputers for data management and statistical analysis.

Dr. Neil Thomas, former SR-CRSP resident in Bogor, participated in training several Indonesians in the use of a simplified model of village production systems. This training was conducted in Raleigh in August 1983 for Budi Haryanto and Subandryo, as a two-week workshop; and in Bogor in November as a one-day workshop for several BPT staff members.

Travel to attend international meetings was supported for M. Rangkuti, I. W. Mathius, and A. Prabowo, who presented papers at the Fifth World Congress on Animal Production in Tokyo, August 1983. M. Rangkuti also was supported for travel to the SR-CRSP meeting in Lubbock, Texas, January 1984, with associated visits to North Carolina State University, Winrock International, and the University of California, Davis.

10. Collaborating Personnel.

Senior Investigators:

Marwan Rangkuti, BPT[1]
Hamzah Pulungan, BPT
J.E. van Eys, NCSU
W.L. Johnson, NCSU (Principal Investigator)

Research Associates

Budi Haryanto, BPT[2]
Wayan Mathius, BPT
Achmad Prabowo, BPT[3]
Marudin Sitorus, BPT[4]
Sorta Silitonga, BPT
P. Pongsapan, BPT
Kuswandi, BPT
Andi Djajanegara, BPT[5]
Alice Reese, NCSU[2]

[1] Animal Husbandry Research Institute
[2] PhD. candidates at North Carolina State University
[3] M.S. candidate at North Carolina State University
[4] PhD. candidates at Bogor Agricultural Institute
[5] PhD. candidates in Australia

Collaborators

Darwinsya Lubis, BPT
Prapti Mahyuddin, BPT
Leo Batubara, BPT (North Sumatra)
Abdul Rais, BPT[6]
Toha Sutardi, Bogor Agricultural Institute
Soedomo Reksohadiprodjo, Gadjah Mada University
Thamrin Panggabean, BPT[5]
M. Winugroho, BPT[4]
Neil Thomas[7]
H. R. Gaskins, NCSU[8]
Toxicology staff of BPPH[9]

[6] M.S. candiate at Bogor Agricultural Institute
[7] Independent consultant
[8] Technician
[9] Animal Health Research Institute

1. Project Title: Nutrition And Confinement Feeding For Sheep In Semi-Intensive Production Systems In Morocco

2. Institutions: Hassan II Institute for Agriculture and Veterinary Medicine, Rabat.
National School for Agriculture, Meknes.
North Carolina State University.

3. Principal Investigator: W. L. Johnson

4. Funding, 1983-84

$49,565 allocated from AID/DSAN/XII-G-0049 subgrant

5. Project Goals:

i. To characterize the nutritional value of byproducts, crop residues, and cultivated forages potentially available for feeding sheep or goats in partial or total confinement.

ii. To quantify the productivity of sheep or goats in relation to levels of energy, protein, and mineral intake.

6. Specific Objectives for 1983-84:

i. To conclude the study of the nutritive value of alfalfa in the Ziz valley.

ii. To continue studies on the utilization of rations with waste palm dates for sheep.

iii. To conduct a survey of sheep production practices in a dryland farming region near the Tadla irrigation perimeter.

iv. To study the effect of dietary energy levels on growth and carcass composition of Timahdit lambs.

7. Work Undertaken and Technical Accomplishments, 1983-84:

i. Nutritive value of alfalfa produced in the Ziz valley. (A. Boualil and F. Guessous.)

This study was conducted between March and November, 1982, at the ORMVA Experiment Station at Errachidia. This is a region of extremely low rainfall, on the edge of the Sahara desert where an expansive valley is irrigated by water from the Ziz river.

Irrigated alfalfa was sampled during seven consecutive harvest cycles, and at 14, 28, 42 and 56 days of regrowth within each harvest cycle.

The proportion of leaf dry matter (DM) in total DM harvested was higher in spring (>50% until the end of April) and fall (maximum 60%) than in summer (40 to 50% in July, the lowest month). Crude protein content paralleled leaf/stem ratios, varying within a range of 15 to 30% of DM.

Total cell-wall fiber, lignocellulose (ADF), and acid-detergent lignin increased with age of the plant, but only in spring and summer. In summer alfalfa was higher in cell-wall fiber constituents than in either spring or fall, at comparable stages of physiological development. At full bloom ADF content was about 30 to 32% in summer but only 25 to 26% in fall. In spring ADF content varied between 14 and 29% for forage in the vegetative and early bloom stages.

In vitro digestibility of the organic matter varied between 57 and 86%. At equal stages of physiological growth, summer forage was less digestible than in other seasons. Spring forage was highest in digestibility and fall forage was intermediate.

Total DM yield was up to 7 metric tons per hectare at any given harvest, reaching a total of 26 MT/ha for the entire season.

These results confirm that the nutritive value of alfalfa in the Ziz valley depends closely on the season within which it is harvested. The forage produced during the hottest month of summer, during which the mean temperature was 30.4°C, was inferior to that harvested in either spring or fall.

ii. Waste palm dates in diets for Moroccan sheep. (N. Rihani, F. Guessous, M. Khal, and W. L. Johnson.)

Two trials were conducted with sheep to evaluate digestibility, intake, growth and carcass yield for diets containing ground waste whole dates of palm (Phoenix dactylifera) grown in the oases of southeastern Morocco. The dates used were high (47%) in soluble carbohydrates and low (25%) in cell walls (NDF), but also low (3.7%) in crude protein (CP).

Trial I: Eight Timahdit rams were fed 1.3 kg ground alfalfa hay (AH) (34% NDF, 19% CP) with 0, 300, 600, or 900 g dates per day in a latin square design with four 21-day periods. Digestibility was estimated by total fecal collection during the final 7 days of each period. Diet influenced ($P<.05$) the digestibility of total organic matter (OM) (64, 68, 68 and 70% for the 4 levels of dates), NDF (44, 50, 50 and 56%) and CP (76, 69, 63 and 55%). Mean digestibility of date OM, calculated by difference, was 78±1.7%. Daily dry matter (DM) intakes per $kg^{.75}$ were 61, 71, 80 and 72 g.

Trial II: Six balanced groups of 8 wether lambs (average initial weight 17 kg), 3 groups each of D'Man (initial age 210 days) and D'Man X Sardi (DS) (120 days) were randomly assigned to one of 3 diets: 100% AH; 75% AH, 25% dates; or 50% AH, 50% dates. Diets were fed ad libitum for 65 days. Urea was added to diets with dates to equalize N concentration with AH. Mean daily DM intakes were 83, 92 and 96 g per kg.75 for the 3 respective diets. Diet influenced ($P<.01$) daily gain (48, 99 and 135 g) and carcass yield (48, 51 and 53%). Genotype by diet interactions were not significant. Across diets, daily gains were higher ($P<.01$) for D'Man (177 g), a reflection of the higher daily DM intakes per $kg^{.75}$ for D'Man (98 g) than DS (83 g).

Waste palm dates appear to be a satisfactory energy source for growing lambs at levels up to 50% of diet DM.

iii. Study of sheep production practices in a rain-fed agricultural zone, Tadla. (D. Ismaili, F. Guessous)

This project was conducted in the Beni Oukil rural community, to the northwest of the Tadla regional agricultural extension office. and bordering the phosphate-rich Khouribga plateau. This is an area which receives about 300 to 400 mm of rain per year, with May - September being quite dry and October - April relatively wet. Monthly mean maximum temperatures range from about 18°C in January to 40°C in July. Monthly mean minimum temperatures are about 2 to 4°C and 20°C in the same months. Wheat, barley and forage peas are the main crops. Farms of 0 to 5 ha in size constitute 43% of the total number of farms; only 3% of all farms are over 50 ha. Approximately half of the land area is used as "parcours" (communal grazing). Livestock production is the major cash-producing activity; cereal grains are more likely kept for home consumption.

Livestock feed is provided from grazing on wheat and barley stubble, communal pastures, and fallows, and from supplemental feeding with barley grain, pea vines, straw, sugar beet pulp, and wheat bran.

The farm survey in this region was made in two phases. A general survey of 80 farms, chosen to represent sub-zones of the region, was made in January - February 1983. A more intensive monitoring of lamb growth took place between November 1982 and May 1983 and included 169 lambs on 15 separate farms. The general survey was conducted with a single visit to each farm; the monitoring involved nine separate visits at 3-week intervals (except that the first and second visits were only two weeks apart).

Samples were collected of supplemental feeds that were observed being used on the 15 monitored farms.

The surveyed farms varied widely in flock size. About one-third kept less than 20 ewes; about one-third kept 20 to 50 ewes; and the remainder kept more than 50 ewes. Only 9% of the surveyed farms had more than 100 ewes in their flock.

Almost half of the farms surveyed also kept a few cows, but seldom more than 6 head and usually less. About 25% of the farms kept some goats; half of the goat herds numbered 6 or less, while half had more than 6 head.

It was interesting to note that very few ewe-lambs are kept as replacement breeding animals. Rather, they are sold when their permanent teeth start to appear, and mature ewes are bought from outside the region when replacement females are needed. The reason for this practice is that fluorine toxicity, a byproduct of phosphatic soils, causes the permanent teeth to be seriously flawed. An implication of this practice is the ease with which superior breeding animals could be introduced on the female as well as the male side, if such were to be found desirable.

In terms of reproduction, the fertility rate was about 90 to 100% during the year of the survey. Prolificacy was 100 to 105% on 73% of the farms, 105 to 110% on 17% of the farms, and 110 to 126 on 10% of the farms.

Feeding practices follow a calendar that is dictated by the weather and

by cropping practices. From February to May, when it is raining, the animals graze on fallow land and community pastures. During the dry months of June to August, grazing on wheat or barley stubble is most prevalent. During the remainder of the year various supplemental feeds are offered occasionally, as available. These include straw, wheat bran, dried beet pulp, pea vine hay, barley, alfalfa hay, and grazing barley in the vegetative growth stage (allowing the regrowth to set grain for harvest). The principal purchased feed is dried beet pulp, used by 85% of the farmers. Alfalfa hay is used by less than 20%.

On the 15 closely-monitored farms, nearly 75% of the lambing occurred between September and December. A second peak of 12% of the lambing occurred in April.

The chemical composition of feed samples from the 15 monitored farms is shown in Table 1.

Table 1. Mean chemical composition of feed samples from farms in the Tadla rain-fed agricultural region (% of total dry matter).

Feed	No. of samples	Crude protein	Total cell wall (NDF)	Lignocellulose (ADF)	Lignin
Barley straw	12	4.7	64	39	5.3
Hard wheat straw	6	4.9	67	43	6.8
Soft wheat straw	3	4.8	71	43	6.5
Barley grain	5	12.2			
Pea vines 5	15.4	46	36	6.9	

Lamb mortality on these 15 farms was about 7% up to 3 months of age; most deaths occurred within the first month.

Ewes, dams of the lambs which were monitored for weight change, weighed an average of 33.4 kg right after lambing. Three to 4 months later (late February) their average weight had declined to 29.0 kg, which is not an unreasonable weight loss for lactating animals.

The lambs themselves weighed about 3.0 kg at birth. They showed a steady gain of approximately 3 kg per month, as shown in Table 2., reaching an average weight of 18.8 kg at 5 months of age. Gains for male and female lambs were nearly the same.

Table 2. Weight gains of lambs on farms in the Tadla rain-fed agricultural region.

Age (days)	No. of lambs	Mean weight (kg)
Birth	13	2.9
10	169	4.2
30	167	6.5
60	160	9.3
90	157	12.2
120	129	15.5
150	87	18.8
180	19	20.6

iv. Effect of dietary energy levels on rate of gain and carcass composition in Timahdit lambs. (A. Kabbali, E. Mohamed, and H. Hassan.)

Twenty Timahdit weanling lambs, initial weight 20.5 kg, were randomly divided into five groups. Four control animals were slaughtered immediately. The remaining four groups were assigned to the following levels of energy intake:

High (ad libitum)
Medium (70% of ad libitum)
Low (to keep a constant body weight)
Very low (to cause animals to lose weight)

The ration consisted of 100 g of chopped wheat straw plus varying amounts of a commercial pelleted concentrate (20.5% crude protein, 14.6% crude fiber). At the end of the trial all animals were slaughtered. The blood was weighed and sampled; skin and hooves were weighed fresh and discarded; the heads were weighed and stored (frozen); the digestive tracts were weighed full and empty, then stored (frozen) with all other visceral organs; the carcasses were weighed hot, divided by sawing through the spinal column, and the left sides were stored (frozen). The carcass sides, the viscera, and the heads were later ground (separately) and sampled for chemical analysis. Results of protein, fat, ash and water analyses are shown in Table 3. Gross caloric determinations are being made by bomb calorimetry, but these data are not yet available.

8. Collaborating Personnel:

Senior Investigators

Fouad Guessous, IAV[1] (Co-Principal Investigator)
Nacif Rihani, IAV

Ahmed Kabbali, National School of Agriculture (Meknes)
W. L. Johnson, NCSU (Principal Investigator)

Research Associates

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M. Khal[2] ,[2]IAV
D. Ismaili[2]. IAV

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Essaadi Mohamed[3] National School of Agriculture
Hafidi Hassan[3] National School of Agriculture

Collaborators

A. Lahlou-Kassi, IAV
Hamid Narjisse, National School of Agriculture
A. Hammoudi, IAV
Yves Berger, University of California
H. R. Gaskins[4], NCSU

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[1] Hassan II Institute of Agronomy and Veterinary Medicine

[2] Third-cycle thesis students

[3] Second-cycle thesis students

[4] Technician

Table 3. Growth, feed intake, and carcass composition of Timahdit lambs on different levels of energy intake (4 lambs per treatment).

Treatment	Total weight gain	Total dry matter intake	Hot carcass weight	Carcass yield (% of empty body weight)	Carcass composition				Whole-body[1] composition			
					Water	Crude Protein	Ether extract	Ash	Water	Crude protein	Ether extract	Ash
	kg	g/kgBW	kg	%	%	%	%	%	%	%	%	%
Control			9.6	53	61	18	15	5	63	17	15	5
Ad libitum[2]	8.9	36	14.6	58	58	16	20	5	59	16	20	5
70% of Ad lib.	5.1	29	11.9	57	57	18	20	5	58	17	18	6
Constant weight	1.6	23	10.9	57	57	17	22	5	58	16	22	5
Weight decline	-2.1	16	8.8	57	58	18	17	6	59	17	17	6

[1] Excluding skin, hooves, and digesta

[2] n = 3

1. **Project Title:** Supporting Research in Small Ruminant Nutrition.

2. **Institution:** North Carolina State University (NCSU)

3. **Principal Investigator:** W. L. Johnson

4. **Funding, 1983/84:**

The total funds available to the NCSU sub-grant for the 1983-84 fiscal year (October 1 - September 30) was $386,128, broken down as follows:

Formula subgrant	$250,000
Special allocation for Brazil	9,500
Carryover from 1982-83	34,702
Matching funds from NCSU	91,926

The allocation of subgrant funds (including carryover) to overseas sites was as follows:

Brazil	$ 48,369
Indonesia	85,733
Morocco	49,565
Total	$183,667

5. **Project Goals:**

i. Obtain information on basic biological questions regarding small ruminant nutrition and feed utilization strategies.

ii. Test new research methodology which may have application at overseas sites.

iii. Provide a productive training situation for host country students as well as for US students interested in international agriculture.

Specific objectives for 1983-84 are implicit in the titles and descriptions of work undertaken.

6. **Work Undertaken and Major Results:**

i. Nutritive value of diets with crop residues. (W. L. Johnson, H. R. Gaskins.)

Diets containing soybean straw, wheat straw, and corn stover were compared with a corn silage control diet in two trials with Holstein steers. Diets ranged in total cell-wall fiber concentration (NDF) from 46 to 60%. Dry matter and NDF digestibilities were lower in diets with 40 or 60% soybean straw than in comparable diets with 40 or 60% wheat straw or 60% corn stover, even though NDF concentrations were similar at each level of by-product inclusion. Dry matter intakes, however, were higher with the soybean straw rations, which meant that intakes of digestible dry matter were almost identical: 76 and 75 g/kg body weight$^{.75}$ at the 40% level of soybean and wheat straw, respectively; and 57, 56 and 53 g/kg BW$^{.75}$ for the 60% soybean

straw, 60% corn stover and 60% wheat straw rations. Digestible DM intake of the control diet with 80% corn silage was 73 g/kg $BW^{.75}$. This trial has been repeated with sheep and goats; the data are not yet fully summarized.

ii. Anhydrous ammonia-treated forages in diets for sheep. (T. J. Parris, R. W. Harvey, and J. W. Spears.)

Two trials were conducted with crossbred wether lambs to evaluate diets with wheat straw, coastal Bermuda hay, fescue hay and 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. The effect of ammoniation on chemical composition can be seen in Table 1. Crude protein was increased in all forages. Fiber constituents were decreased (especially hemicellulose) in wheat straw, fescue and switchgrass, but not in coastal. These results were reflected as well in the animal trials, where weight gains were improved (or losses avoided) when the ammoniated forages were fed, compared to the non-treated forages (Table 2).

iii. Intake, digestibility and rate of passage of two hays by purebred and cross-bred ram lambs. (D. L. Mann, L. Goode, and K. R. Pond.)

Twenty-one growing ram lambs, seven each of purebred Barbados Blackbelly, purebred Dorset and Blackbelly X Dorset crossbreds, were fed pelleted coastal Bermuda hay (trial I) or alfalfa-orchardgrass hay (trial II). Chromium-mordanted fiber was used to estimate rates of passage. In trial I, breed differences were not significant ($P>.10$) for voluntary intake (98 g/kg body $weight^{.75}$), dry matter digestibility (42%), NDF digestibility (41%) or crude protein digestibility (46%). In trial II, intake was higher for Blackbellies (92 g) than for Dorsets (77 g) or crossbreds (84 g/kg $BW^{.75}$; $P<.05$). Dry matter digestibility was 54, 53 and 55% for Blackbelly, Dorset, and crossbred lambs, respectively; crude protein digestibility was 62, 62, and 64%; and NDF digestibility was 50% across the three genotypes. The Blackbelly sheep appeared to have a slower rate of fiber passage through the digestive tract than the other two genotypes, along with a longer mean residence time and higher levels of digesta fill. The crossbred sheep, on the other hand, had a faster rate of passage and shorter mean residence time than both parent breeds.

iv. Digestive kinetics in sheep and goats fed alfalfa or wheat straw/alfalfa diets. (H. R. Gaskins, R. Quiroz, W. L. Johnson, E. A. Tolley, K. R. Pond.)

Eight Toggenburg goats (avg. 45 kg) and eight Suffolk-Dorset-Blackbelly sheep (57 kg), all wethers, were fed alfalfa hay (AH) or 75% wheat straw, 25% AH (W/A) to test effects of diet and forage particle size on digestive kinetics, in a time-dependent (TD), time-independent (TI) model. Diets contained 59 (AH) and 80% (W/A) neutral-detergent fiber (NDF), and were fed ad libitum, chopped, in two 18-day periods in a reversal design. Mean dry matter intakes per

Table 1. Effect of anhydrous ammonia treatment on the chemical composition and *in situ* dry matter disappearance of four forages.

Forage	NH_3 treatment	Chemical composition (%) Crude protein	NDF	Cellulose	Hemi-cellulose	24-hour dry matter disappearance
Wheat straw	No	3.3	81	41	29	42
	Yes	7.5	77	42	24	46
Coastal bermuda hay	No	11.1	74	30	36	
	Yes	15.8	76	30	36	
Fescue hay	No	9.3	77	35	31	40
	Yes	17.0	73	35	26	52
Switchgrass hay	No	5.7	81	37	33	28
	Yes	14.2	78	39	26	38

Table 2. Performance of wether lambs fed diets with untreated or ammoniated forages (5 lambs per treatment).

Diet	Forage intake (g/day)	Average gain (g/day)
Trial I[a]		
1. Wheat straw + corn	498	86
2. Ammon. straw	825	45
3. Ammon. straw + corn	820	168
Trial II[b]		
4. Fescue, untreated	674	-114
5. Ammon. fescue	1066	-4
6. Coastal, untreated	1070	45
7. Ammon. coastal	1104	86
8. Switchgrass, untreated	459	-134
9. Ammon. switchgrass	667	-8

[a]Corn fed at equal amounts in diets 1 and 3.

[b]227 g of corn per day was fed to all animals after first 2 weeks.

weight$^{.75}$ during the final six days of both periods were 69±8.1, 44±2.1, 94±5.4 and 44±3.5 g/day for goats AH, goats W/A, sheep AH and sheep W/A. Two additional rumen-cannulated goat wethers were fed AH or wheat straw (WS), after emptying the rumen. Samples of the masticate collected via the empty rumen were wet sieved with a Tekmar Analysette-3 mechanical shaker fitted with 250 and 1700 μm screems. NDF residue of intermediate-size particles (250/1700) was soaked overnight in a 5% $YbCl_3$ solution. On day 12 of each period of the intake trial AH animals were dosed orally with 5 g of the Yb-labeled AH fiber in gelatin capsules, and W/A animals were dosed with 6 g of labeled WS fiber. Subsequent to dosing, fecal samples were collected from each animal at 18 intervals (4 hr for 2 days, 8 hr for 1 day, 12 hr for 2.5 days). Fecal Yb was determined by AA spectrophotometry. Diet by species interaction was evident ($P<.05$) for residence time (RT) but not for TD or TI rates. Goats had longer RT than sheep for AH ($P<.06$); for WS, species effect was not significant. TD rate was not influenced by diet or species. TI rate was faster ($P<.01$) for AH than WS but not different for goats and sheep. A 4-variable model including above parameters plus lag time showed goats and sheep to behave differently ($P<.001$) with regard to overall digestive kinetics.

v. Criteria for selection of gamma time-dependent models for digesta movement in ruminants. (R. A. Quiroz, E. A. Tolley, K. R. Pond, W. L. Johnson.)

One and two compartment models are widely used to describe the passage of particles and liquids through the gastro-intestinal tract (GIT) of ruminants. Most particles, especially from roughages, undergo many physical alterations with time during the digestive process. This suggests, to describe this movement, the use of a time-dependent distribution such as the gamma, $\Gamma(n,1)$. Eight Toggenburg wether goats ($\bar{X}$ wt 42±5 kg) were fed coastal bermudagrass or a mixed alfalfa hay diet, ad libitum, and dosed with four external markers; Co-liquid phase, Cr-particles ranging from 32 to 500 μm, Yb-particles ranging from 500 to 1700 μm, and Er-particles >1700 μm. A specific objective was to test gamma-time dependent models for estimating the initial concentration of the marker in the GIT, lag time, and passage rates of liquid and solid phases in the GIT. Fecal collections were made every four hours for six days and analyzed for the markers using atomic absorption spectrophotometry. Data were pooled across diet and period and fitted to the following models:

(1) $\Gamma(2,1)$, one compartment model
(2) $\Gamma(3,1)$, one compartment model
(3) $\Gamma(4,1)$, one compartment model
(4) $\Gamma(2,1)$, two compartment model

Selection of the most appropriate model is difficult because of their complexity. Therefore, the Davidson and MacKinnon procedure for non-nested hypotheses was used to test the validity of these models. The best models ($P<.001$) for describing the behavior of the markers in the GIT were: Co-(1) and (4), Cr-(1) and (4), Yb-(2) and (4) and Er-(2) and (4). It appears that the liquid phase and the small particles behave similarly and can be described with gamma two time-dependency,

whereas larger particles require higher orders of time-dependency.

vi. Effect of accelerated growth and fattening during rearing on reproduction and lactation in ewes lambing at 13 months. (M. A. McCann, L. Goode, E. V. Caruolo, and R. W. Harvey.)

A total of 64 Dorset (D), 90 Suffolk (S) and 49 Barbados Blackbelly (B) ewe lambs were weaned at 42 days and randomly assigned to either growing or finishing diets fed ad libitum. They were bred at 7 to 9 months of age. Data were obtained on gain, shoulder height, condition score, age at puberty, conception rate, lambing rate and 4-hr milk yield and composition at 25 days of lactation. Ewes were stratified, within breeds and trials, into high and low gaining groups based on mean daily gain to puberty. Mean daily gain, weight/height ratio and condition score at 120 days, at puberty and breeding were greater ($P<.01$) for high gaining than low gaining lambs. S ewes had higher means ($P<.01$) for daily gain and weight/height ratio at 120 days, at puberty and breeding than D and B ewes. S ewes were also taller at puberty and breeding. Mean age at puberty (200 days), conception rate (88%), gestation length (145 days) and lambing rate (1.3) were similar for gain groups. Gestation period was longest ($P<.01$) in B ewes, and S ewes had the highest lambing rate ($P<.05$). Mean 4-hr milk yield for low gaining lambs (334 g) was higher ($P<.10$) than for high gaining lambs (284 g). There was a negative correlation (-.36***) between daily gain to puberty and milk yield. An increase in .1 kg in daily gain to puberty decreased 4-hr milk yield 50 g. Mammary duct development was also greater in low gaining than in high gaining lambs. Milk yield and composition varied significantly among breeds.

vii. Supplemental zinc for male and female lambs. (P. A. Hatch, J. W. Spears, L. Goode, and B. H. Johnson.)

In recent years zinc supplementation to grazing ruminants has improved growth and reproductive performance. These studies have been conducted in different areas; thus it appears that marginal zinc deficiency may be wide spread. Zinc requirements of ruminants fed forage-based diets are not well defined. A series of studies were conducted with the following objectives: 1) to better define zinc requirements of male and female lambs fed forage-based diets and 2) to study factors which influence zinc requirements.

Zinc supplementation of a 70% chopped hay diet containing 22 ppm zinc did not effect growth or testicular development in ram lambs. A study is currently underway involving 52 ewe lambs representing three breeds (Suffolk, Dorset and Barbados Blackbelly). This study is designed to determine if supplemental zinc will improve growth and reproduction in ewe lambs fed a diet containing 24 ppm zinc. The ewe lambs are presently in the 4th month of gestation and so far no differences in growth have been noted.

A study was also conducted to determine if forage quality affects zinc utilization and requirements in lambs. Zinc supplementation increased gains and feed intake in lambs fed a high quality cool season grass containing 19 ppm zinc, but had no affect on performance of lambs fed

a low quality grass containing 16 ppm zinc. In the absence of supplemental zinc, lambs fed high and low quality forages were in negative zinc balance. Zinc supplementation increased zinc balance in lambs fed high quality forage but not in those fed low quality forage. These data suggest that forage quality is one factor which may affect zinc availability in forages.

viii. Sulfur fertilization of fescue and orchardgrass for hay and its effect on mineral and fiber utilization. (J. W. Spears, J. C. Burns, and P.A. Hatch.)

Deficiency of sulfur, even slight, can have a detrimental effect on fiber digestibility in ruminants. Two studies were conducted to ascertain the effect of sulfur fertilization on intake and nutrient utilization of Kenhy tall fescue and orchardgrass hay by steers. Hay was harvested in a vegetative stage from paddocks that had been fertilized with 0 or 132 kg of sulfur per ha as gypsum. Forage sulfur was increased by fertilization from .33 to .40% in tall fescue and from .29 to .37% in orchardgrass. Forage intake was not affected by sulfur during a 28-day intake phase. At the end of the intake phase 4 steers per treatment were placed in metabolism crates. A seven-day adjustment preceded a five-day total collection of feces and urine. Sulfur fertilization of orchardgrass significantly increased ($P<.01$) apparent digestibility of dry matter, ADF, NDF and lignin by 5.1, 11.9, 12.9 and 67.2%, respectively, but decreased ($P<.01$) protein digestibility by 5.7%. Dry matter and fiber digestibility of tall fescue were not affected by sulfur but protein digestibility was increased ($P<.05$). Apparent absorption of sulfur and urinary sulfur excretion were increased by sulfur fertilization with both grasses. Increasing forage sulfur in orchardgrass through fertilization reduced apparent absorption of calcium ($P<.01$) and magnesium ($P<.10$). Sulfur fertilization of tall fescue tended to decrease apparent absorption of magnesium and calcium but increased ($P<.05$) forage potassium and absorption and retention of potassium by steers. The present studies suggest that sulfur fertilization may increase fiber digestibility but reduce calcium and magnesium availability.

ix. Use of secretagogues to enhance digestive efficiency. (W. J. Croom, M. A. Froetschel, and W. M. Hagler.)

Secretagogues are a class of compounds which can enhance the production of digesttve secretions such as saliva and pancreatic enzymes. There is evidence that on certain diets an increase in such secretions could enhance utilization of dietary nutrients. One such compound, slaframine, which is produced by the common mold R. leguminicola, has increased digestive excretions in beef cattle and chicks with no change in feed intake. Studies now in progress will demonstrate whether or not a benefit can be derived in terms of growth or efficiency of feed utilization.

7. Collaborating Personnel:

Senior Investigators:

W. L. Johnson, forage fiber utilization (Principal Investigator)
W. J. Croom, rumen physiology
Lemuel Goode, sheep production systems
R. W. Harvey, low-quality forage utilization
K. R. Pond, forage fiber utilization
T. W. Robb, ruminant nutrition
J. W. Spears, mineral nutrition

Research Associates:

D. M. Amaral, MS completed 1983
L. E. Brown, PhD candidate
A. S. Bryson, Technician
H. J. Burstein, PhD candidate
H. R. Gaskins, Technician, MS candidate
Mark Froetschel, PhD candidate
Budi Haryanto, MS completed 1983; PhD candidate (Government of Indonesia scholar)
P. A. Hatch, MS candidate
E. S. Leonard, Technician, MS candidate
J. M. Luginbuhl, MS completed 1983; PhD candidate
D. L. Mann, Technician, MS candidate
T. J. Parris, MS candidate
J. D. Pettyjohn, Technician
Achmad Prabowo, MS candidate (Government of Indonesia scholar)
Roberto Quiroz, MS candidate (USAID scholar from Panama)
Sharon Ray, Technician
Alice A. Reese, PhD candidate
L. J. Samsell, Technician, MS candidate
Barbara Smith, Technician, MS candidate

Research Assistants:

Susan Ammons
Demetria Arvanitis
Ann Krush
Scott Melton
Chris Merrill
Ruth Peterson
Heath Thomas

Collaborators:

J. C. Burns
A. C. Linnerud
Elizabeth Tolley

1. **Title:** Rangeland Research for Increasing Sheep and Goat Production in Northestern Brazil.

2. **Institution:** Utah State University

3. **Principal Investigator:** John C. Malechek

4. **Funds Allocated from:**

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant:	$211,551
Matching Contribution from 1983/84 Subgrant:	$86,088

5. **Project Goals and Rationale:**

Rangeland research for animal production differs fundamentally from many other kinds of agricultural research in that it is concerned with a whole system (i.e. the rangeland ecosystem). It must deal not only with select components of the system (plants, soil, climate, livestock) individually, but more importantly, with interrelationships among these components. Many of these relationships are time-dependent, so range research is generally protracted in time as well as broad in scope.

For the range livestock production system of Northeastern Brazil, we have identified the annual dry season as a major limiting factor to animal production. Therefore, much of our research has focused on how animals cope with limited forage resources during this period and on land manipulations that might alleviate or reduce the impacts of this stress period. However, events and circumstances of the dry season often are determined by what happens during other parts of the year. Moreover, such relationships vary from place to place and from year to year. Therefore, our research has taken a holistic approach of attempting to learn what happens to forage and animals throughout the year, from one year to the next, and how this might be affected by such typical land manipulations as thinning and clearing of the woody vegetation that dominates the plant communities of the sertao of Northeastern Brazil.

With this rationale in mind, we have identified four general research areas needing attention. They are as follows:

i. Ecological assessment of the range forage resource. Soils, vegetation, and climate of the sertao are highly diverse on a geographic scale and climate varies profoundly from season-to-season and from year-to-year. To understand how these factors affect forage and animal production and to enable extension of local experiment station results to the broader region, such ecological studies are necessary.

ii. Plant-animal relationships. Typical of many tropical ecosystems, the vegetation of the sertao, known as caatinga, contains a wide

diversity of plant species. These species vary widely in their productivity, palatability and nutritional value to sheep and goats, and any particular species may vary markedly over the year. Studies are aimed at understanding the nutritional relationships of animals to their erratic and diverse forage resource.

iii. Rangeland improvement and brush management. One of the few so-called "management" alternatives available to smallholders of the sertao is manipulation of the woody caatinga vegetation. Local wisdom holds that clearing and thinning improve forage conditions. While this may be true in the near-term, the long-range consequences of land clearing are not well known, neither from the standpoint of animal production nor land stability. If they do turn out to be desirable practices, we need to know the extent and how to achieve the best result. If they are negative, attention should be given to ways of minimizing the impacts.

iv. Grazing management. With information in-hand from the first three objectives, we will ideally be able to design and recommend grazing management practices and land treatments that will optimize the relationship between effective animal production and sustained forage production.

6. Specific Objectives for 1983/84:

i. To determine dietary selectivity by sheep and goats grazing uncleared native caatinga on a year-round basis.

ii. To assess the nutritional status of these animals in relation to requirements for maintenance, growth and reproduction.

iii. To determine the effects of complete clearing of caatinga woody vegetation on forage production and availablitity for sheep and goats on a year-round basis.

iv. To determine how such clearing affects dietary selectivity and nutritional value.

v. To identify and quantify specific variables involved in forage decay and disappearance during the annual dry season.

vi. To determine how method and season of cutting affects subsequent regrowth and production of forage by selected woody species.

vii. To determine how time and method of cutting affects the subsequent timing (phenology) of forage regrowth.

viii. To assess the relationships between range sites (specific units of land composed of uniform soil and climatic conditions) and plant community composition and productivity.

ix. To determine the feasibility of using LANDSAT satellite imagery for identifying and mapping range sites.

x. To determine ecological relationships between soil and vegetational characteristics of farms.

7. Description of Work Undertaken:

Work under Objectives 1 and 2 has been the topic of PhD research by Dr. James Pfister. His dissertation was completed in October, 1983 (see Pfister 1983). Generally, this work involved measuring the nutritional status of sheep and goats grazing together on native, unmanipulated caatinga rangeland. Variables measured on a monthly basis included dietary botanical composition, dietary chemical composition (crude protein, cell walls, lignin) in vitro digestibility, and intake. Dietary constituents were measured on samples collected by free-grazing esophageally fistulated animals, and intake was measured by total collection of feces and then applying the relationship: $I = F/1 - D$, where I = intake, F = fecal output, and D = digestibility, as measured in vitro. Additionally, the forage available for consumption was measured periodically and was related to seasonal precipitation.

In a related sub-objective, the foraging behavior of sheep and goats was compared to test the hypothesis that goats are more adapted to restricted forage conditions (as during drought) by virtue of their ability to employ a bi-pedal feeding stance, which would presumably allow them access to over-head forage unavailable to sheep.

Work under Objectives 3-5 is being done primarily by Ph.D. candidate Robert Kirmse with major supervision by co-investigator Fred Provenza. Follow-up field work is being done by Ph.D. candidate Walter Schacht. First-stage field work was completed in early 1983 and results on forage yields (including both herbaceous ground-story vegetation and tree leaves) was reported in "Partners in Research." Subsequent to that report, work has continued in the lab and on data analysis. This component of the project is scheduled for completion in December, 1984, when Kirmse finishes his Ph.D. program. Walter Schacht has re-measured forage production in the same area treated by Kirmse in 1981 to determine 2-year-post-clearing responses.

Work under Objectives 6-7: Results from this part of the project have not been reported in previous reports. They form a vital part of our understanding of the rangeland ecosystem of the sertao because of the prevalence of tree cutting and land clearing as a tradional land manipulation practice in the area. If different responses are possible, then integration of improved practices into an existing local technology would be far easier and much more likely to be received than imposition of a totally new technology.

This work is being conducted by Mrs. Linda Hardesty, PhD candidate, under direct supervision of co-investigator Thad Box.

Work under Objectives 8-10: Description and quantification of relationships between soils and vegetation is being done by Ph.D. candidate Joao Queiroz with major supervision by co-investigator B.

E. Norton. Queiroz is now in Utah completing final lab work and will begin writing his dissertation in late summer, with a target completion date of December 31, 1984. Major lab efforts currently involve computer analysis of LANDSTAT data to determine if reliable "signatures" can be produced that correlate with plant community and soil type complexes earlier defined in the field (Brazil).

Another major effort this year was a collaborative project involving Joao Queiroz (Utah Range) with Nestor Gutierrez of Winrock International and Abel Ponce de Leon, IICA consultant to the CNPC in Sobral. During October, November and December of 1983, 28 of the farms in Ceara State earlier surveyed by Gutierrez were re-surveyed to better assess their ecological resources in terms of soils and vegetation types available on the property, how the various soils are used (for cropping or grazing), the relation of soils to farm grazing capacity and kinds of animals produced, and how both the land and vegetation resources are used to cope with the dry-season forage bottleneck. These data have been summarized and a draft publication by Gutierrez, Queiroz and Ponce de Leon is now in editorial review. Publication is anticipated in either Livestock Production Science or Agricultural Systems.

8. Technical Accomplishments:

Sheep and Goat Nutrition on Native Caatinga (Objectives 2-3): Seasonal nutrition of sheep and goats on intact, native caatinga range is portrayed in Figs. 1-4. Crude protein levels remained surprisingly high, even during the dry months of September - December. This finding (initialiy reported in "Partners in Research", 1983) questions widely-held perceptions about inadequacy of protein for animals on caatinga range, provided they have access to a broad array of plant species (or shed leaves) from which to choose their diets. Only minor differences were noted between sheep and goats for crude protein. Dietary lignin (Fig. 2) on the other hand was considerably higher for goats than sheep during the rainy season, while in vitro digestibility showed the opposite response (Fig. 3). Greater consumption of woody browse by goats during the wet season may be the cause of these differences.

Intake was greater for sheep (2.2% of body weight) than for goats (2.0%) over the study. Figure 4 illustrates periods when the major differences occurred. Further lab work is needed (and is presently in progress) to convert the organic matter intake data shown to digestible energy values. Only then can we begin to draw conclusions about major limiting factors (protein? energy?) to animal production.

The comparisons on feeding behavior indicate that goats have no real advantage over sheep in caatinga vegetation where most of the forage species are deciduous and leaves fall to the ground during the dry season, making them equally available to both animal types. This may not be true in other ecosystems where evergreen browse might be available overhead to goats but not to sheep.

Effects of Clearing on Animal Nutrition and Forage Production (Objectives 3-5): Results from recent lab analyses are shown in Figs 5-7. These findings suggest only minor differences in crude protein and *in vitro* digestible dry matter content of diets selected on cleared *vs* noncleared ranges. However, lignin was appreciably higher throughout most of the year in diets from uncleared range (Fig 7). The basis for this difference is still being sought. The influence of reduced light (shading) under the canopy appears important in elevating lignin levels.

In relation to forage decomposition studies, shed leaves from trees still retained about half of their biomass after 9 months while material from understory herbs was almost 80% decomposed. While the relative forage value to these residues is low and probably not that different near the end of the dry season, it is likely that tree leaf litter would provide more soil cover and erosion protection than would forb residues once the rains began. Thus, any apparent advanges to total forage production achieved by clearing must be weighed carefully against long-term risks associated with cover removal and potentially accelerated soil erosion.

Recent re-measurements 2 years post-clearing show that the initial "flush" in yields of herbaceous vegetation is quickly diminished once the coppicing trees regrow and regain structural dominance of the site. The tree canopy has now recovered to 74% groundcover. Yields of herbaceous species have declined to 950 kg/ha compared to 3,200 kg/ha during the first year after clearing. This is despite the fact that the 1984 rainy season has been considerably wetter than the one of 1982. The current-year's yields of herbaceous vegetation on uncleared caatinga are 550 kg/ha, compared to about 580 kg/ha in 1982. This suggests that above a critical level, current year's precipitation seems to have little effect on yields of herbaceous forage plants under the tree canopy. Work is in progress to further define these relationships.

Method and Season of Tree Cutting (Objectives 6-7): First year's results show promising shifts in leaf phenology of trees due to timing of cutting. Leaves typically begin falling from mature trees in June. However, leaf fall from the coppice growth of recently-cut trees did not fall until August, some 60 days later. Moreover, coppicing stumps browsed by goats late in the rainy season (April-May) did not begin dropping leaves until September. We still do not understand the nutritional consequences of having some proportion of the tree stand in this juvenile coppice form so that a source of green forage is available well into the dry season. However, the idea has intuitive appeal and subsequent studies will address the question. It suggests possibilities for cutting small areas or staggering the period of cutting over several years to maximize the range of phenologic variation and maintain a varied forage supply. There also appears to be potential for increasing coppice production from palatable tree species by low (<30 cm above-ground) cutting to encourage production from adventitious sprouts. On the other hand, high cutting (above 30 cm), followed by heavy goat browsing might be useful to remove less desirable species through

exhaustion of dormant buds.

Soil-Plant-Climate Ecological Relations (Objectives 8-10): New results since the last report are mainly from the ecological survey of 28 farms throughout Ceara. A major finding of this study was the importance of cropland to the overall forage-animal balance on most farms, particularly to cattle and sheep. Crop aftermath and weedy residues produced in conjunction with cultivation sustain stocking rates of 0.3 to 7.6 ha per animal unit for a month or more. On the average, 26% of the land area of the farm is cropped, but the variation is extreme, ranging from 1% to 70%. So called "good" soils are cultivated annually, but marginal soils are usually left to revert to caatinga cover after a short cropping period and may not be cropped again for up to 20 years. Cotton is planted on 93% of the farms. This is split roughly equally between perennial and annual varieties. Perennial cotton which lasts from 6-15 years is weeded only during the first two years after planting. After that the weeds are used as dry season forage following harvest. There appears to be a potential for replacing the weed component with easily established and adapted legumes such as Stylosanthes hemata. This would probably not be any more competitive with the cotton than are the weeds and may even offer an advantage to cotton yields through nitrogen fixation. Australian work clearly demonstrates the dry season forage potential of these species, many of which were originally collected in northeastern Brazil.

The major interim conclusion from this work is that production systems of the sertao are extremely diverse in the land, climatic, and dense vegetational resources available. Farmers have responded by devising equally diverse management schemes, both for livestock and crops. This diversity should be encouraged as a strategy for coping with drought. Moreover, researchers and extension specialists must begin viewing the farm production system in a more holistic light, including cropland as well as livestock and native rangeland in their analyses.

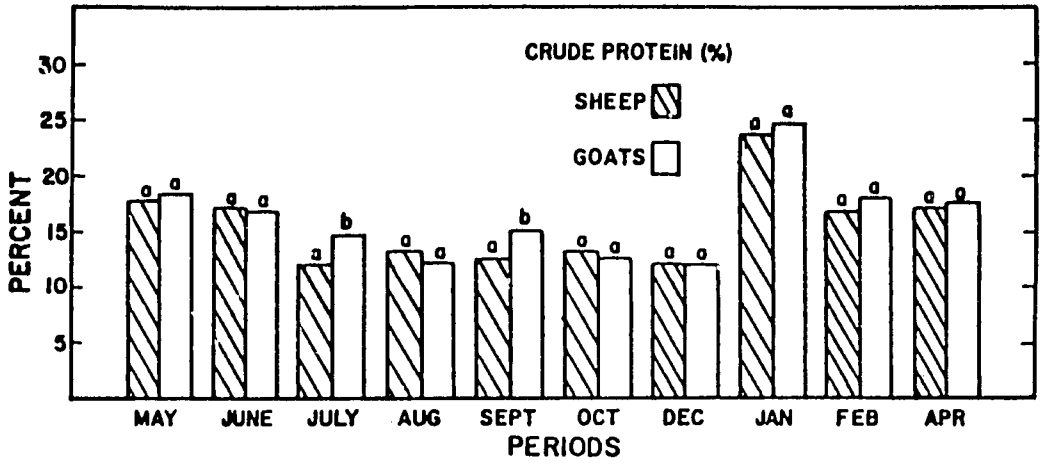

Figure 1. Crude protein content (%) of samples collected from fistulated goats and sheep during 10 sampling periods. Different letters above bars for the same period indicate significant differences (P<.05).

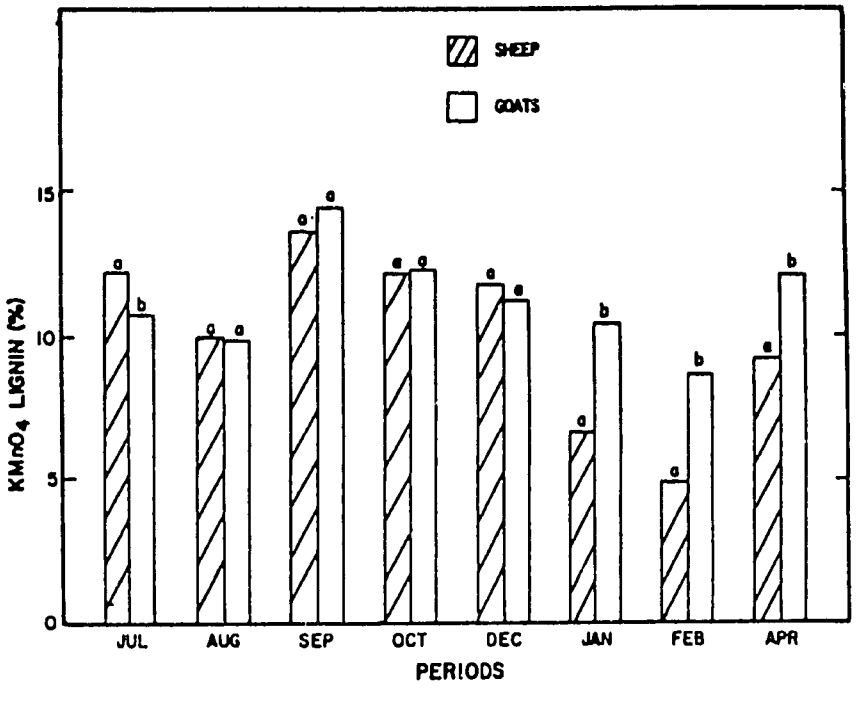

Figure 2. Lignin content (%) of dietary samples collected from fistulated animals during eight sample periods. Different letters above bars for the same period indicate significant differences (P<.05).

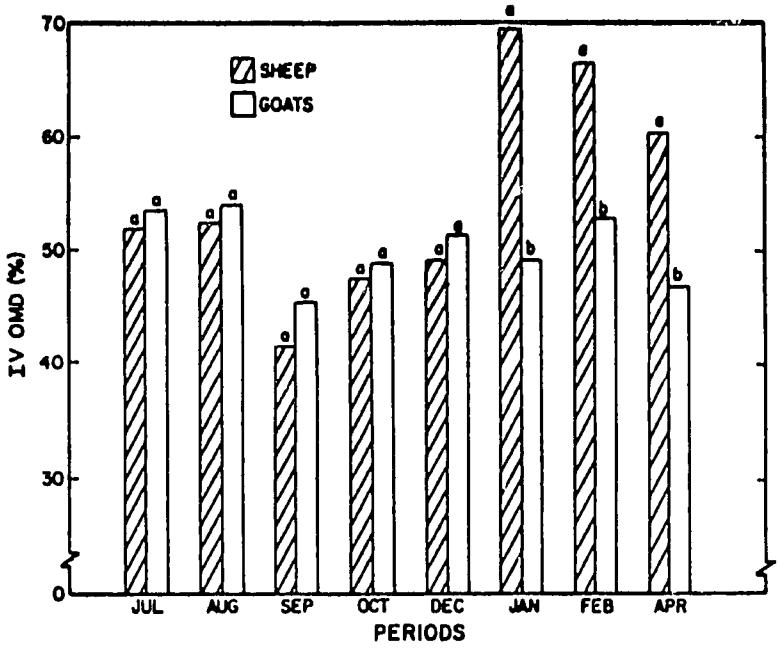

Figure 3. In vitro digestibility (%) of dietary samples collected from fistulated animals during eight sample periods. Different letters above bars from the same period indicate significant differences ($P<.05$).

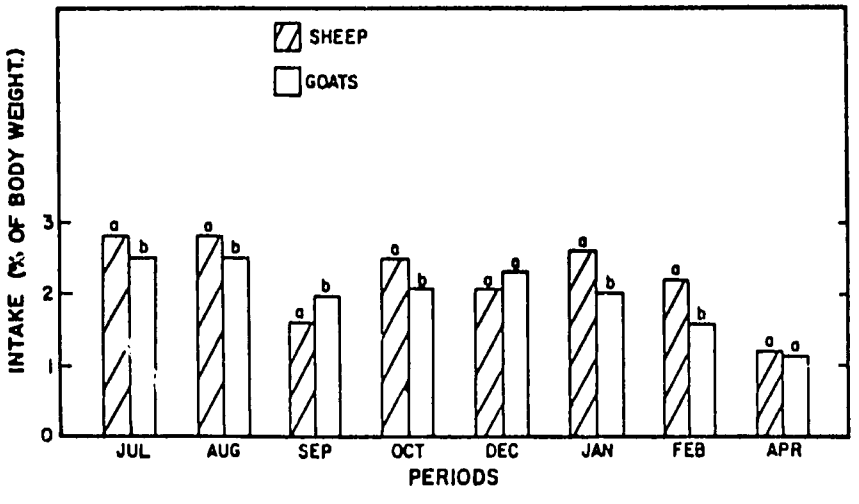

Figure 4. Voluntary intake (% of body weight) of goats and sheep during eight sample periods. Different letters above bars from the same period indicate significant differences ($P<.05$).

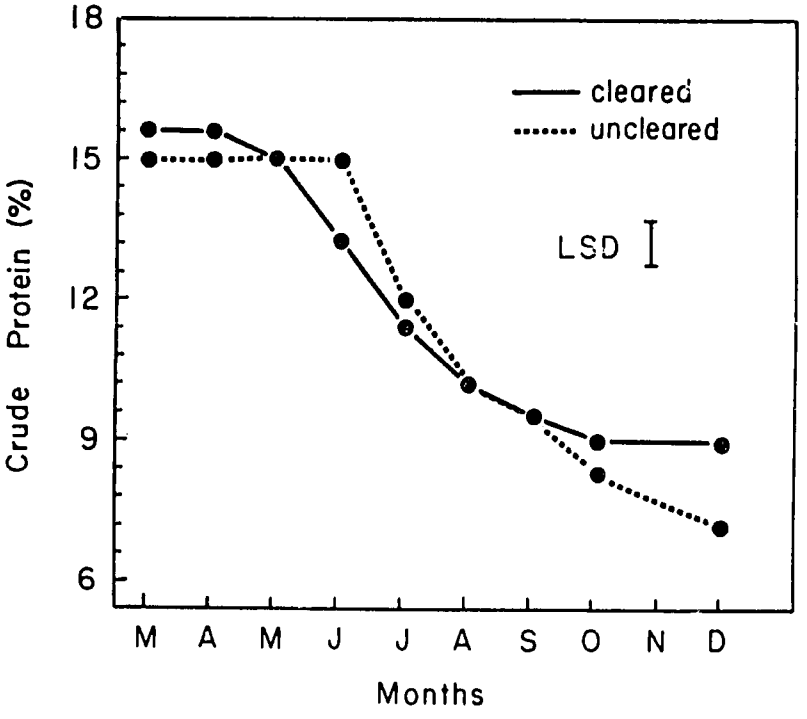

Figure 5. Monthly crude protein levels in diets selected by sheep and goats on cleared and uncleared caatinga rangeland.

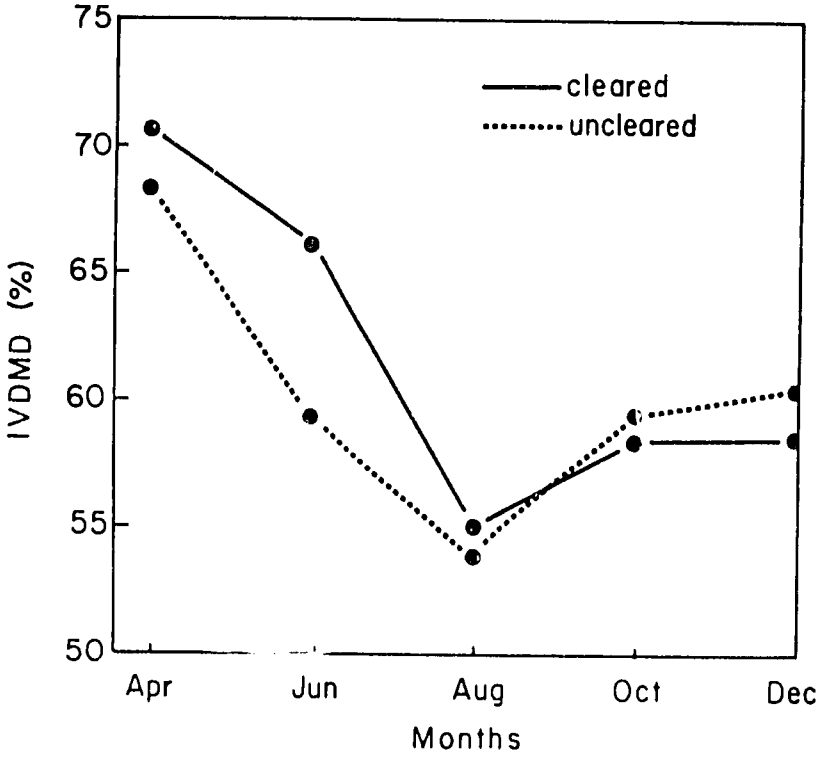

Figure 6. Monthly in vitro dry matter digestibility levels for diets selected by sheep and goats on cleared and uncleared caatinga rangeland.

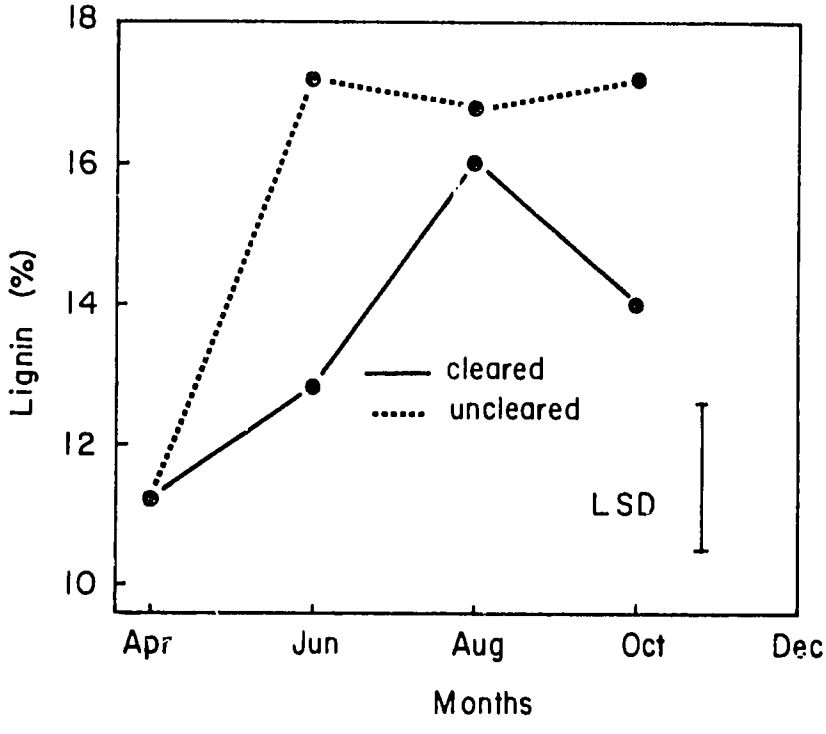

Figure 7. Seasonal dietary lignin levels for sheep and goats on cleared and uncleared caatinga rangelands.

1. Project Title: Rangeland Research for Increasing Small Ruminant Production in Northeastern Brazil: Supporting Work Conducted in US.

2. Institution: Utah State University

3. Principal Investigator: John C. Malechek

4. Funds Allocated: See Brazil portion of report.

5. Project Goals:

i. To provide research experiences that will serve in the training of graduate students from the US and from various developing countries.

ii. To address research problems pertinent to the small ruminant (principally sheep) industry of Utah and the Western US.

iii. To conduct research on questions that are relevant to work in Brazil but that for various reasons (lack of proper equipment, work of "basic" nature, etc.) may not be feasible or appropriate for doing in Brazil.

6. Statement of Specific Objectives for 1983/84.

i. To determine if rumen microbes adapt to tannins which are present in many tropical and temperate forage species (especially shrubs).

ii. To determine the effects of pH on the protein binding capacity of various tannin compounds.

iii. To define the nutritional and behavioral relationships between sheep grazing in combination with cattle on native rangeland.

iv. To determine the effects of the group of secondary plant compounds classified as monoterpenoid hydrocarbons on feeding behavior of sheep in response to sagebrush on rangelands.

7. Description of Work Undertaken:

i. Many tropical and temperate shrubs and trees contain high levels of tannins. Whether these compounds act mainly as feeding deterrents or if they truly impact ruminant nutrition (mainly through complexing with proteins, reducing their digestion) is a matter of conjecture. Controlled studies conducted by Mohamed Hussein, an MS student from Sudan, suggest that rumen microbes adapt to tannins which causes protein digestibilities to increase. Work is continuing on this study.

ii. The group of secondary plant compounds known collectively as "tannins" comprises a wide variety of chemicals of various molecular structure, reactivity, and physiological effect. A major contributor to variability in physiological effect on digestion is pH. For example, a particular molecular species of tannin might bind with protein at

one pH and diassociate from it at another pH. Considering the varieties of pH's encountered through the course of the gastro-intestinal tract, better information is needed on this question. Research technician Elizabeth Burritt is pursuing this work. No interpretations are yet available.

iii. Grazing by combinations of livestock species is probably the rule, rather than the exception, for rangelands throughout the world. Yet information on this topic is amazingly scarce. This study, conducted by PhD candidate George Ruyle and supervised by CRSP co-investigator Don Dwyer, was initiated to provide such insights relative to combined sheep and cattle grazing on summer range in southern Utah. Both the feeding behavior (diet selection and feeding station activities) and nutrition of sheep were studied on ranges previously grazed by sheep alone, by cattle alone, and by the combination of sheep and cattle.

iv. Monoterpenoid hydrocarbons constitute another group (as do tannins) of compounds known for their aversive effects on plant palatability and speculated effects on animal nutrition. These compounds are extremely widespread throughout the plant family Asteraceae and are present in high concentrations in sagebrush (Artemisia sp), a plant genus of considerable importance in Utah and other western US states.

Wilson Yabann, an MS candidate from Kenya, has been studying the effects of these compounds on dietary usage of Basin big sagebrush (A. tridentata subsp. tridentata), an especially unpalatable species. He observed grazing sheep and hand-harvested plant material representative of that either selected or rejected by the sheep and then analyzed samples of these two groups by gas chromotography. Nutritional analyses were also conducted on samples taken from esophageally fistulated sheep.

8. Technical Accomplishments:

i. Combination sheep-cattle grazing (Objective 3): Ruyle found that sheep grazing on previously ungrazed paddocks selected diets higher in forbs, digestibility, and crude protein than they did in previously grazed paddocks. Where sheep followed cattle in the grazing sequence or when they followed the combination of sheep and cattle, diets were less digestible but higher in protein than where sheep alone had previously grazed. Sheep were able to continue selection of a high quality diet considerably longer than were cattle as forage supply was depleted by continued grazing pressure.

ii. Monoterpenoids and dietary selection of sagebrush: Yabann found large differences in total monoterpenoids between selected and rejected plant material. Rejected material averaged about 1% total monoterpenoids (% of dry weight) compared to about 0.4% for selected material (see Fig. 1). Selection operated both at the plant level (selection from individual plants within the stand) and at the plant part level (selection of old leaves and rejection of young leaves) within a particular individual plant. Plant-to-plant analysis showed an extreme level of variation in monoterpenoids among individual plants in the stand. Ecologically, this leads to the hypothesis that

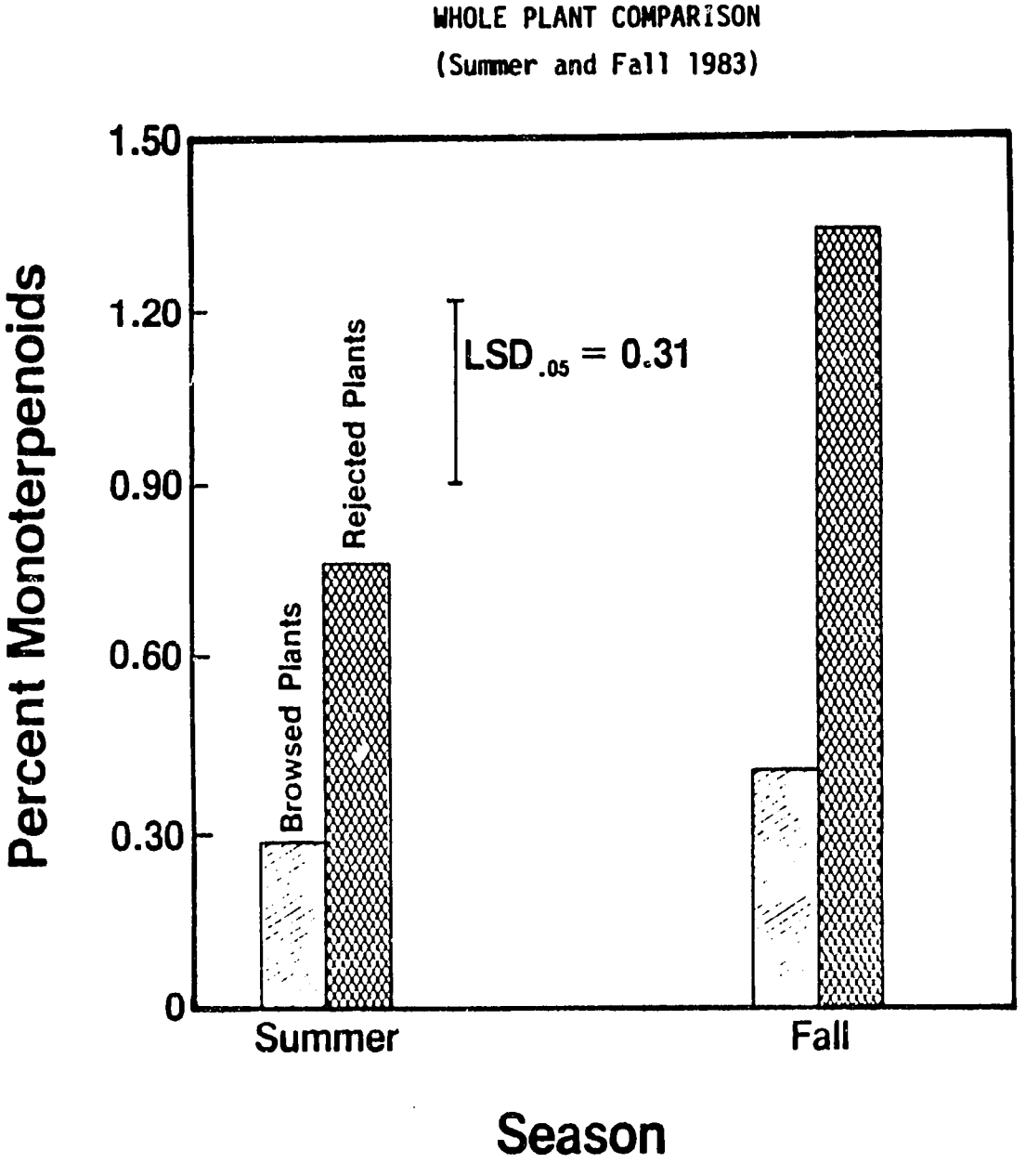

Figure 1. Percent total monoterpenoid concentrations of Atremisia tridentata subsp. tridentata (on dry matter basis) by season and treatment.

if non-toxic plant chemicals have evolved as defenses against herbivores (mainly invertebrates), a highly variable defense might be advantageous because it forces the herbivore to move often in order to find material suitable for consumption. In so doing, the herbivore is rendered more vulnerable to various predators and spends more time and energy in search of food. For practical range management this variability implies the potential for genetic selection of low-monoterpenoid plants for forage breeding and improvement programs (sagebrush is "nutritional" by proximate standards). It also implies that if browsing animals are used as brush control agents, they will likely kill the least obnoxious types, leaving behind the most unpalatable to re-populate the stand. Thus, one has the potential to change the brush component of the range community from a bad situation to a worse one. This line of inquiry needs to be pursued for other so-called "brush" species on rangelands.

9. PERSONNEL COLLABORATING ON PROJECT ACTIVITIES

Basic Supporting Research in U.S. for the Project

Research Participants

Title	Name and Degree	Instruction	Dates
Principal Investigator	John C. Malechek, PhD	Utah State Univ.	Oct. 1978-
Senior Investigators, Research	Thadis W. Box, PhD	Utah State Univ.	May 1981-
Asst., and Staff Assistant	B. E. Norton, PhD	Utah State Univ.	Oct. 1978-
	Don D. Dwyer, PhD	Utah State Univ.	Oct. 1978-
	Frederick D. Provenza, PhD	Utah State Univ.	May 1981-
	Elizabeth Burritt, MS (Res. Asst.)	Utah State Univ.	Jan. 1983-
	Robin Scherting, BS (Staff Asst.)	Utah State Univ.	July 1979-
Graduate Students	Mustafa Mohamed Hussein, MS	Range and Pasture Admn., Sudan	Oct. 1982-Jan. 1984
	George B. Ruyle, PhD	Utah State Univ.	Sept 1980-Oct. 1983
	Wilson Yabann, MS	Utah State Univ.	Jan. 1983-July 1984

1. **Project Title:** Kenya Animal Health Research Component.

2. **US Institution:** Washington State University (WSU).
   Kenyan Institution: Ministry of Agriculture and Livestock Development (MALD).

3. **Principal Investigator:** Travis C. McGuire

4. **Funds Allocated For 1983/84:**

Subgrant:	$175,000
Matching Contributions:	$58,275

5. **Brief Statement of Project Goals:**

The common goal of the MALD and WSU is for the research and training program to provide long term solutions to disease problems that represent a constraint on dual purpose goat production. Research priorities for animal health have been established based on this goal, on previous information on health problems of goats in Western Kenya and on results from small farm animal health investigations.

The research objectives are accomplished in three ways:

i. Training of Kenyan veterinarians through an M.S. or Ph.D. degree program on a relevant subject with the thesis research conducted in Kenya.

ii. Collaborative research involving staff members of MALD, SR-CRSP scientists and other scientists in Kenya.

iii. Supportive research on technical aspects initiated at WSU and transferred to the MALD.

6. **Statement of specific objectives for 1983/84, description of work undertaken, and technical accomplishments. We have combined these three items and organized the report topically.**

i. One of our objectives is to determine the efficiency of IVOMEC against mixed nematode infections (predominantly Haemonchus contortus) in goats in Kenya as shown by egg counts and worm identification. The efficiency of IVOMEC will also be compared to currently used routine treatment (Thiabendazole drench) to formulate guidelines for use of anthelmintics in goats in Kenya.

Infection by H. contortus is probably the most significant single parasitism constraint to production among goats in Kenya. This species possesses strains resistant to Thiabendazole (TBZ), which is the standard anthelmintic used in Kenya. SR-CRSP tested a new Ivermectin, a broad spectrum anthelmintic, as a control measure for H. contortus. The studies indicated that Ivermectin is efficacious in the control of gastrointestinal nematodes found in goats at Ol'Magogo near Naivasha, Kenya. Its effectiveness in controlling nematodes resistant to TBZ makes it the preferable drug. In order to avoid

rapid development of a nematode strain resistant to Ivermectin, the work performed by SR-CRSP personnel indicated that the drug should be used sparingly and in conjunction with management methods that minimize nematode infections.

The majority of this work is being done by Dr. James Njanja, a Kenyan veterinarian working toward a master's degree at WSU. The results of the study form the basis of his thesis. Dr. R. Wescott, his thesis advisor at WSU, is currently reviewing the first draft of his thesis.

ii. Another objective is to provide for the immunoprophylaxis for contagious caprine pleuropneumonia (CCPP).

CCPP is the most serious disease of goats in Kenya, causing high mortality and substantial economic loss. SR-CRSP has developed an effective diagnostic test for the various Mycoplasma sp. which may cause CCPP (see 9b below) and now the focus of activity is on a vaccine. The most commonly used vaccine is a liquid that is transported to the field on ice. The immediate consideration for SR-CRSP work was whether a lyophilized vaccine against Mycoplasma strain F-38 would confer protective immunity when the vaccinated goats were challenged by contact. F-38 strain of mycoplasma used for production of monovalent CCPP vaccine was grown in Newing's tryptose broth medium and the usual processes of vaccine production (at Veterinary Laboratories, Kabete, Kenya) were followed except that Tween 20 and chloroform were excluded. Protein estimation of the vaccine was made and the vaccine was lyophilized in vials at a concentration of 8 mg/ml. The vials were stored at 4°C. The freeze-dried vaccine was not used until 36 days later. Eight goats were immunized with the freeze-dried vaccine at the dose rate of 8 mg/dose. The goats received similar booster doses 21 days after the initial doses. The 8 vaccinated goats and 8 unvaccinated control goats were challenged by contact exposure 64 days after initial immunization. The results are shown in table 1. Six controls out of 8 died of CCPP while only two survived. Only one vaccinated goat died of CCPP; a second one died of other causes. The results indicated that such a vaccine will protect against various Mycoplasma strains when the immunizing dose is determined precisely and when used with an appropriate adjuvant.

Table 1. Immunity of Goats to Challenge with the F-38 strain of Mycoplasma Two Months Post Immunization with Freeze Dried Antigens Incorporated in Saponin and Algel.

Months Post Immunization	Group	Days to Pyrexia	Number Reacted	Reaction Period (Days)	Number Died of CCPP
	controls	21.0 ± 6.5	8/8	4.9 ± 2.7	6/8
2	vaccinates	24.0 ± 6.1	6/8	10.8 ± 2.4	1/8
	intubates	3.7 ± 2.1	3/3	6.3 ± 1.5	3/3

Isolation and characterization of mycoplasma proteins that induce protective immunity would lead to new and probably cheaper ways of producing a vaccine such as genetic engineering. Before this can be done, the protein(s) have to be identified. The identification of the proteins was achieved by surface labeling the mycoplasma (F-38) with radioactive iodine and carrying out immunoprecipitation with antisera made in goats and rabbits, which have specific activity against mycoplasma (F-38). The antigen(s) were identified from the radio-labeled mixture by specific precipitation and analyzed by polyacrylamide gel electrophoresis followed by autoradiography. Three proteins were precipitated with growth inhibiting sera from rabbits and goats immunized with F-38 antigens and were not precipitated by preimmunization sera nor a pool of normal goat or rabbit sera. The three proteins were found to have molecular weights of about 1.6×10^5, 1.3×10^5 and 1.1×10^5. These same proteins were precipitated by sera from goats which had undergone natural infection (contact) and recovered. The mycoplasma proteins prepared as for immunoprecipitation were run on disc polyacrylamide gels and the proteins corresponding in molecular weight to those specifically precipitated by the growth inhibiting sera were cut out. The protein bands were used to immunize rabbits. Sera from the rabbits were tested for growth inhibition. The rabbit sera from both rabbits immunized with the protein of molecular weight 1.6×10^5 were found to inhibit growth, suggesting that the protein(s) responsible for induction of growth inhibiting antibody to F-38 in goats or rabbits had been identified.

Dr. Fred Rurangirwa, WSU's on site coordinator in Kenya, is the primary person involved with this research. His collaborators include Drs. A. Kibor, J. Bari, S. Waghela, A. Wambugu, C. Nkonge and A. Musoke.

iii. SR-CRSP also plans to determine whether the field trypanotolerance noted in indigenous breeds of goats is mediated by environmental influences.

This work forms the basis for Dr. Derrick Mwamachi's master's thesis at WSU. He completed his coursework in February 1984 and returned to Kenya to begin his research. The project has purchased and bred 100 goats. The trypanosome clone has been made and soluble antigen including variant surface glycoprotein is being isolated for injection.

iv. Another SR-CRSP objective is the continuing monitoring of goats for the presence of caprine arthritis encephalitis virus (CAEV).

No new cases of the infection have been found in Kenya. Testing is currently being done on blood samples from 300 sheep and goats. These samples will be evaluated by a new serologic test developed at WSU. Preliminary work shows the test is more sensitive than the test used previously and may pick up cases missed in previous surveys.

v. SR-CRSP is monitoring goats introduced to project sites in Western Kenya to determine health problems.

This task is the work of Dr. Robert Shavulimo and several other members of the SR-CRSP team at Maseno. Initial problems with internal parasites have been brought under control by drenching. Procedures to minimize mastitis have been introduced. Current problems of mineral imbalance are being evaluated. A report of the past year's findings is included in the 1984 workshop proceedings.

7. Personnel Collaborating on Project Activities:

Training:

WSU is operating a training program designed primarily to provide Kenyans with the necessary education for a master's degree in veterinary science. Kenyan veterinarians working for the MALD study at WSU for one year to complete the necessary coursework then they return to Kenya to complete their research. Once the thesis is completed and accepted by a committee in Kenya, it is transmitted to WSU where a committee in the College of Veterinary Medicine reviews and accepts it. By arrangement with the WSU Graduate School, the student does not have to travel to campus to defend the thesis.

J. Bari and S. Mbwiria are the first two students to complete their degrees under this program.

S. Mbwiria, a veterinarian working for the MALD, recently completed his master's degree. His research involved selenium, a microelement important for animal health and production. A systematic mapping technique based on blood, forage and soil selenium concentrations was employed to locate areas of selenium deficiency, adequacy or excess in selected areas of Kenya. Using blood samples, forage samples and soil samples, Dr. Mbwiria found that the percentage of selenium deficiency in sheep and goats varied from 3% to 76% depending on season and the area of Kenya. Goats had generally higher blood selenium concentrations than sheep except in the Siaya-Kakamega-Maseno area.

Forage samples had a range of 0.03 to 0.66 ppm selenium concentration. Napier grass from the Yatta division of the Machakos area was found to have the lowest selenium concentration. The difference between pasture selenium concentrations in the wet and the dry seasons was statistically significant ($p < 0.05$); soil selenium concentrations ranged from 0.06 to 0.98 ppm.

This research indicates that it may be necessary to add selenium to the diets of small ruminants in certain areas and at certain times of the year. Publications involving this research are currently being written.

J. K. Bari, also a veterinarian working for the MALD, completed his master's degree this year. He developed an enzyme-linked immunosorbant assay (ELISA) test for detection of contagious caprine pleuropneumonia (CCPP) in goats. In comparison with two standard tests for the disease--complement fixation test (CFT) and indirect fluorescent antibody test (IFAT)--ELISA showed about 90% agreement in

the detection of antibodies to CCPP in field serum samples. The test also detected more goats in subacute disease and more goats were ELISA positive during the latter stages of strain PG3 pathogenicity trials.

The research also involved vaccination of goats with a bivalent vaccine, which resulted in about 82 percent protection. Most of the survivors had high ELISA and CFT antibody levels suggesting some correlation between serum antibody levels and resistant to infection. Antibodies were detected against strain F38 and G290 in field serum samples from Mweiga, indicating the possibility of mixed infections in CCPP outbreaks in Kenya.

The ELISA is easy to perform and is much cheaper than the standard tests in terms of both necessary reagents and equipment. The development of this test is a major step forward in the control of CCPP, which is one of the most economically important diseases of goats in Kenya. A publication on this research is also in preparation.

J. Njanja is a MALD veterinarian who has completed his coursework at WSU. He is now in Kenya performing thesis research on the evaluation of a new anthelmintic for control of nematode infections of goats.

D. Mwamachi is in the same training program. He is a veterinarian working for the MALD who completed his coursework at WSU in February 1984 and has returned to Kenya. His research project involves trypanosomiasis.

E. Oluoch earned her B.S. at the University of Nairobi and is now studying toward a Ph.D. at WSU. Her project involves trypanosomiasis diagnosis and when it is completed she will return to the University of Nairobi faculty.

S. Waghela is a veterinarian and MALD employee who has begun work toward a Ph.D. at WSU. Tentative plans for his research project involve the study of heartwater. He will do his research in Kenya but will return to WSU for his thesis defense.

A. Garmendia is a Peruvian veterinarian with a master's degree who is working toward a Ph.D. at WSU in collaboration with the SR-CRSP animal health component at Colorado State University. His project involves the failure in passive transfer in alpacas. He traveled to Peru to take samples and anticipates returning in May 1984 to begin analyzing his data.

1. Project Title: Kenya Animal Health Research Component.

2. Institutions: Washington State University (WSU) and the Kenyan Ministry of Agriculture and Livestock Development (MALD).

3. Principal Investigator: Travis C. McGuire

4. Funds Allocated for 1983/84:

Subgrant:	$175,000
Matching contributions:	$ 58,275

5. Project Goals:

The project goals for work conducted in the United States are the same as those in Kenya. We are trying to reduce losses to disease while increasing production of milk and meat among small ruminants in Kenya.

6. Specific Objectives, Description of Work and Technical Accomplishments.

i. Some of the work involving trypanotolerance noted previously is being conducted in the United States. The purpose of this research is to determine if any one of the four common milk-producing breeds of goats (Toggenburg, Nubian, Alpine and Saanen) has a comparative advantage in regard to introduction into areas where trypanosomiasis is common. Since the tsetse-infested range in Kenya is such an area, this research might be important in determining which breeds to introduce into the area to increase milk production.

This work involved experimental infection of the four daily breeds with Trypanosoma congolense and subsequent superinfection with T. brucei. The research revealed no major differences with regard to packed cell volume, body weight and parasitemia. It appears, therefore, that none of the four breeds has an advantage over the other in regard to survival in areas where trypanosomiasis is common.

A publication on this topic is in the process of review at WSU.

ii. As part of the effort to monitor CAEV, SR-CRSP helped support a survey of CAEV in 14 countries. The objective was to determine how widespread the virus is.

The 14 countries involved in the research were the United States, Canada, Fiji, France, Great Britain, Kenya, New Zealand, Norway, Peru, Somalia, South Africa, Sudan, Switzerland and Mexico. In only three of the countries surveyed--Somalia, South Africa and Sudan--did the goats have no antibody to CAEV in their sera. Kenya had only one positive sample from non-imported goats and the positive animal had been in contact with imported seropositive goats for several months.

A publication on this topic has been accepted by Veterinary Record.

7. Personnel Collaborating on Project Activities:

i. Training: SR-CRSP has an ongoing training program involving Kenyan and other foreign nationals studying at WSU, but no Americans are in a training status.

Collaborators at WSU include Drs. S. Adams, R. Wescott and A. Barbet.

1. **Project Title:** Sociological Analysis of Small Ruminant Production Systems.

2. **Institution:** University of Missouri-Columbia

3. **Principal Investigator:** Michael F. Nolan

4. **Funds Allocated From:**

Grant No. AID/DSAN/XII-G-0049 from 1983-84 subgrant: $225,000
Matching contribution from 1983-84 subgrant: $75,000

5. **Sub-Project Title:** Paraiba Goat Producers Study

Objectives for 1983-84:

Completion of the field research phase of the project to understand the socioeconomic context of goat production and the prospects for introducing dairy goats among small producers in Paraiba.

Analysis of the research data at the University of Missouri and preparation of final report and of MA thesis.

6. **Work Undertaken and Technical Accomplishments:**

Marisa Neumaier finished conducting the in-depth interviews of Paraiba sample. She also collected data from other secondary sources and then returned to Missouri in May 1983. There, she analyzed all of the data and presented it as her MA thesis and is in the process of adapting the material for presentation as a CRSP technical report. Her thesis, "The Social Organization of Peasant Goat Production in Northeast Brazil", arrives at several conclusions:

i. There is great variability among small producers regarding their central economic orientation;

ii. Small producers were primarily subsistence producers, and that subsistence strategies were affected by the general level of income and by a high dependence on crop production;

iii. Producers were not able to change production strategies rapidly;

iv. They were incorporated into the market economy and therefore were affected by changes in this economy;

v. That for a complex set of economic reasons the introduction of dairy goats is unlikely to be successful even though the small producers are, in principle, favorable to this.

7. **Personnel Collaborating:**

M. Neumaier, Graduate Research Assistant, University of Missouri.
C. Zometa, Resident Scientist, Texas A & M.
G. Primov, Resident Scientist, University of Missouri.
J. Gilles, Co-PI, University of Missouri.

8. Sub-Project Title: Social Organization of Goat Production in Bahia.

Objectives for 1983-84:

Completion of the field research phase of the project to understand the role of goat production within the farm production system of small producers in Bahia.

Analysis of the research data at the University of Missouri and preparation of final report.

Work Undertaken and Technical Accomplishments:

George Primov finished conducting the in-depth interviews of the Bahia sample. He also collected data from other secondary sources and then returned to Missouri in June 1983. There, he analyzed all of the data and presented it as a CRSP technical report. Primov's technical report, "Goat Production within the Farming System of Smallholders of Northern Bahia", concluded that:

i. The main constraint on goat production is disease, especially caseous lymphadenitis;

ii. Goats are produced mainly to satisfy household needs for meat, milk and cash;

iii. Goats are regarded as best suited for surviving dry season stress and are easiest to manage;

iv. The specific advantage in producing goats lies with their production system. The reason that these small producers produce goats is that these animals require almost no investments. If their production system were to be made more complex or costly, then goat production might decrease.

9. Personnel Collaborating:

R. Nobre (EMEPA)
A. Rodrigues (EMEPA)

1. **Project Title:** Sociological Analysis of Small Ruminant Production Systems.

2. **Institution:** University of Missouri-Columbia and Balai Penelitian Ternak

3. **Principal Investigator:** Michael F. Nolan

4. **Funds Allocated From:**

Grant No: AID/DSAN/XII-G-0049 from 1983-84 subgrant:	$225,000
Matching contribution from 1983-84 subgrant:	$75,000

5. **Project Goals:**

   i. To develop an understanding of the social and cultural context in which small ruminant production occurs.

   ii. To describe the framework within which small ruminant producers in Java allocate resources and make decisions.

   iii. To undertake detailed studies of the role of women, characteristics of non-producers of small ruminants and animal sharing arrangements.

   iv. To increase the capability of BPT to carry out sociological analyses with its own staff resources.

6. **Sub-Project Title:** Village Trader Study

   Objectives for 1983-84:

   i. To study the variation and functions served by the village collector and how this is related to factors such as average herd/flock size, distance to market, frequency of market days, etc.

   ii. Assess the possibilities of village collectors serving as change agents through a study of their social relationships with villagers, including the feasibility of using these persons for drop schemes, credit schemes, buck/ram services, etc.

   Work Undertaken and Technical Accomplishments:

   A major data collection effort related to the role of the villager trader was undertaken in Central Java by collaborators at Satya Wacana University during 1983-84. The data are now all collected and are being analyzed and the final report of this project is expected by mid 1984. Preliminary analyses of the data indicates that a major problem facing the typical small farm producer of sheep and goats is the high transaction cost involved in marketing a single animal, particularly when the animals are often not sold but brought back to the village by the owner. The village collector serves the role of reducing these costs by collecting larger numbers of animals, holding them for short periods of times and selling large numbers of animals during a given market day. These traders also can serve the role of finance and

production costs, placing animals with other farmers on sharing arrangements and serving as a source of technical advice on small ruminant production.

Personnel Collaborating:

Kedi Suradisastra, BPT
John Ihalauw, Satya Wacana University
Henk Knipscheer, SR-CRSP Resident Scientist (Economics)

7. Sub-Project Title: Characterization of Non-Small Ruminant Producers in West and Central Java

Objectives for 1983-84:

i. To identify differences between producers and non-producers of small ruminants of West and Central Java.

ii. To identify constraints on production and the factors farmers consider in deciding to raise or stop raising small ruminants.

Work Undertaken and Technical Accomplishments:

Data collection for this project was begun in late 1983 and is expected to be completed by mid 1984. The data base will nicely supplement data already in hand from small ruminant producers. To date, the SR-CRSP has only collected data from those producing small ruminants yet in some villages this does not constitute even a majority of farm households. This project seeks to develop an understanding of the differences between producers and non-producers and why some farmers choose to raise small ruminants and others do not. It also will seek to document whether or not systematic constraints exist which are preventing a greater proportion of farmers from entering small ruminant production.

Personnel Collaborating:

Kedi Suradisastra, BPT
John Ihalauw, Satya Wacana University
Henk Knipscheer, SR-CRSP Resident Scientist (Economics)

8. Sub-Project Title: Women's Roles in Small Ruminant Production

Objectives for 1983-84:

i. To develop an understanding of women's roles and responsibilities in small ruminant production and management.

Work Undertaken and Technical Accomplishments:

Planning for this study was undertaken in 1983-84. It is expected that data will be collected during the period April-June, 1984 and Central Java will be the site of the first phase of the study. In the latter part of 1984 a similar study will be undertaken in West Java.

To date, all small ruminant CRSP data has been collected from men by men yet there is good reason to believe that women play a crucial role in the small ruminant production process in Javanese villages. This project will seek to document and understand that role and in so doing provide the information useful in developing outreach programs.

Personnel Collaborating:

Sri Wahyuni, BPT
Kedi Suradisastra, BPT
John Ihalauw, Satya Wacana University
Henk Knipscheer, SR-CRSP Resident Scientist (Economics)

9. Sub-Project Title: Monthly Meetings of Farmers in West Java Study Locations

Objectives for 1983-84:

i. The monthly meetings are designed as a systematic effort to increase contact between researchers and farmers. The farmers have the opportunity to be informed about sheep/goat husbandry techniques and the researchers can become better acquainted with those issues of greatest concern to farmers. Such interchanges are essential for any program of technology transfer to be successful. Monthly meetings of farmers with a particular BPT discipline group (e.g. breeding, nutrition, socio-economics) are held throughout the year. The coordination is carried out by the socio-economics group. This program has been very successful in terms of establishing a base which has allowed the SR-CRSP and BPT to successfully conduct research in the village situation.

Personnel Collaborating:

Kedi Suradisastra, BPT (Coordinator)
All SR-CRSP Resident Scientists and BPT Collaboratng Scientists

10. Sub-Project Title: Training Activities

Objectives for 1983-84:

During 1983-84 the SR-CRSP sociology project sponsored Syahrar Mawi's Master's Degree program IPB in Bogor. Informal training efforts were undertaken with Sri Wahyuni (BPT) to acquaint her with survey data collection techniques.

1. **Project Title:** Sociological Analysis of Small Ruminant Production Systems.

2. **Institution:** University of Missouri-Columbia and Ministry of Agriculture and Livestock Development (Kenya).

3. **Principal Investigator:** Michael F. Nolan

4. **Funds Allocated from:**

Grant No. AID/DSAN/XII-G-0049 from 1983-84 subgrant:	$225,000
Matching contribution from 1983-84 subgrant:	$75,000

5. **Project Goals:**

   i. To develop a body of information which would allow for the assessment of technological interventions and management strategies related to dual purpose goats regarding their likelihood of acceptance within the West Kenya small farm population.

   ii. Assess whether the existing infrastructure could adequately support the dual purpose goat package being proposed.

   iii. Through graduate training and technical support, to increase the capability of the Ministry of Agriculture and Livestock Development to conduct sociological research related to agricultural/livestock production problems in Kenya.

6. **Sub-Project Title: Support for Institution Building in MALD.**

   i. Objectives for 1983-84:

   To identify and facilitate the hiring of an MALD counterpart scientist for sociology.

   ii. Work Undertaken and Technical Accomplishments:

   During 1983-84 a counterpart research scientist was identified and hired by the Ministry of Agriculture and Livestock Development. Mr. Adial Nkonge Mbabu became an MALD employee in September 1983 and has been residing in Maseno where he has taken an active role in research activities. Current plans are for Mr. Mbabu to begin his PhD program at the University of Missouri in September 1984.

   iii. Personnel Collaborating:

   J. Eric Reynolds, Resident Scientist, University of Missouri
   A. N. Mbabu, MALD

7. **Sub-Project Title: Annual Agricultural Shows.**

   i. Objectives for 1983-84:

   To coordinate SR-CRSP exhibits at annual agricultural shows in Western

Kenya.

ii. Work Undertaken and Technical Accomplishments:

The sociology project has been providing coordinating assistance for the SR-CRSP exhibits at the annual agricultural shows in Western Kenya. This activity was undertaken in November 1982 and has been carried out twice yearly since then. The objectives of the activity are to inform a wider public about SR-CRSP research work in Western Kenya including the overall aims of the program, the trials and experiments conducted both at the Maseno station and on local farms and the resources the SR-CRSP has at its disposal. It is hoped that through this effort, the SR-CRSP will be able to build up interest and cooperation among local people as well as government personnel. Public response to these exhibits has been very positive.

iii. Personnel Collaborating:

J. Eric Reynolds, Coordinator, University of Missouri.

SR-CRSP Resident Scientists: A. Sidahmed, Winrock International; M. Onim, Winrock International; A. Mukhebi, Winrock International; F. Ruvuna, Texas A&M University; F. Rurangura, Washington State University.

MALD Counterpart Scientists: F. Nyaribo, M. Salim, R. Chavulimu, K. Otieno.

8. Sub-Project Title: Historical Profiles of West Kenya Ethnic Groups.

i. Objectives for 1983-84:

To compile historical and ethnographic profiles of Luo and Luhya study communities with particular emphasis on changing lifestyles and the implications of those for small scale farming and livestock development.

ii. Work Undertaken and Technical Accomplishments:

With the exception of final report writing, the study of historical and ethnographic profiles of Luo and Luhya communities in Western Kenya has been completed. This study aimed at charting out the significant developments which have lead to present circumstances of community life in Western Kenya -- rapid expansion of population, growth of the economic and social amenity facilities, and transformation in crop and livestock production activities -- and assessing their implications for the future. The study should aid researchers in devising new approaches to small scale farm production which will have an effective long-term impact. Substantial information was collected from available archival sources and socio-economic research reports on the study region. In addition, extensive key informant interviews were conducted by the sociology resident scientist, rural sociology field assistants and CBS enumerators during the past year. Further information pertinent to this study will be

collected as part of the case study work on smallholding in the Emuhaya-Maseno areas plans for 1984. One of the major activities during 1983-84 was to more extensively involve and make use of the field enumerators in the collection of data pertinent to the sociological project goals. The objectives of this activity were to develop the capabilities of the enumerators to gather, on their own initiative, information on aspects of community-life relevant to the research and planning needs of the Maseno SR-CRSP team and also to supply such information to all members of the team for possible use in research reports and the design of future studies. Enumerators were trained to keep regular journals in which they recorded their observations. These were turned in on a weekly basis and put on file after discussion. The enumerators were asked to prepare evaluations of their work. In the two summary reports prepared thus far, the enumerators have raised some critical issues related to past approaches to data collection in the study areas; local people's responses to SR-CRSP activities, problems in the monitoring and care of trial goats on local farms and working relationships between research officers and their "people on the ground."

iii. Personnel Collaborating:

J. Eric Reynolds, Resident Scientist, University of Missouri
A. N. Mbabu, MALD
A. Mukhebi, Winrock International
F. Nyaribo, MALD

9. Sub-Project Title: An Evaluation of Extension Services.

i. Objectives for 1983-84:

To develop the participant observation capabilities of the SR-CRSP field enumerators.

To assess the capability of the extension service to deliver technical information to smallholder livestock producers.

ii. Work Undertaken and Technical Accomplishments:

The first of two planned studies related to the effectiveness of the extension service was undertaken in 1983-84. Technical and extension field personnel of the MALD represent an important focus of research for several reasons: 1) they should be readily available to provide information on livestock health and management problems in their areas of posting; 2) they are likely to be quite familiar with local farmers and their circumstances; and 3) the development of a dual purpose goat technology package in Western Kenya must take into account existing livestock extension services and the capability of extension agents to support smallholders efforts by delivering appropriate technical assistance and advice. A study was organized to survey these personnel operating the SR-CRSP on farm study sites and adjoining areas. The survey was laid out in three parts: questions concerning the technical/extension personnel themselves, questions about field staff duties and the communities they serve; questions dealing with

livestock health and management issues. The survey was successfully carried out in five districts in Western Kenya. The second part of this study will deal with how extension services actually reach smallholders and will include an investigation of local farmers' experiences and their views on livestock extension services.

iii. Personnel Collaborating:

J. Eric Reynolds, Resident Scientist, University of Missouri
A. N. Mbabu, MALD

10. Sub-Project Title: Samia Women's Dairy Goat Project: A Reexamination.

In addition, reexamination of the Samia Women's Dairy Goat project was conducted during 1983. This Samia project was the subject of a study conducted earlier by Amanda Noble (SR-CRSP Technical Report No. 18) in 1980-81. Following reports that the project was not fairing well, the possibility of doing a restudy was examined. As a preliminary step to such a restudy a brief assessment of the current status of the project was made by a team of SR-CRSP researcher from Maseno who made two visits to the area to review the situation with members of the women's groups involved and MALD officers in Busia District. It was found that the situation and most of the Samia project units was one of crisis with little prospect of improvment. Mortality rates among the animals were high, overall health conditions were poor and the women's groups seemed disorganized and demoralized. A more extensive restudy of this situation is strongly recommended.

i. Personnel Collaborating:

J. Eric Reynolds, Resident Scientist, University of Missouri
R. Chavulimu, MALD
F. Nyaribo, MALD
M. Salim, MALD

1. **Project Title:** Sociological Analysis of Small Ruminant Production Systems.

2. **Institution:** University of Missouri-Columbia and the Institut Agronomique et Veterinaire

3. **Principal Investigator:** Michael F. Nolan
   Co-PI: Jere L. Gilles

4. **Funds Allocated from:**

   Grant No. AID/DSAN/XII-G-0049 from 1983-84 subgrant: $225,000
   Matching contribution from 1983-84 subgrant: $75,000

5. **Project Goals**

   i. To describe the context in which small ruminant producers make decisions about animal production. Priority in Morocco has been given to decisions concerning pasture and forage utilization.

   ii. To identify the social and economic factors that lead to over use of Moroccan ranges in order to understand what must be taken into account when developing range improvement programs.

   iii. To evaluate the effectiveness of traditional Moroccan resource management systems, particularly the "Agdal" pasture reserve systems, as range management tools.

6. **Objectives for 1983-84**

   a. Conduct baseline survey of t Rheraya Valley.

7. **Work Undertaken and Technical Accomplishments:**

Baseline survey data from the Rheraya Valley study was collected. It has been summarized by village. The data includes information on rules and rituals surrounding the use of the Oukimedene Agdal. A study of the biological basis of the Agdal was begun and a survey of the vegetation in the Rheraya Valley was completed.

8. **Personnel Collaborating:**

   A. Hammoudi, IAV
   M. Mahdi, IAV
   T'hami Ait M'hand, IAV (student)
   L. Mendes, Graduate Assistant, University of Missouri and Utah State University
   P. Peyre, Faculty of Sciences, Marrakech

1. **Project Title:** Sociological Analysis of Small Ruminant Production Systems.

2. **Institution:** University of Missouri-Columbia collaborating with Instituto Nacional de Investigacion y Promocion Agropecuaria, San Agustin University (Arequipa), University of Huancayo and University of the Altiplano.

3. **Principal Investigator:** Michael F. Nolan
Co-Principal Investigator: Jere L. Gilles

4. **Funds Allocated From:**

Grant No. AID-DSAN-XII-G-0049 from 1983-84 subgrant: $225,000
Matching contribution from 1983-84 subgrant: $75,000

5. **Project Goals:**

i. To develop baseline data on livestock production in Peruvian peasant communities.

ii. To develop an understanding of the role livestock production plays within the context of mixed crop-livestock production in Andean peasant communities.

iii. To establish a framework that helps relate animal production strategies to marketing issues.

iv. To explore the social aspects of goat production in Piura-Chiclayo regions.

Sub-Project Title: Privitization of Community Landholdings.

6a. Objectives for 1983-84:

To study the effects of privatization of communities in the highlands of Arequipa and the links between the phenomenon and the kind of technologies employed by pastoralists in the region.

7/8a. Work Undertaken and Technical Accomplishments:

For the study on privitization of communities, nearly all data gathering and fieldwork was completed by April 1984. This work is being undertaken in the alpaca producing communities in Cailloma Province of Arequipa at the extreme upper end of the Colca Valley. The advantage of this location was of its close proximity to the research area of Professor Guillet which allowed for frequent exchanges between the Principal Investigator for this project, Dr. Juan Gomez and Dr. Guillet. Four students were advised by Dr. Gomez during the fieldwork periods. Research is now in the analysis and writing stages. A reconstruction of the events and forces which shapes production systems has been developed for the region. This should contribute to a deeper understanding of traditional production systems.

9a. Personnel Collaborating:

Juan Gomez, University of San Agustine
Pilar Vega, student, University of San Agustine
Corina Rojas, student, University of San Agustine
Juan Mamani, student, University of San Agustine
Paul Macedo, student, University of San Agustine
Keith A. Jamtgaard, Resident Scientist, University of Missouri
David Guillet, Collaborating Scientist, University of Missouri

Sub-Project Title: Family Division of Labor.

6b. Objectives for 1983-84:

To study the family division of labor and pastoral production in the southern Sierra of Peru.

7/8b. Work Undertaken and Technical Accomplishments:

The study of family division of labor was conducted in a community in the Department of Puno which was chosen as the focus of SR-CRSP activities in southern Peru. The community, Quishuara, was selected in part because of its nearness to other SR-CRSP station work sites in the region -- LaRaya and Chuquibambilla. The study objectives focused on the different types of labor providing mechanisms used for alpaca herding and relations between these and certain production indicators. Given that the community was relatively large (over 400 families), it was decided to choose between the two principal population centers opting for the higher altitude village which was the most heavily involved in Alpaca production. Approximately 30 of the planned 40 interviews were conducted by April 1984. Excellent relationships have been established both within the community and with local researchers and development institutions which has permitted interrupted data collection and provides a good base for future SR-CRSP activities in the community. The research assistant conducting this project, Ms. Lidia Jimenez, organized a three day workshop in the community regarding alpaca production. Quechua speaking technicians were brought into the community and approximately 50 community members attended.

9b. Personnel Collaborating:

Lidia Jimenez, Graduate Research Assistant, University of Missouri
Jorge Flores Ochoa, University of Cuzco
Luis Chavez, IICA
Manuel Estofanero, Organization Melgar Micro-Region Project
Keith A. Jamtgaard, Resident Scientist, University of Missouri

Sub-Project Title: Enhance Capabilities of UNA Computer Center.

6c. Objectives for 1983-84:

To upgrade the capabilities of the computing center at the National Agrarian University.

7/8c. Work Undertaken and Technical Accomplishments:

At the request of the Management Entity, a committee was formed and a proposal written to solicit funds and equipment to upgrade the UNA Computing Center in May 1983. The recommended improvements revolved around an upgrade of the IBM 4331 CPU to handle four megabytes of core storage from its current one megabyte capacity. A significantly faster processor would be included as part of the upgrade along with the capability to handle more terminals and communication links. Following its approval, the proposal was circulated among a number of potential donors. By October 1983, AID/Peru had expressed interest in the proposed improvements and the SR-CRSP manifested its enthusiastic support for this possibility. We were later advised that AID and UNA had reached agreement on the improvements and that the items had been ordered. As of April 1984, the upgrade package had not yet arrived but was expected momentarily. The improvements to the UNA Computing Center should have a dramatic impact on the capacity of this system to process research data in-country. One of the biggest obstacles to achieving this end has been the slow response time of the existing system given the heavy demand on it. It should be added that the SR-CRSP has had a major role in increasing faculty and graduate students usage of the machine by providing the statistical analysis system (SAS) to UNA. The rural sociology resident scientist had filled the role of providing technical support for SAS.

9c. Personnel Collaborating:

Ben Quijandria, SR-CRSP, University of California
Grimaldo del Solar, Nacional Agrarian University
Domingo Saenz, Nacional Agrarian University
Domingo Martinez, Nacional Agrarian University
Keith A. Jamtgaard, Resident Scientist, University of Missouri

Sub-Project Title: Social Relations in Mantaro Valley:

6d. Objectives for 1983-84:

Undertake a study of the social relationships of production of the peasant communities in the highlands of the Mantaro Valley.

7/8d. Work Undertaken and Technical Accomplishments:

The project on the social relationships of production in the Mantaro Valley has been lead by Professor Rual Santana. It is involved with assessing the social relationship known as "mishipa" which is associated with exchanging herding labor for access to pastures. One of the two students involved with Professor Santana was incapacitated early in the year and unable to complete his thesis research. The other student, Juan Zamudio has completed his fieldwork and is now engaged in the elaboration of his final report which will serve as the basis for his bachelor's degree thesis. Communities belonging to SAIS Cahuide and Tupac Amaru were selected for fieldwork. While the importance of a parrallel relationship that of the "Huachilleros," has

been relatively well documented in the case of former haciendas (now Agrarian Reform Enterprises). Little is known about the case of communities and the existence of mechanisms for exchanging labor for access to pastures.

9d. Personnel Collaborating:

Raul Santana, University of Huancayo
Juan Zamudio, student, University of Huancayo
Miriam Castillo, student, University of Huancayo
Narda Ibanez, student, University of Huancayo
Keith A. Jamtgaard, Resident Scientist, University of Missouri

Sub-Project Title: The Effects of El Nino on Goat Production in Northern Peru.

6e. Objectives for 1983-84:

To assess the consequences of the "El Nino" rains for livestock production in northern Peru.

7/8e. Work Undertaken and Technical Accomplishments:

The major sociological activity in the northern goat project has been completed and published in Technical Reports. Dr. Avi Perevolotsky made a return visit to the north to evaluate the effects fo the El Nino phenomenon on goat production systems there during the Summer of 1983. Hugo and Christina Rojas completed their work in the community of Salas and in addition the projects of Huaman and Cordoba were completed as well. Probably the most complete inventory of limited resource small ruminant producers for geographical region of Peru has been assembled for the goat producing area of northern coastal Peru. Important benefits are already occurring in that a goat production project sponsored by IDRC is able to take advantage of this information to give their project a more realistic orientation.

9e. Personnel Collaborating:

Avi Perevolotsky, University of California, Davis
Hugo Rojas, Center for Agricultural Research
Christina Espinoza, Center for Agricultural Research
Hildegardo Cordova, University of San Marcos
Nicole Debernux, University of San Marcos
Marta Huaman, student, University of Pedro Ruiz Gallo-Lambayque

Sub-Project Title: Community Clarification Study

6f. Objectives for 1983-84:

To organize census data on peasant communities and develop a classification scheme.

8/7f. Work Undertaken and Technical Accomplishments:

Efforts continued in 1983-84 to organize and analyze the peasant community census data and to link it with other data sources to provide the most complete data bank available to researchers and develop institutes in Peru. Some 60 data fields were chosen for verification with original questionnaire forms. Population data from the 1972 census was obtained and entered into the data bank at the community level. Analysis also continued toward the development of a typology of peasant production systems. All work has been completed on verifying and cleaning the various data sources. Master tapes will be distributed at the end of May 1984 to the sponsoring institutions.

9f. Personnel Collaborating:

Jose Portugal, Dreccion de Comunidades Campesinas
Ivan Pardo, Dreccion de Comunidades Campesinas
Victoriano Caceres, Dreccion de Comunidades Campesinas
Keith A. Jamtgaard, Resident Scientist, University of Missouri

Sub-Project Title: Agricultural Intensification and Livestock Production

6g. Objectives for 1983-84:

To study the efforts of agricultural effects of agricultural intensification for livestock production in the Colca Valley of Arequipa.

7/8g. Work Undertaken and Technical Accomplishments:

The study on intensification of agricultural production has been undertaken during 1984-84. Ethnographic fieldwork was started in the community of Lari in the Colca Valley of Arequipa. A household census, an animal census, detailed survey of the irrigation and high altitude herding systems, over 54 generation geneologies and a questionnaire on agrarian change have been collected. In addition, documents on agro-pastoralism from the 16th century have been collected and paleographic transcriptions made. They have not as yet been analyzed. The tentative outlines of a set of findings would include: 1) the interrelations of the introduction of alfalfa, the decline of communal pastures and a 30 year decline in rainfall; 2) familiar herding management strategies; 3) communal responses to drought.

9g. Personnel Collaborating:

Flora Cutipa, University of San Agustine, student
Etelmi Cruz, University of San Agustine, student
Cristobil Gonzalez, University of San Agustine, student
Juan Gomez, University of San Agustine
David Guillet, Collaborating Scientist, University of Missouri

1. Project Title: Small Ruminant Flock/Herd Health Program in Smallholder Systems.

2. Institution: University of California, Davis in Collaboration with the National Center for Goat Research - Brazilian Enterprise for Agricultural Research (CNPC-EMBRAPA)

3. Principal Investigator: Harvey J. Olander

Grant No. AID/DSAN/XII-G-0049 1983/84 Subgrant Funds Allocated:	$175,000
UCD Matching Funds	$59,228

4. Statement of Project Goals:

The major constraint to livestock production in Northeast Brazil is considered to be the uncertain supply of feed and water. However, these deficiencies are both aggravated by and predisposing to serious animal diseases which include the full spectrum of causative agents from worms and poisonous plants to viruses and nutritional imbalances.

The major goal of the animal health project is to develop the means for controlling the major disease problems of goats in the Northeast and thereby increase the productivity of the goatholder. Research projects have been selected in large part on the basis of the importance of the disease processes as recognized by the Brazilians and confirmed by field surveys. Furthermore, the project is pursuing research which has a reasonable chance for success not only in terms of controlling the diseases in question but also in developing research capabilities, both physical facilities and trained personnel, that are needed and will continue to serve the animal industry in Brazil in the future.

Intestinal parasitism, caseous lymphadenitis and pneumonia have been identified as the major disease processes which are important to the Brazilians and can be studied with expectation of success at CNPC. The project has provided support for the existing parasitology, pathology and clinical pathology research laboratories and has developed laboratory facilities and trained technical personnel for a functional bacteriology laboratory which is a prime necessity for continued progress in research on infectious diseases. This work has been in collaboration with Brazilian veterinarians at CNPC working within the framework of the EMBRAPA research projects. The animal health project also has attempted to integrate with other CRSP projects by providing consultation and collaboration in projects in which health factors have been significant.

5. Specific Objectives at CNPC in 1983-84:

i. Support of the longterm projects on the dynamics of intestinal parasitism in sheep and goats in the desert conditions of northeast Brazil was continued.

ii. Studies on bacterial pneumonias were expanded to include microbiologic investigations not previously available.

iii. A microbiology laboratory was established Dr. Mary Sawyer who also

trained a Brazilian veterinarian, C. Almeida, to carry on the work. (After Dr. Sawyer's departure, Dr. Almeida left the employ of CNPC for personal reasons, primarily involving returning to her family in Minaus Gerais. The function of the laboratory was maintained by the placement of Dr. Corrie Brown, a UCD graduate student, at the Center to pursue research on caseous lymphadenitis. In the process she is training a Brazilian veterinarian, Dr. Francisco Selmo, and a lay technician who are native to the region. We also have been successful in arranging for a research veterinary bacteriologist, Dr. Eugene Johnson, to join the CNPC staff under the aegis of IICA.)

iv. An investigation of the pathogenesis of caseous lymphadenitis and the significance of the subclinical infection while developing and using the necessary bacteriologic and serologic capabilities was begun by Dr. Mary Sawyer and Dr. John Sawyer and is being continued by Dr. C. Brown.

6. Specific Objectives at UCD in 1983-84:

i. The pathogenesis of caseous lymphadenitis was studied by experimental infections in goats to provide baseline serologic parameters for field work in Brazil.

ii. Studies on the etiology and natural history of mastitis and other periparturient diseases in goats were completed.

iii. Studies on mycoplasmosis including the natural history of the severe disease of young goats and the prevalence, pathogenicity and characteristics of various Mycoplasma spp. in goats were continued.

iv. Studies on the epidemiology and control of round worms of small ruminants in pasture management systems in support of a graduate program at UCD for Dr. Terezhina Charles, an EMBRAPA scientist were begun.

v. An attempt is being made to establish a goat herd free of Caprine arthritis-eincephalitis (CAE) virus and Mycoplasma infection to provide a safe source of animals for research and breeding.

7. Work Undertaken and Technical Accomplishments at CNPC:

i. Parasitologic studies have been carried on by Carlos Costa and Luis Vieira with CRSP support. The effect on GI parasitism of keeping goats on elevated slotted floors during the nighttime holding period was compared to holding on solid floors. The results follow in Table 1.

The results indicate that housing had no effect on the parasite loads in the abomasum and large intestine in either wet or dry seasons. However there is an apparent affect on the small intestinal population during the wet season.

Studies on the seasonal variation in parasite loads and transmission were also analyzed. Necropsy of 30 kids 12 months of age

Table 1. Median number of roundworms in 34 kids maintained for 42 days in different nightly housing.

Organ	Season	Solid Flooring	Slotted Floors
Abomasum	Dry	70.4 (5)*	65.6 (7)
	Wet	915.4 (12)	961.6 (10)
Small Intestine	Dry	0.4 (5)	0.3 (7)
	Wet	5.4 (12)	49.4 (10)
Large	Dry	2.2 (5)	1.9 (7)
	Wet	0.5 (12)	1.2 (10)

* Parenthetic figures represent number of animals examined.

indicated that parasitism was maintained throughout the year with heavier parasite loads in February, April, June and October. The parasites identified included Haemonchus contortus, Strongyloides papillosus, Trichostrongylus colubriformis, =Oesophagostomum columbrianum, Trichuris Sp. and Skrjabinema sp. By necropsy of 50 worm free tracer kids exposed to pastures in groups of 3 for 30 days it was observed that transmission of parasites occurred only from March to May coincidental with the second half of the rainy season and the beginning of the dry season.

ii. Preliminary bacteriologic examinations have been made of the pneumonias considered to be the major cause of deaths in goats at the CNPC. Pasteurella and Corynebacterium sp. have been the predominant agents isolated.

iii. A microbiology laboratory capable of providing bacteriology and serology support for research on caseous lymphadenitis, mastitis and mycoplasmosis was established by Dr. Mary Sawyer and maintained by Dr. Corrie Brown. From March 1 to June 30, 1982 Dr. Mary Sawyer and Dr. John Sawyer cultured 64 abcess specimens, processed 1600 serum samples by the synergistic hemolysin inhibition (SHI) test, cultured 72 mastitis samples for bacteria and mycoplasma, and 31 additional tissues including lungs for routine bacteriology. The sensitivity and specificity of the SHI test were determined to be 99% and 95% respectively in 166 samples from animals known to be positive (by culture of abcesses) or negative (by precolostral collections from kids). It was determined that vaccination with the EMBRAPA vaccine did not produce an SHI titer and that 12 of a group of 19 isolated vaccinated kids and 7 of 16 isolated non-vaccinates seroconverted when exposed to infected premises 12 to 20 weeks after vaccination. This suggests the vaccination provided little or no protection against infection. Of 124 animals with abscesses tested on 6 premises 111 (89.5%) had positive SHI tests. Drops in titer were observed in a limited number of animals which were tested after lancing the abcesses. All precolostral serum samples tested were negative, and the youngest age of goats with positive titers was 4 1/2 mo. One goat herd was found from which no animal with a positive titer was found by repeated extensive testing. This herd has and will be used as a

source of susceptible kids for natural exposure to infected premises.

These studies and findings are currently being expanded upon by Dr. C. Brown and Dr. Francisco Selmo (the Brazilian in training).

8. Work Undertaken and Technical Accomplishments at UCD:

i. It was established that following intradermal inoculation C. pseudotuberculosis of goat origin readily produced local abscesses in kids while that of horse origin did not. Intranasal inoculation of pure suspensions of the organism did not produce infection with either strain. SHI titers correlated directly with the development and presence of abscesses.

ii. In a study of mastitis of 2522 dairy goats from 12 herds in Northern California 20.0 to 23.1% were associated with bacteria and 0.8 to 1.6% with Mycoplasma. Coagulase negative staphlococci were the most common bacterial isolates. There was no correlation between age or kidding date and infection. Nubian goats were at greater risk than other breeds, and risk of infection correlated directly with length of dry period and length of lactation.

iii. It was determined that Mycoplasma mycoides subsp. mycoides is a common cause of mastitis, polyarthritis, pneumonia and high kid mortality. The organism is transmitted by ingestion of colostrum in which the organism is shed heavily by infected dams. Experimental inoculations demonstrated the extreme pathogenicity of the agent for young goats.

iv. Preliminary results indicate that the epidemiology of stomach worm infection of small ruminants (sheep) is different from that of cattle. Larger numbers of infective larvae are present in the lumen of the abomasum in sheep compared to cattle. The effect of this on transmission in normal pasture management systems is being determined.

v. The dairy goat herd at U.C.D. is well on its way to being CAE and Mycoplasma free through a combination of serologic testing, culling and pasteurization of all colostrum fed to kids.

9. Collaborators and Trainees:

Carlos Costa, DVM, MS parasitologist, CNPC.
Luis Vieira, DVM, parasitologist, CNPC.
Janete Santa Rosa, DVM, MS, pathologist CNPC; planning to begin PhD studies at Davis in 1985.
Francisco Selmo, DVM trainee in bacteriology, CNPC; planning MS training in Brazil and PhD at UCD.
Terezhina Charles, DVM, MS parasitologist in PhD program at UCD with Dr. Norman Baker. Completion of PhD expected in 1985.
Corrie Brown, DVM, pathologist, graduate student in PhD program at UCD; currently working at CNPC and expected to complete PhD in 1986.
Norman Baker, DVM, PhD, parasitologist, UCD.
Mary Sawyer, MS, PhD, microbiologist, UCD.
John Sawyer, DVM, MPVM, clinical scientist, UCD, USDA.

Ernest Biberstein, DVM, PhD, bacteriologist, UCD.
Nancy East, DVM, MPVM, clinical scientist, UCD.
Al Damassa, PhD, microbiologist , UCD.
Dale Brooks, DVM, PhD, microbiologist, UCD.
B.I. Osburn, DVM, PhD, pathologist, UCD.
B. McGowan, DVM, clinical scientist, UCD.
E.F. Birnie, DVM, MPVM completed 1983, UCD.
K. Carberry, DVM, MPVM completed 1983, UCD.
F. Arguello, DVM, MPVM completed 1983, UCD.
M. da Silva, DVM, MS, PhD, clinical pathologist, CNPC.
E. da Silva, DVM, clinical scientist, CNPC.
J. Kleber, DVM, clinical scientist, EMEPA.
R. Bondurant, DVM, clinical scientist, UCD.

1. Project Title: Breeding and Management of Sheep and Goats to Maximize Meat and Milk Production in Arid and Tropical Environments.

2. Institution: Texas A & M University
Texas Agricultural Experiment Station

3. Principal Investigator: Maurice Shelton

4. Funds Allocated From:

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant:	$200,000
Matching Contribution from 1983/84 Subgrant:	$66,667

5. Brief Statement of Project Goals:

The initiation of the SR-CRSP activities in Brazil coincided somewhat with the establishment of the EMBRAPA-CNPC Center at Sobral, Ceara in Northeast Brazil. Conditions in Northeast Brazil approximate to varying degrees that found in many developing countries where sheep and goats make important contributions. Thus, working with and developing the research capability of the CNPC group of researchers at Sobral offered the possibility in the near term of generating useful research information and of developing at the center the capability of making important long-term contributions. Production conditions and genetic resources of the area have been described by Shelton and Figueiredo (1982).

Goals of Breeding Efforts

The Texas A&M University component in Brazil was initially charged with the responsibility for genetics or breeding. However, the 1983/84 project year marks the first full year in which this institution has been responsible for a management component as well. A brief restatement of the objectives for each of these components will be attempted.

In an area with the environmental and socio-economic constraints which characterize Northeast Brazil, the presence of adapted, productive genotypes is an indispensable requirement for efficient animal production. If these do not already exist, they must be either introduced or created based on breeding programs within the country. The overall goals of the CRSP breeding project in Brazil may be stated approximately as follows:

i. To describe the existing genetic resources (breeds) to facilitate communication and reporting.

ii. To characterize the distinctive genotypes (or breeds) in respect to their performance traits as a guide to determining their utility in an overall breeding and productive strategy.

iii. To identify the environmental constraints to production and the individual animal characteristics which contribute to improved adaptation and productivity, with the view that emphasizing some of these in selection might increase efficiency of selection.

iv. To collect or obtain the necessary genetic parameters and design and place in motion the indicated long-term improvement programs.

v. To evaluate the potential gain which might be realized from introducing selected exotic genotypes.

vi. To attempt to extract from the work in the U.S. and Brazil the maximum amount of information which may be transferable to other areas or other environments.

If each of these goals is pursued in series and carried to a relative completion, many decades and extensive resources would be required. To a substantial degree they have been pursued in parallel and some progress on each aspect has been realized.

Management Goals

It must be realized that breeding efforts are of a long-term nature and may never be carried to finality. By contrast, alteration of management practices offers the potential for immediate improvement, but requires repetition with season or each generation. In the near term, management, in the broadest context, offers the only means of bringing about quick improvement. Even in an adverse environment such as Northeast Brazil, few problems of a technological nature are encountered in suggesting practices which will bring about improved productivity. However, serious problems of a socio-economic nature are encountered in implementation of known technology. Thus, the overall goal of the management component of this project is to:

a. Ferret out those practices based on existing or new technology which can be implemented or recommended for implementation within the socio-economic constraints existing in Northeast Brazil and other similiar environments, and which have a high probability of making a contribution to improved productivity.

b. The management component of the TAMU SR-CRSP project was asked to evaluate the potential for, and to assist in, the development of guidelines for dairy goat production in the Northeast. This work has up to now been centered in Paraiba; however, the CNPC also has plans to take initiatives in respect to dairy goats.

6. Statement of Specific Objectives for 1983/84:

Breeding

a. Continue with establishment of breeding flocks and routine data collection.

b. Initiate preliminary analysis of data collected relating to the Morada Nova flock at Quixada.

c. Initiate planning of long-term improvement strategy for sheep and goats.

Dairy Goat Production

a. Collect preliminary data on levels of production which could be used to evaluate the feasibility of dairy goat production in the Northeast.

b. Evaluate alternative ration formulations or ration supplements which could be used to improve production in the area.

c. Assist workers at EMEPA to establish a viable research program which could provide long-term service to sheep and goat producers in the state of Paraiba.

Management of Sheep and Goats

Initiate studies designed to ferret out those practices based on existing or new technology which can be implemented or recommended for implementation to improve meat production from sheep and goats within the environmental and socio-economic constraints existing in Northeast Brazil.

7. Description of Work Undertaken:

Breeding

Breeding work consisted primarily of a continuation of the establishment of flocks and data collection relating to the following projects:

Title: Selection Criterion for Morada Nova Sheep Adapted to Production Conditions of Northeast Brazil.

Title: Evaluation of Crosses of Native and Exotic Breeds of Goats of the SRD type in Northeast Brazil.

Title: Evaluation of Genetic Resources of Sheep and Selections Based on Weight and Elimination of Genetic Defects

Title: Evaluation of the Comparative Productivity of Exotic and Native Goats and Crosses Between These (for Milk and Meat Production) in the State of Paraiba.

Dairy Goat Production Systems

Much of the work undertaken during the year had to do with feeding regimes. This approach derived from two factors. First, the area of Northeast Brazil, and especially that surrounding Fazenda Pendencia, has been hit by a severe drouth lasting for over 18 months. Thus, feeding for animal survival became a major activity at the station. Second, it is generally recognized that feed or nutrition is a major limiting factor to all types of production in the region and thus a high priority subject for investigation. Some of the studies undertaken by the TAMU component or in collaboration with other disciplines are: a comparison of buffel grass and sorghum hay for lactating goats, a comparison of algaroba pods vs. corn as a energy source and cottonseed meal vs. varying levels of urea as a protein source, an investigation of cutting date of cunha (Clitoria ternatea) on production and

nutritive value, the influence of system of feeding for early weaned kids, voluntary consumption of various feedstuffs (silage, hay, cactus, grass and complete ration) for lactating goats maintained in confinement, comparisons of cottonseed meal vs. legume hay and various NPN sources as protein sources for lactating goats and age of initiation of rumination of kid goats of the Anglo Nubian and Parda Alema breeds. Manuscripts have been prepared covering essentially all these studies and can be made available to interested parties, but these data will be abstracted briefly in the following section of this report.

Other Management Studies

One study was conducted utilizing energy (molasses), protein (NPN) or combinations of these for replacement goats grazing caatinga. Another study was concerned with feeding chopped, thornless cactus to Santa Inez lambs along with supplements of algaroba and cunha hay or molasses-urea. Another study concerned the evaluation of the productivity of Santa Inez sheep in the micro region of Dos Cariris Paraibanos. Still another study involved the slaughter characteristics of castrate and intact male goats which are surplus to dairy programs. The results of some of this work are available in manuscript form and others will be reviewed briefly in the following section.

8. Technical Accomplishments:

Breeding

In the project concerned with Morada Nova sheep, 345 ewes were exposed to rams in the fall of 1983. Of this number 326, or 94.5 percent, were mated, 12 percent returned to service and as of this writing 282 ewes have lambed with a lambing rate of 126 percent. This flock is currently made up of three selection lines. The birth, weaning and 12-month weights for the lines are shown in Table 1. These weights are low, and this represents the primary problem with this flock and to some extent the sheep of the area. The females weighed heavier at 12 months than the males. However, the primary explanation for this is that the two sexes were not managed the same after weaning. The reproductive rate in this flock is reasonably satisfactory. The major challenge is to find a management system or systems which will promote better growth rates. The data from this flock is currently being analyzed and should be complete by the end of the program year. In the project concerned with crossbreeding of goats at Fazenda Iracema, 400 does were exposed for mating in the fall of 1983. Of this number 317, or 79.3 percent, were mated and 36, or 11.4 percent, of those mated returned to service. As of this writing, and thus based on incomplete data, only 148 does have kidded with an average kidding rate of 124.3 percent of does kidding. Although data for this year is incomplete, it agrees with that of earlier years indicating a problem with reproduction in this flock. It is significant that this is a greater problem than with sheep run on the same property, but not necessarily in the same area. In this flock observed abortions are not the problem, but unobserved abortions may be a problem. For the most part, these goats are run on areas which have reverted largely to a cover of panasco grass. Some weights of kid goats are shown in Table 2. These data indicate that with this flock management practices should be an early subject of research. Data on growth rate of crossbred kids from this flock have been analyzed and submitted as a manuscript during the past year.

The project entitled "Evaluation of Genetic Resources of Sheep and Selections Based on Weight and Elimination of Genetic Defects" is conducted on 10 farms in various regions of the state of Ceara. For the most part, the males used are Santa Inez, and thus the results represent a grading up to this breed along with the institution of improved management practices. For the most part, the numbers in the flocks are small (see Table 3). Control flocks of Crioulla have now been established on five farms. The 112 day weights for the 1983 lamb crop are shown in Table 3. It will be noted that these animals show substantially faster growth rates than the experimental flock of Morada Novas. This may be explained by crossing to Santa Inez, smaller flock size and perhaps greater management inputs. If it is determined that the higher lambing rate of the Morada Nova is not a great advantage, the alternative of crossing to the Santa Inez should be considered.

The breeding project at Fazenda Pendencia in Paraiba is primarily an EMEPA-CNPC project. CRSP input is minimal except that a number of CRSP projects have made observations on this flock with Dr. Zometa as the contact person. CRSP (TAMU) financial support has assisted in the maintenance of this flock during the very critical drouth in the area. Also, the results of this study are critical to evaluating the potential for dairy production from goats in the region. A number of short-term evaluations of the three starting genotypes (SRD, Anglo Nubian and Parda Alema) for milk production have been made. The results of all these tend to agree, suggesting that the SRD shows a very low level of milk production, while the Parda Alema produces at a much higher level. All these studies have been conducted with supplemental feeding. There is a very real question concerning the results which would be obtained from non-fed goats and with much longer study periods. Resources available at present do not permit superimposing these types of studies on the overall project.

Management

Sorghum has proved superior to buffel grass hay for goats, and lactating does benefitted from supplemental energy, regardless of the type of forage fed. This study was a collaborative effort with NC State. Algaroba pods can be satisfactorily used for lactating goats. From an energy content they are not comparable to corn, but most of the time they provide a more economical feed source. Urea was a more satisfactory protein source when fed with corn than algaroba, but 1 percent urea in the ration gave reasonably good results regardless of the energy source used. Some data on this study are shown in Table 4. In respect to cutting date for cunha hay, the highest yields were obtained at 90 days, while the maximum feed quality apparently occurred in the range of 45 to 74 days. Feeding value appeared to vary less with age than is the case for many forage species. Legume hays (Conovalia ensiformes and Clitoria ternatea) proved to be satisfactory substitutes for cottonseed meal as protein sources, provided differences in energy content were taken into consideration. Thus, the choice between these should be made based on economics. The mean age for initiation of rumination for kid goats was 24 days and approximately 10 kg. of weight. Manuscripts or reports covering these various studies are listed on the attached pages.

Other Management Studies

In one brief trial, replacement goats reared on caatinga responded to

supplements of urea or molasses, but the best response was obtained from a combination of these treatments. Lambs fed thornless cactus failed to maintain weight whereas those fed algaroba pods and cunha hay or molasses-urea as a supplement to cactus gained weight, with the algaroba-cunha giving a greater response. Slaughter studies with surplus male goats of dairy breeding indicated very low carcass yields (ca. 40%). Castrates tended to have higher yields, but the differences were small.

9. Personnel Collaborating on Project Activities (In Brazil):

Texas A & M University: C.A. Zometa

EMBRAPA-CNPC: Francisco de Assis Melo Lima
Abel Ponce de Leon Bravo

EPACE: Francisco Helio Ferreira Machado
Joao M. de S. Andrade
Moizes Ferreira Neto
Jose Barroso Felho

EMEPA: P.R.M. Leite
W.M. Sousa
W.C. da Silva

Brazilian students at Texas A & M University:
Elsio Antonio P. de Figueiredo
Antonio Amaury Oria Fernandes
Eneas Leite

Other training activities in Brazil:

Dr. C.A. Zometa taught a graduate course in nutrition at a University in Paraiba. He has provided on the job training to five young scientists (traineeships). He has or is currently working with three graduate students at Brazilian Universities.

Dr. Zometa has also presented papers at a number of symposia, short courses and field days throughout the Northeast. Some of these presentations are listed at another point in the attached.

Table 1. Weights of Offspring in Morada Nova Selection Lines

		Females[1]	Males
Line 1	Birth wt. (kg)	2.52 (51)	2.67 (46)
	Wean wt. (kg)	8.81	9.46
	12 mo. wt. (kg)	16.72	12.46
Line 2	Birth wt. (kg)	2.54 (33)	2.63 (47)
	Wean wt. (kg)	9.00	9.33
	12 mo. wt. (kg)	16.98	12.71
Line 3	Birth wt. (kg)	2.21 (37)	2.43 (29)
	Wean wt. (kg)	8.10	8.71
	12. mo. wt. (kg)	15.35	11.68

[1]Number in parenthesis represents the number in each group at birth.

Table 2. Representative Weights of Goat Kids at Fazenda Iracema

Breeding		Females[1]	Males
½ Anglo Nubian	Birth wt. (kg)	2.43 (12)	2.99 (9)
½ SRD	Wean wt. (kg)	9.12	9.61
	12 mo. wt. (kg)	13.61	10.91
½ BHUJ	Birth wt. (kg)	2.52 (11)	2.60 (6)
½ SRD	Wean wt. (kg)	8.98	9.71
	12 mo. wt. (kg)	14.02	10.83
½ SRP	Birth wt. (kg)	2.17 (19)	2.30 (8)
½ SRD	Wean wt. (kg)	8.16	8.69
	12 mo. wt. (kg)	12.79	10.43
½ SRD	Birth wt. (kg)	2.19 (20)	2.44 (8)
½ Moxoto	Wean wt. (kg)	7.64	8.54
	12 mo. wt. (kg)	12.43	11.19
½ SRD	Birth wt. (kg)	1.97 (20)	2.37 (12)
½ Marota	Wean wt. (kg)	6.85	7.99
	12 mo. wt. (kg)	11.75	9.96
½ SRD	Birth wt. (kg)	2.24 (16)	2.52 (10)
½ Caninde	Wean wt. (kg)	7.98	9.93
	12 mo. wt. (kg)	12.36	10.90
½ SRD	Birth wt. (kg)	2.01 (15)	2.28 (8)
½ Repartioa	Wean wt. (kg)	6.83	8.45
	12 mo. wt. (kg)	11.05	10.22

[1]Number in parenthesis represents the number in each group at birth.

Table 3. Growth Rate of Lambs in 10 Flocks in Various Regions of the State of Ceara.

		112 day weights in Kg			
Municipality	Farm No.	Single Males	Twin Males	Single Females	Twin Females
Morada Nova	01	16.99 (n=14)	13.41 (n=2)	15.00 (n=7)	13.41 (n=2)
	02	20.46 (n=19)	15.31 (n=16)	19.44 (n=25)	15.16 (n=23)
Quixada	03	22.14 (n=17)	16.91 (n=7)	17.67 (n=9)	15.67 (n=14)
	04	26.51 (n=13)	19.69 (n=6)	24.12 (n=14)	23.17 (n=25)
Crateus	05	18.47 (n=21)	14.45 (n=3)	17.18 (n=14)	13.58 (n=5)
	06	30.54 (n=19)	23.85 (n=20)	26.33 (n=20)	22.28 (n=12)
Quixeramobim	07	26.84 (n=22)	20.88 (n=10)	24.88 (n=20)	20.95 (n=7)
Sobral	08	14.17 (n=17)	9.00 (n=1)	12.89 (n=14)	9.30 (n=3)
Independencia	09	18.23 (n=18)	15.88 (n=10)	19.92 (n=17)	13.50 (n=7)
	10	25.40 (n=19)	18.10 (n=6)	23.23 (n=24)	19.70 (n=9)

Table 4. Milk Production from Three Types of Goats Fed Various Rations

Parameter Measured	Rations with Algaroba		Rations with Corn	
	Cottonseed Meal 1 %	Urea 2 %	Cottonseed Meal 1 %	Urea 2 %
	(n=12)	(n=12)	(n=12)	(n=12)
Anglo Nubian				
Milk Production, kg	0.93	0.76	0.76	0.85
Ration Consumed, kg	2.41	1.99	2.08	1.74
Feed Efficiency	2.59	2.62	2.74	2.05
Sem Raca Definida (SRD)				
Milk Production, kg	0.69	0.60	0.53	0.56
Ration Consumed, kg	1.65	1.27	1.37	1.00
Feed Efficiency	2.39	2.12	2.58	1.79
Parda Alema				
Milk Production, kg	1.71	1.36	1.92	1.80
Ration Consumed, kg	2.13	2.53	2.43	2.28
Feed Efficiency	1.25	1.86	1.27	1.27

1. Project Title: Breeding and Management of Sheep and Goats to Maximize Meat and Milk Production in Arid and Tropical Environments.

2. Institution: Texas A & M University
Texas Agricultural Experiment Station

3. Principal Investigator: Maurice Shelton

4. Funds Allocated From:

Grant No. AID/DSAN/XII-G-0049 from 1983/84 Subgrant: $200,000.
Matching Contribution from 1983/84 Subgrant: $66,667.

5. Brief Statement of Project Goals:

The overall goals of the SR-CRSP-related activities are to generate new information and perhaps superior breeding stock which can make a contribution to sheep and goat production in the US and the international community. A second and closely related goal would be to provide training and international experience to students and staff in order to place them in a position to make a contribution to small ruminant production in the US and in developing countries. These overall goals require on-going programs in training and data collection which cannot be easily broken up into discrete annual increments.

6. Statement of Specific Objectives for 1983/84:

One objective for 1983/84 calls for the continuation of programs as outlined above. Included in this is a program of data collection on breeding flocks of hair sheep and meat type goats. These were not expected to reach a definitive end point during the period of time covered by this report. Another objective called for summarization and reporting, or publication, of work completed to date. Specific studies have related to evaluating potential means of selecting for a higher reproductive rate based on measurements which might be taken on the young growing male. Work continued during the year relating to diet selectivity of sheep and goats and how this related to the tannin acid content. Plans also called for summarizing a number of studies relating to meat production and carcass values.

7. Description of Work Undertaken:

The nature of the work undertaken can be ascertained from a review of sections 5, 6, and 8 of this report.

8. Technical Accomplishments:

The technical accomplishments are too numerous and varied to detail in this report. The nature and details of the studies completed during this time period are shown in the attached list of reports. A few of these will be highlighted in this section.

Early weaning or limited suckling of kid goats has been shown to reduce the post-partum anestrus for does kidding in the fall, but not for those kidding in the spring. Analyses of a series of studies concerned with meat qualities of hair sheep and goats indicate that the carcass is the primary product realized at slaughter, and that yield as well as quality traits should be considered even in developing countries, especially where marketing to larger population centers or institutional markets is being considered. These studies also indicate quality problems with goat meat that may be important in commercialization of this product. There is a tendency for people who consume goat meat to expect it to be cheaper.

Studies completed during the year have shown within-species and within-breed variation in foraging behavior. The within-species variation appears sufficiently important that this should be considered in transferring breeds from one resource area to another. However, information available to date is not sufficient to suggest within-breed selection programs designed to alter diet selectivity. Attempts to devise a means to select for increased fecundity based on measures which could be taken in the young male have been unsuccessful. In the absence of more detailed information, the best way to select for increased reproductive rate would be to select for small lambs or kids at weaning which could scarcely be recommended. The corollary of this is that selection of large lambs or kids at weaning is a way to select for single bearing ewes, which unfortunately has been practiced in many areas. Based on data collected to date in the US, hair sheep or meat goats have not been shown to be more productive or more profitable than traditional finewool sheep. Thus, recommendations to use the former should be based on their utilization in resources where more traditional types are not well adapted.

9. Personnel Collaborating on Project Activities:

Professors:

Dr. J.O. Sanders
Dr. D.N. Ueckert

Research Associates:

Lee Warren (part of year)

Technicians:

Tim Willingham (part of year)
Ron Lewis (part of year)

Graduate students completing thesis during period:

Janet Lee Lawson
John M. Campbell

Training

Two students completed MS degrees with thesis work contributing to SR-CRSP goals and interests. Titles of these theses are shown in the publication list. The writer (M. Shelton) is presently serving as chairman or committee member for 8 graduate students doing thesis projects with sheed to date in the U.S., hair sheep or meat goats have not been shown to be more productive or more profitable than traditional finewool sheep. Thus, recommendations to use the former should be based on their utilization in resources where more traditional types are not well adapted.

9. Personnel Collaborating on Project Activities (in the US):

Professors:
Dr. J.O. Sanders
Dr. D.N. Ueckert

Research Associates:
Lee Warren (part of year)

Technicians:
Tim Willingham (part of year)
Ron Lewis (part of year)

Graduate students completing thesis during period:
Janet Lee Lawson
John M. Campbell

Training

Two students completed MS degrees with thesis work contributing to SR-CRSP goals and interests. Titles of these theses are shown in the publication list. The writer (M. Shelton) is presently serving as chairman or committee member for eight graduate students doing thesis projects with sheep or goats and which relate in various degrees to SR-CRSP interests. Included in this number are two students from Brazil.

The writer is currently involved in a post doctoral program for one Scientist from an LDC country. He has also presented papers at numerous symposia and field day programs during the past year, the number of which are too numerous to attempt a listing. In addition to the writer, Dr. J. O. Sanders is working with graduate students involved in SR-CRSP efforts.

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. The following sums have been received by 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
Total	$19,662,043

The University has distributed these funds under the direction of the Board of Institutional Representatives (BIR) in the manner outlined in Table 1.

Future Funding by AID

At the time of writing, it is understood that USAID intends to fund SR-CRSP for a further three years under a new grant of $12,000,000 through September 30, 1987.

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 well over $300,000.

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 the Moroccan side estimated at over $150,000.

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 provided 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 well over $200,000 over two years.

In Kenya, ILCA provided $5,000 for joint work with the production systems project.

In Morocco, funds that were previously awarded by the Near East Bureau were finally transferred into the sixth operational year budget ($85,000).

In Brazil, 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.

Management Entity Expenses

The Management Entity has closed its ledgers on the first five fiscal years. 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 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, 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 1983/84 indicates that a total of some $6,997,134 was expended, the source of funds being:

USAID	$4,085,000 or 58%
US Institutions	$1,377,134 or 20%
Overseas Institutions	$1,100,000 or 16%
External Grants	$ 435,000 or 6%

TABLE 1. THE SR-CRSP PROGRAM BUDGET

Institution	Discipline	BOARD Approved Year One 10/78-5/80	BOARD Approved Year Two 6/80-10/81	BOARD Approved Year Three 10/81-9/82	BOARD Approved Year Four 10/82-9/83	BOARD Approved Year Five 10/83-9/84
California	Breeding	206,786	266,666	185,104	220,000	200,000
California	Health	196,145	233,333	175,000	190,000	175,000
Cal Poly	Physiology	60,000	100,000	97,761	---	---
Colorado	Health	150,000	233,333	175,000	190,000	175,000
Missouri	Sociology	174,992	253,333	200,000	275,000	225,000
Montana	Breeding	200,000	200,000	149,999	165,000	150,000
N. Carolina	Nutrition	109,435	266,666	200,000	295,000	250,000
Ohio State	Forages	166,016	233,000	150,000	---	---
Texas A&M	Breeding	160,000	212,800	150,000	240,000	200,000*
Texas A&M	Systems	184,000	253,333	200,000	240,000	150,000*
Texas Tech	Range	200,000	266,666	200,000	295,000	250,000
Tuskegee	Management	104,000	153,000	115,000	---	---
Utah State	Range	196,081	266,666	200,000	295,000	200,000
Utah State	Physiology	99,800	160,599	124,000	220,000	200,000
Washington	Health	200,000	233,333	175,000	190,000	175,000
Winrock	Economics	175,000	265,333	200,000	220,000	153,000
Winrock	Management	100,000	153,333	215,000	240,000	200,000
PROGRAM SUBTOTALS		2,682,255	3,751,394	2,911,864	3,275,000	2,703,000
Management Entity		516,691	468,154	515,429	435,000	435,000
Prolific Sheep Proposal		---	---	---	100,000	---
Morocco Program Development		---	50,000	100,000	---	---
Exchanges between LDCs		---	---	---	100,000	100,000
General Contingency Funds		---	200,000	200,000	240,187	522,000
Site Development		196,000	---	---	---	---
Overseas Sites		---	---	---	---	325,000
GRAND TOTAL		3,394,946	4,469,548	3,727,293	4,150,187	4,085,000
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*

Institution	Discipline	Inception to May 1980	June 1980 to Sept 1981	Oct 1981 to Sept 1982	Oct 1982 to Sept 1983	Oct 1983 to Sept 1984
California	Breeding	$ 35,828	$ 108,827	$ 129,073	$ 97,997	$ 90,164
California	Health	87,872	88,160	62,871	63,552	59,228
Cal Poly	Physiology	105,408	110,709	74,770	---	---
Colorado	Health	47,897	101,500	58,333	72,561	60,335
Missouri	Sociology	65,183	81,316	86,268	94,331	90,666
Montana	Breeding	120,663	171,305	206,622	277,747	59,767
N. Carolina	Nutrition	46,353	93,881	85,564	98,406	91,926
Ohio State	Forages	95,231	190,419	114,226	---	---
Texas A&M	Breeding	44,021	70,465	45,711	60,506	66,669
Texas A&M	Systems	62,234	110,877	52,957	32,416	123,495
Texas Tech	Range	66,192	63,407	73,416	108,990	123,523
Tuskegee	Management	32,763	41,143	60,247	---	---
Utah State	Range	140,879	175,366	121,986	131,226	100,767
Utah State	Physiology	106,610	112,551	85,549	119,905	268,748
Washington	Health	58,095	73,161	58,042	74,146	69,545
Winrock	Economics	40,214	80,437	85,771	64,505	85,170
Winrock	Management	31,913	65,502	71,178	81,334	118,704
TOTAL		$1,187,358	$1,739,032	$1,472,584	$1,377,622	$1,408,707

*As of 10/9/84

TABLE 3. MANAGEMENT ENTITY EXPENSES

	October 1980 - September 1981 EXPENDED	October 1981 - September 1982 EXPENDED	October 1982 - September 1983 EXPENDED
Salaries	$96,717.26	$118,021.37	$135,861.84
Benefits	34,945.69	40,505.09	48,445.30
Subtotal	$131,662.95	$158,526.46	$184,307.14
Supplies and Expense	35,782.86	42,153.91	41,127.03
Equipment	896.97	0	6,059.74
Travel			
International			
Management Entity	25,110.74	28,725.01	24,859.04
External Evaluation Panel	16,652.21	15,564.57	11,530.61
Board	0	7,427.72	3,777.51
Technical Committee	195.00	0	31,727.09
Subtotal	41,957.95	51,717.30	71,894.25
Domestic			
Management Entity	9,799.39	13,820.29	11,615.34
External Evaluation Panel	5,595.49	12,928.59	9,715.74
Board	18,953.05	13,497.69	9,238.81
Technical Committee	11,358.86	12,235.35	6,823.45
Meeting Rooms	583.82	355.64	232.88
Subtotal	46,290.61	52,837.56	37,626.22
Other		9,165.00	18,876.61
EEP Consulting	16,850.00	29,830.00	23,196.50
Audit	38,500.00	0	5,729.00
Subtotal	55,350.00	38,995.00	47,802.11
Indirect	60,836.78	67,813.37	75,403.07
TOTAL	$372,728.12	$412,043.60	$464,219.56

TABLE 4. SITE COORDINATOR EXPENSES

	Kenya		Peru	Brazil	Indonesia	Morocco	Total
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 /%**	57,900		64,200	54,458	25,583	27,459	229,600
Actual Expenditures	38,830		141,940	72,809	59,257	17,284	330,120
1983/84 Budgeted	54,052		99,600	72,000	60,000	30,000	315,652

* Arrows represent shifts of OSU, CPP, and USU to Brazil and Peru.
**Percent of subgrants.